



1. INTERNATIONAL Warsaw

SCIENTIFIC RESEARCH AND INNOVATION CONGRESS

19-22 June 2025

Warsaw- Poland

CONGRESS BOOK



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CONGRESS ID

CONGRESS TITLE

1. WARSAW SCIENTIFIC RESEARCH AND INNOVATION CONGRESS

DATE AND PLACE

19-22 JUNE 2025 Warsaw/POLAND

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1. INTERNATIONAL WARSAW SCIENTIFIC
RESEARCH AND INNOVATION CONGRESS

19-22 JUNE 2025

WARSAW/POLAND
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CONGRESS PROGRAM

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19.06.2025
THURSDAY/ 10:00-11:00

SESSION-1 HALL-1
MODERATOR: Assoc. Prof. Dr. Özlem KAYA

AUTHORS	AFFILIATION	TOPIC TITLE
Sándor FÖLDVÁRI, Dr.	Debrecen University, Hungary	The Livonian War As A “Clash Of Civilizations” Between The Polish-Lithuanian Commonwealth And The Moscovian Tsardom: Huntington Applied To Early Modern History
Assoc. Prof. Dr. İlker KÖMÜRCÜ	Zonguldak Bülent Ecevit University	The Effect Of Generation Z’s Short Video Culture On Music Consumption And Music Production: The Tiktok Example
Assist. Prof. Dr. Süleyman KARAAHMET	Anadolu University	Separation Of Directorship And Teaching Roles In Stage Study Courses In University Theatre Departments
Assoc. Prof. Dr. Özlem KAYA Rawen GHABRI	Usak University	Circular Design: Rethinking Waste In The Creative Industry
Assoc. Prof. Dr. Özlem KAYA Rawen GHABRI	Usak University	The Relationship Between Fashion Brands And Social Media
ALIYEV ROVSHEN NATIG	Ministry of Science and Education, Republic of Azerbaijan	The Profit That Tourists Bring To The State
Prof. Dr. Mohammed WAHEEB	The Hashemite University, Jordan	Touristic Routes in Site of Jesus Baptism and Future Perspectives- Jordan-South Levant

19.06.2025
THURSDAY/ 10:00-11:00

SESSION-1 HALL-2
MODERATOR: Assoc. Prof. Dr. Funda NALBANTOĞLU YILMAZ

AUTHORS	AFFILIATION	TOPIC TITLE
Assoc. Prof. Dr. Funda NALBANTOĞLU YILMAZ	Nevşehir Hacı Bektaş Veli University	The Effect Of Scoring Key Type On Reliability In Automatic Scoring Of Performance Tasks With Artificial Intelligence
GÜNEL ARZU GIZI SHADLINSKAYA	ADPU-nun Quba filiali	Organization Of Teacher-Student And Student Relationships In The Socialization Of Children In Inclusive Education
Derya BEKİROĞLU Assoc. Prof. Dr. Nur ÜTKÜR GÜLLÜHAN	Istanbul University- Cerrahpaşa	The Impact of Scratch Programming on Preschoolers' English Language Learning: A Quasi-Experimental Approach
Assoc. Prof. Dr. Nur ÜTKÜR GÜLLÜHAN Derya BEKİROĞLU	Istanbul University- Cerrahpaşa	Parental Perceptions of Helicopter Parenting in Early Childhood: A Qualitative Study
Dr. Kazım KANDEMİR	Ministry of National Education, Üsküdar, İstanbul	Conservatism And Religion In The Context Of The Sociology Of Religion
Associate Professor Lale Zahir ALLAHVERDİYEVA	Nakhchivan State University	Competences That Need To Be Formed In Pedagogically Oriented Specialties At The Master's Level
Tahira BAGIROVA	Azerbaijan University of Languages	Kapsayıcı Yeterlilik Ve Kültür: Modern Öğretmenlerin Temel Niteliği
Doctor of Pedagogical Sciences, Professor BAĞIROVA Tamilla Əli qızı	Azerbaijan State Pedagogical University	A Synergetic View Of Creative Thinking

19.06.2025
THURSDAY/ 11:00-13:00

SESSION-2 HALL-3
MODERATOR: Assoc. Prof. Dr. Kübra YAZICI

AUTHORS	AFFILIATION	TOPIC TITLE
Asisst. Prof. Dr. Serkan GÜLDAL	Adiyaman University	Structural, Elastic, And Electronic Properties Of $Y_{1-x}Sr_xTiO_3$ ($x=0.01, 0.10, 0.50, 0.99$) By Means Of Density Functional Theory
Assoc. Prof. Dr. Abdurrahman GÜNDAY Cemal KARAYEL Emre GÜLEÇ	Bursa Uludağ University	Detection Of Thermal Behaviors Of Li – Ion Batteries Used In Electric Vehicles With Fbg Based Quasi Distributed Sensors
Terane SAFAROVA QASIM Qanira ABBASOVA FAİQ	Azerbaijan State University of Economics, Azerbaijan University of Technology	Modern Trends In The Use Of Azerbaijani Ornaments In Knitted Fabrics Structure And The Specifics Of Their Production
Soner ASTAN Assoc. Prof. Dr. Aysun GÜRAN	Doğuş University	Stylometric Insights: BERT vs. N-grams in Authorship Attribution
ASGAROVA N.A. CAFAROVA A.E. OMAROVA A.Sh.	Azerbaijan State Oil and Industry University Public Legal Entity	The Application Of Modern Technologies In Oil And Gas Fields In Azerbaijan And Their Key Role
Onur ÇETİNKAYA Assoc. Prof. Dr. Metin YURDDAŞKAL	Dokuz Eylul University	Rapid Prototyping Of Radar Absorbing Materials With Fused Deposition Modelling
Nsikak AFFIA Ephraim OKAFOR Isdore AKWUKWAEGBU Michael BASSEY	Akwa Ibom State Polytechnic, Federal University of Technology Owerri, Nigeria	Optimization of Power Generation and Storage Systems for Rural Health Centers using HOMER
Ph.D Nazila RAGİMOVA graduate student ALMAMMADOVA Mehriban graduate student KAMENİEVA Nina	Azerbaijan State Oil and Industry University Ukrainian State University of Railway Transport	Research Of Periodic Monitoring Of The Technical Diagnostics Subsystem Of Object Controllers Of Microprocessor Centralization

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SESSION-2 HALL-4
MODERATOR: Prof. Dr. Ahmet Niyazi ÖZKER

AUTHORS	AFFILIATION	TOPIC TITLE
Prof. Dr. Ahmet Niyazi ÖZKER	Bandırma Onyedi Eylül University	Recent Changes In Turkey's Balance Of Current Accounts And Expectations From Balance On Secondary Income
Jalə MİRZƏBƏYOVA	Ministry of Science and Education of the Republic of Azerbaijan	The Impact Of Digitalization On Increasing The Efficiency Of The Human Factor
Assoc. Prof. Dr. İffet KESİMLİ	Kırklareli University	Japanese Sox Versus American Sarbanes-Oxley Act
Res. Asst. Dr. Pınar ÜNAL	Bahçeşehir University	The Relationship Between Corporate Stock Performance And Sustainability Indices: Evidence From Euro Stoxx 50
Res. Asst. Dr. Pınar ÜNAL	Bahçeşehir University	The Effect Of Esg Scores On Firm Value: An Empirical Analysis Of Europe's Largest Companies
Elmira TALİBZADE	Bakü Devlet Üniversitesi	Recalibrating Western European Geopolitical Doctrines In The South Caucasus After 2020: Strategic Ambiguities And Emerging Reconfigurations

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SESSION-2 HALL-5
MODERATOR: Asisst. Prof. Dr. Abdülazim İBRAHİM

AUTHORS	AFFILIATION	TOPIC TITLE
Asisst. Prof. Dr. Abdülazim İBRAHİM	Karabük University	The Role of Constitutional Courts in the Protection of Constitutional Rights: The Case of Turkey and Europe
Asisst. Prof. Dr. Abdülazim İBRAHİM	Karabük University	Extending the Duty of Constitutional Loyalty to Non-Public Officials: A Dangerous Trend?
Farid Shariatzadeh BAMI	Shapurabad Municipality, Isfahan, Iran.	Feasibility of Establishing Integrated Urban Management and its Establishment Requirements in Metropolitan Cities (Case Study: Isfahan)
Mr. Nguyen Hoang PHAT	Thu Dau Mot University, Vietnam	Inheritance Rights In The Caregiving Relationship Between Stepparents And Stepchildren Under The Vietnamese Civil Code
Oral ORPAK	University of Maria Curie-Skłodowska (UMCS), Lublin, Poland	Yezidi Diaspora in Germany: Opportunities, Challenges, and Debates on Official Recognition
MA. KHÁNH LY, Nguyễn Thị	Thu Dau Mot University, Vietnam	Oral Wills Under Current Vietnamese Civil Law
Ms. Tran Thi Thanh HANG Nguyen Thi Khanh LY	Thu Dau Mot University, Vietnam	Filing Of Criminal Charges As Per The Crime Victim's Petitions According To Vietnamese Criminal Procedure Law

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SESSION-2 HALL-6
MODERATOR: Dr. Associate Professor Khayala MAMMADOVA

AUTHORS	AFFILIATION	TOPIC TITLE
Asisst. Prof. Dr. Emine Dilek ÖZYILMAZ	Eastern Mediterranean University, KKTC	Preparation And Characterization Of Microemulsion Formulations
R. VIDHYALAKSHMI Dr. K. RAJAGANAPATHY Dean and Prof. R. SRINIVASAN	Bharath Institute of Higher Education and Research, India	Phytochemical Analysis and Quality Control of Herbal Medicines using Chromatographic and Spectroscopic Techniques
PhD Ayten ASGAROVA Prof. Dr. Khammed ASADOV Prof. Dr. Khalil NAGHIYEV Neyla MAMMADOVA	Baku State University	Integration Of Metacognition In Teaching And Learning Chemistry In Secondary School
Prof. Dr. Muhammad TAYYAB	University of Veterinary and Animal Sciences, Pakistan	Enzymes And Poultry Feed Industry
Kalsoom TARIQ Hashim KHAN Bela INAYAT	Khyber Girls Medical College, Rehman medical college, Pakistan	Effect Of Antenatal Use Of High Energy Nutritional Supplements On Cardio Metabolic Risk Markers In Underweight Primi Gravidas
Dr., Full Prof. Tahira ASKAROVA Dr., Asisst. Prof. Nazanin HASANZADE Dr., Assoc. Prof. Khayala MAMMADOVA	Azerbaijan Medical University	CRISPR and Gene Editing Technologies, Revolutionizing Genomic Medicine
Dr., Asisst. Prof. Samira BAGHIROVA Dr., Assoc. Prof. Khayala MAMMADOVA	Azerbaijan Medical University	Targeting Metabolic Reprogramming in Cancer
HEYBATOVA Milana Faiq gizi	Azerbaijan Medical University	Study Of The Effect Of Repeated Use Of Cyclophosphamide And Doxorubicin On The Concentration Of Sex Hormones In The Blood Of Female White Rats

19.06.2025
THURSDAY/ 11:00-13:00

SESSION-2 HALL-6
MODERATOR: M. Törehan ASLAN, MD, MSc

:

AUTHORS	AFFILIATION	TOPIC TITLE
RZAYEVA Ayten	Azerbaijan Medical University	Peculiarities Of Pregnancy In Patients With Hypertension
HASANOVA Nurlana AMIRASLANOVA Shafa BAYRAMOVA Elnara KARIMOVA Sevinj MAMMADOVA Samira	Azerbaijan Medical University	Urgent Cerclage
M. Törehan ASLAN, MD, MSc	Koç University Hospital	Neonatal Morbidity Profile Of Preterm Infants Born Via In Vitro Fertilization: A Retrospective Comparative Analysis
Muhammad Muddassir ALI Muhammad Usman JAMIL	University of Veterinary and Animal Sciences, Lahore, Pakistan	Biotechnology For Wastewater Treatment: Innovative Approaches And Technologies
ISMAYILOVA Hacer ABDULAZIMOVA Gulchin ALIYEVA Gulnara ABBASOVA Rumiya	Azerbaijan Medical University	Dentine Hypersensitivity
Major Gheorghe GIURGIU Prof dr med Manole COJOCARU	Deniplant-Aide Sante Medical Center, Titu Maiorescu University, Romania	Natural Modulation Of The Gut Microbiota In Patients With Food Allergies. Impact Of Alergiplant
Tamara GULIYEVA	Azerbaijan Medical University	Soft Tissue Sarcomas
Ayşenur GÜNTAÇ Şükriye YEŞİLOT Çiğdem AYDIN ACAR	Burdur Mehmet Akif Ersoy University	The New Generation Therapies: The Role Of Biosimilars And Biologics
Ayşenur GÜNTAÇ Şükriye YEŞİLOT Çiğdem AYDIN ACAR	Burdur Mehmet Akif Ersoy University	Nutrigenomics And Nutrigenetics In Obesity

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SESSION-3 HALL-7
MODERATOR: Assist. Prof. Dr. Muhammed ULUCAN

AUTHORS	AFFILIATION	TOPIC TITLE
Serkan ÜNAL Hakan ÇAĞLAR Assoc. Prof. Dr. Arzu ÇAĞLAR	Kırşehir Ahi Evran University	Usability Of Aerogel And Boron Wastes In Building Material Production: A Compilation
Yasir PAZAR Hakan ÇAĞLAR Assoc. Prof. Dr. Arzu ÇAĞLAR	Kırşehir Ahi Evran University	Academic Perspective On The Use Of Raw Perlite And Aerogel In Lightweight Concrete
Assist. Prof. Dr. Mehdi ÖZTÜRK Merve BOZÜYÜK	İstanbul Arel University	Seismic Performance Evaluation Of Masonry Structures Through Macro Modeling Within The Framework Of Turkish Seismic Codes
Assist. Prof. Dr. Muhammed ULUCAN	Firat University	Prediction Of Compressive Strength Of Concrete Containing Silica Fume Using The Response Surface Method
Melih AKKAYA Assist. Prof. Dr. Mine TUNÇOK SARIBERBEROĞLU	Düzce University, Bolu Abant İzzet Baysal University	A Spatial Perception Analysis Via Syntactic Structures And User-Based Mapping: A Faculty Building Case Study
Subhashish DEY	Gudlavalleru Engineering College, Andhra Pradesh, India	Effect Of Non-Biodegradable Organic Solids In Mixing Water On Cement Mortar
Subhashish DEY	Gudlavalleru Engineering College, Andhra Pradesh, India	Crack Detection On Concrete Structures Using Convolutional Neural Networks Architecture

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THURSDAY/ 12:00-14:00

SESSION-3 HALL-8
MODERATOR: Assoc. Prof. Sylvia STAMOVA, PhD

AUTHORS	AFFILIATION	TOPIC TITLE
Kadriye TOKLU Helin Ezo ARSLAN Asiye Esra EREN EROĞLU İhsan YAŞA	Ege University	Synergistic Effects of Iron Chelators and Antibiotic Combinations in the Control of <i>Vibrio anguillarum</i> and <i>Vibrio harveyi</i>
Gülperi BULUT Elif Zeynep KOCAOĞLU Asiye Esra EREN EROĞLU İhsan YAŞA	Ege University	Inhibition Of Escape Pathogene <i>P. Aeruginosa</i> With Quorum Quenching Approach
Zeynep ÖZTEKİN Res. Asst. Dr. Fatma SAĞIR	Istanbul Medeniyet University	Identification And Functional Annotation Of Differentially Expressed Micro RNA's In Multiple Sclerosis: A Bioinformatics Analysis Based On GSE21942 Dataset
Neli ERMENLIEVA Assoc. Prof. Sylvia STAMOVA PhD Gabriela TSANKOVA Sevginar IBRYAMOVA Rozalina BRAYKOVA Gergana NEDELICHEVA Emilia GEORGIEVA	Medical University of Varna, Bulgaria Konstantin Preslavsky University of Shumen	Evaluating Caraway Essential Oil As A Natural Antimicrobial In Low-Sodium Cheese Brine
Assoc. Prof. Sylvia STAMOVA, PhD Neli ERMENLIEVA Gabriela TSANKOVA Nadezhda IVANOVA Emilia GEORGIEVA	Medical University of Varna, Bulgaria	Assessment Of The Antimicrobial Interaction Between Lavender Essential Oil And A Simple Quaternary Compound Against Clinical Microorganisms
Murtala SAADU Shamsudeen Muhammad MUHAMMAD Isah MUSA	Kebbi State University of Science and Technology Aliero Nigeria,	Medicinal Plants As Antibacterial Agents: Exploring Natural Therapy In The Era Of Antibiotic Resistance
Assist. Prof. Dr. Ali IKRAM Sidra BASHARAT Muhammad Tayyab ARSHAD	The University of Lahore, Lahore institute of science and technology, Pakistan	Utilization of Brown Rice and Eggshell Powder to Improve the Nutritional and Sensorial Properties of Cupcakes
Research Scholar, Saloni SHARMA MSc. Clinical Research Student, Suhani SHARMA	Manav Rachna International Institute of Research Studies, Jamia Hamdard University, India	CRISPR and Genetic Therapies: A Future Cure for Celiac Disease?

19.06.2025
THURSDAY/ 12:00-14:00

SESSION-3 HALL-9
MODERATOR: Asisst. Prof. Dr. Gaye BULUT

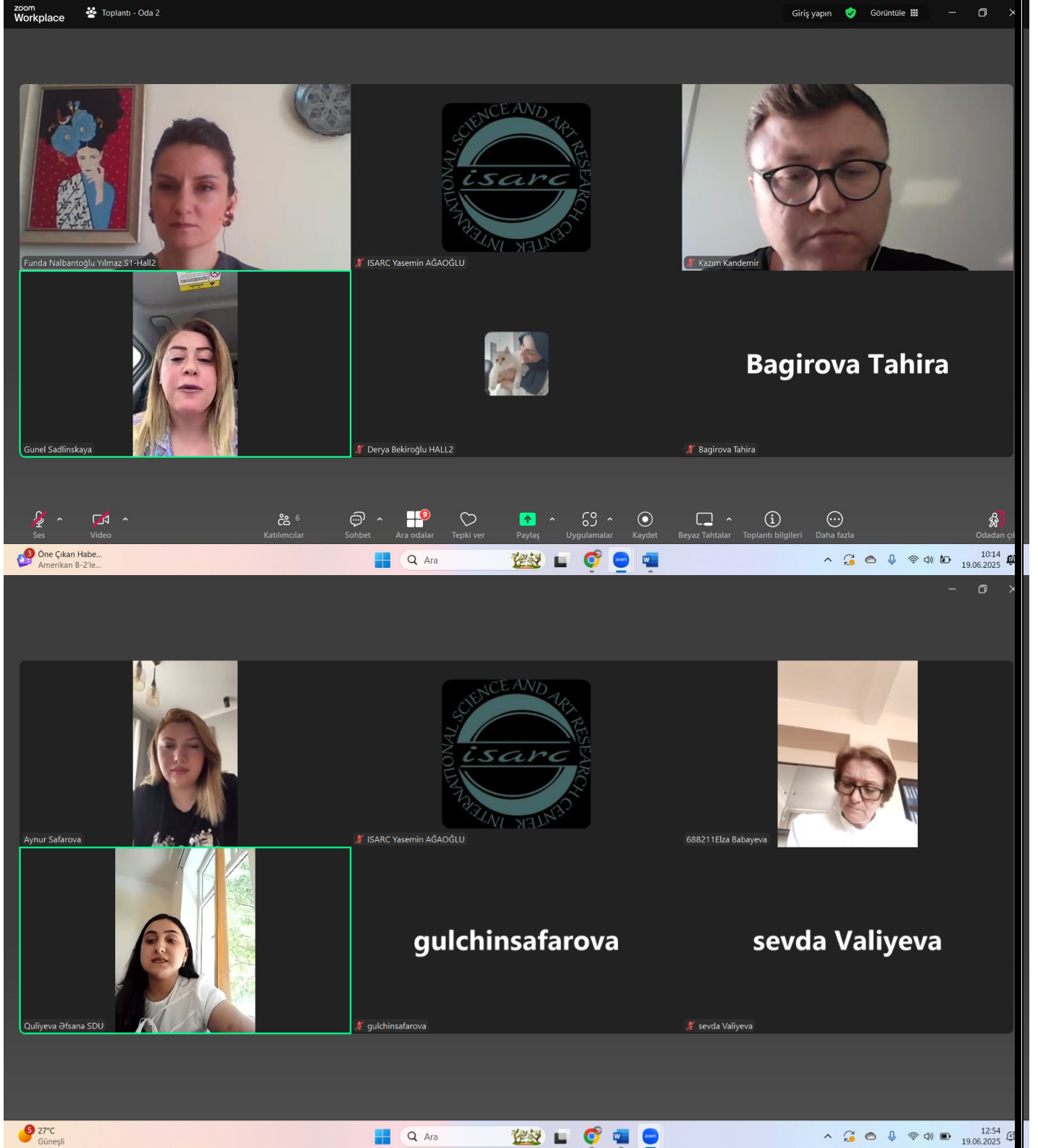
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Emir ÜŞENMEZSOYLU Assoc. Prof. Dr. Fatma HEPSAĞ	Osmaniye Korkut Ata University	Climate Change And Food Security Relationship
İlhan Berat AŞIK Assoc. Prof. Dr. Fatma HEPSAĞ	Osmaniye Korkut Ata University	Obtaining Animal Milk Powder From Whey And Casein Produced From Artificial Sources
HÜSEYNOV Həsənsadiq Elçin (Doktorant)	Azerbaijan State University	Comparative Study of Water Quality Parameters of Different Brands of Soft Drinks
HÜSEYNOV Həsənsadiq Elçin (Doktorant)	Azerbaijan State University	The Role Of Water In Food Products
MAMMADOVA Ulkar	Azerbaijan University of Cooperation	Conceptual Issues In Facilitating Access To Finance For Agricultural Producers
Resc. Assist. Enes ÇERÇİ Asisst. Prof. Dr. Gaye BULUT	Aksaray University	Should A Healthy Uterus Be Expected In Every Healthy Animal?
Resc. Assist. Enes ÇERÇİ Asisst. Prof. Dr. Gaye BULUT	Aksaray University	Cause Of Dystocia In A Malakh Bitch: Adenocarcinoma
Ahmet Murat SAYTEKİN Muhammed Yaşar DÖRTBUDAK Akın YİĞİN Emine ATÇI SAYTEKİN Mehmet DEMİRCİ	Harran University, Kırklareli University,	Isolation Of <i>Aeromonas Bestiarum</i> In Rainbow Trout (<i>Oncorhynchus Mykiss</i>) And Determination Of Antibacterial Resistance Profile

19.06.2025
THURSDAY/ 12:00-14:00

SESSION-3 HALL-10
MODERATOR: Assoc. Prof. Dr. Dilshoda MUBARAKOVA

AUTHORS	AFFILIATION	TOPIC TITLE
Aynur SAFAROVA	Məhəmməd Füzuli adına Əlyazmalar İnstitutunun mütəxəssisi	Heydar Aliyev's Role In The Protection And Promotion Of Azerbaijan Literature
Gulchin Safarova Elchin	Baku Slavic University	Neurodidactic Approaches To Teaching German As A Foreign Language: Enhancing Language Acquisition Through Brain-Based Methods
VƏLİYEVA SEVDA ƏKRƏM	Odlar Yurdu Universiteti, Bakı, Azərbaycan	Post-Müharibə Ədəbiyyatında Travmatik Yaddaş Və Onun Poetik Rekonstruksiyası
Afsana GULİYEVA	Sumgait State University, Sumgait, Azerbaijan	The Implementation Of Developmental Teaching Methods In The Instruction Of Texts In Azerbaijani Language Classes
Fidan Faiq qızı Əli-zadə	Odlar Yurdu Universiteti, Bakı, Azərbaycan	Neurosistemlərdə Musiqi və Dilin Koqnitiv Uyğunluğu: Azərbaycan Modelləri əsasında
Elza Babayeva Ənvər qızı	ADPU Quba	Azərbaycan-Polşa Ədəbi Əlaqələri: Adam Mitskeviç və Şərq
Assoc. Prof. Dr. Dilshoda MUBARAKOVA	Tashkent Devlet Gazetecilik ve İletişim Üniversitesi, Özbekistan	Çok Dillilik ve Tercüme
Vahyala Adamu Tari, PhD Gwaison Panan Danladi PhD	Nigeria Police Academy, Wudil-Kano	Character and Operational Strategy of the Yan Shila Boys Extremists Group in Yola-North Metropolis, Adamawa State, Nigeria

PHOTO GALERY



zoom
Workplace
Toplantı
Hall-7 Doç. Dr. Arzu ÇAĞLAR adlı
Giriş yapın
Görüntüle
Toplantı güvenliği

1. International Warsaw Scientific Research and Innovation Congress (19-22 June, 2025)

22
3.5. Aerojel ve Bor Atıklarının Diğer Yapı Malzemesi Üretiminde Kullanımı

Christogerou vd. (2009) seramik üretimi için kullanılan kile %0, %5 ve %15 oranında bor atığı ekleyerek seramik hamuru oluşturmuşlardır. Oluşturduğu bu hamuru 800 °C, 850 °C, 900 °C, 950 °C gibi farklı sıcaklıklarda pişirmişlerdir. Numuneler üzerinde uyguladıkları testler sonucuna göre, seramik için en uygun sonuçların %5 oranında bor atığının 900 °C pişirmesiyle elde edilebileceğini tespit etmiştir.

Erdogan (2016) yılında yapmış olduğu çalışmada, halı atıklarının ham kolemanite atığı ve kolemanite gölet atığı katkı solüsyon ile karıştırarak izolasyon malzemesi üretimi yapmıştır. Seri üretim için gerekli ortalama karışım oranlarını belirledikten sonra yaptığı deneylerle türünün fiziksel özelliklerini araştırmıştır. Ürettiği numunelerin piyasadaki ürünler ile fiziksel özelliklerinin karşılaştırmasını yapmıştır. Sonuç olarak, yapılar da sorunsuz bir şekilde kullanılabilecek yüksek ısı ve ses yalıtım özelliği taşıyan bir yalıtım malzemesi üretmişlerdir.

Serkan ÜNAL, Hakan ÇAĞLAR, Arzu ÇAĞLAR

Hall-7 Muhammed ULUCAN
ISARC Yasemin AGAOGLU
Merve688211
Hall-7 Doç. Dr. Arzu ÇAĞLAR
Doç Dr Arzu cag...
Doç Dr Arzu caglar.
Melih AKKAYA

Ses
Video
Katılımcılar
Sohbet
Tepki ver
Paylaş
Uygulamalar
Kaydet
Beyaz Tahtalar
Toplantı bilgileri
Daha fazla
Odadan çı

27°C
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Ara
12:33
19.06.2025

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Hall-4 Ahmet Niyazi Özker adlı k
Giriş yapın
Kayıt
Görüntüle

COMPLEMENTARY EFFECTS OF SPANISH FISCAL MONETARY POLICY AND CHALLENGES IN THE PROTECTION OF POLICE - Case 12.001 - PowerPoint

The main purpose of the study is to determine the place of the secondary income items (especially workers' remittances, donations, unrequited transfers and social aids) that directly or indirectly affect the formation of the current account deficit in the Turkish economy, to analyse the contribution levels of these items to the current account balance and to reveal the recent developments in this area.

As is known, the current account deficit is one of the macroeconomic indicators that are of critical importance in terms of sustainability in a country's foreign economic relations, and in the case of Türkiye, this deficit takes place in the process by gaining concrete form in the form of an imbalance that increases the need for external financing and creates the need for external borrowing. The item in question includes elements that provide direct external resource inflows, such as workers' remittances abroad, social aid, donations, and grants.

In particular, the fact that these transfers are "unrequited", that is, they occur without being dependent on any exchange of goods or services, creates a positive effect in terms of the current account balance. The approaches regarding the secondary income balance, which have a significant impact on reducing Türkiye's current account deficit, reveal that the changes experienced in this area over the recent period have made substantial contributions to the current account balance. The current account accounts in 2021 and beyond, the increase in donations, social aid, and remittances from abroad created a dynamic that strengthened Türkiye's foreign exchange reserves and diversified the resources available to the current account deficit.

Ifet Kesimli S2 H4
ISARC Yasemin AGAOGLU
pinarunal
Hall-4 Ahmet Niyazi Özker

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Kaydet
Beyaz Tahtalar
Toplantı bilgileri
Daha fazla
Odadan çı

26°C
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11:07
19.06.2025

zoom Workplace Toplantı İker Komurcu adlı kişinin ekranı Giriş yapın Görüntüle

MUSIC ON TIKTOK

1. Study on TikTok Music Trends

2. Experimentation with TikTok Music

3. Recommendation and Analysis

Doç. Dr. Özlem KAYA (Ses. 1 - Hall 1)

ISARC Yasemin AGAOĞLU

Session 1 HALL1

Süleyman Karaahmet

İker Komurcu

Rovshen Aliyev

MICHAEL BASSE...

MICHAEL BASSEY -SESSION 1 Hall 1

Hall-3 Sándor Földvári

Ses Video Katılımcılar Sohbet Ara odalar Tepki ver Paylaş Uygulamalar Kaydet Beyaz Tahtalar Toplantı bilgileri Daha fazla Odadan çı

26°C Güneşli Ara 11:04 19.06.2025

zoom Workplace Toplantı Serkan Güldal, Adıyaman adlı kişi Giriş yapın Görüntüle

RESEARCH METHODOLOGY

1 DFT Calculations

The study utilized the CASTEP code with ultrasoft pseudopotentials for DFT calculations. The GGA-PBE was used to solve the Kohn-Sham equations.

2 Geometry Optimization

Initial geometry optimizations were performed using the GGA-PBE functional with a $6 \times 6 \times 6$ Monkhorst-Pack k-point mesh. The cutoff energy was set at 630 eV based on pseudopotentials and finite basis set correction.

3 Structural Relaxation

Complete structural relaxations were achieved using the Broyden-Fletcher-Goldfarb-Shanno (BFGS) minimization method with energy convergence tolerance set at 5.0×10^{-6} eV/atom.

4 Doping Method

Virtual Crystal Approximation is used.

5 Elastic Properties

Elastic constants were determined using the finite strain theory. Young, bulk, and shear modulus are evaluated.

3

Onur Çetinkaya

ISARC Yasemin AGAOĞLU

Omarova Aytan

Hall-1 Mehriban Almammadova

Soner Aştan

Serkan Güldal, Adıyaman

Meriyan Sasmaz

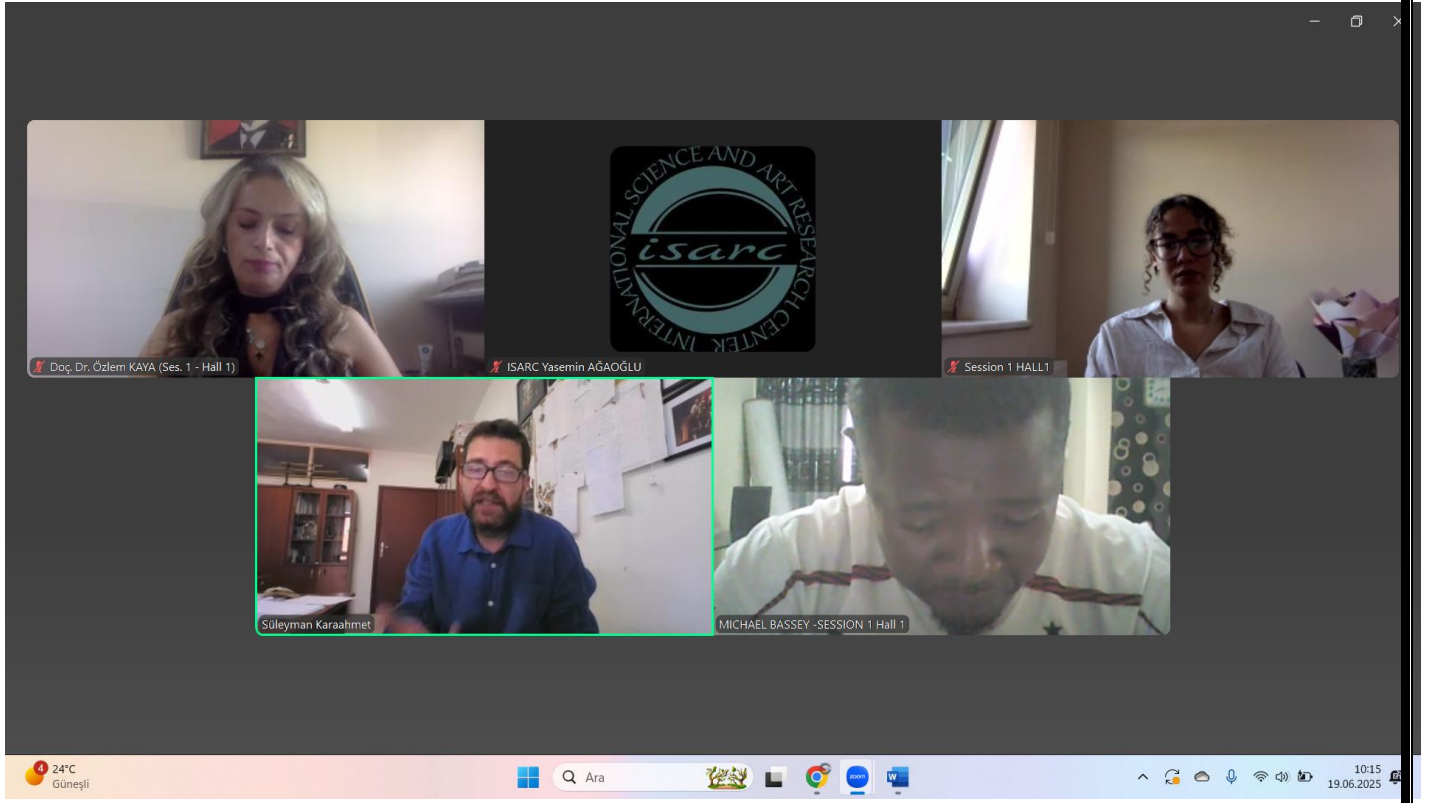
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26°C Güneşli Ara 11:05 19.06.2025



INTERNATIONAL SCIENCE AND ART RESEARCH CENTER

REF: AKADEMİK TEŞVİK

10.07.2025

İLGİLİ MAKAMA

1. ULUSLARARASI VARŞOVA BİLİMSEL ARAŞTIRMALAR VE İNOVASYON KONGRESİ 19-22 HAZİRAN 2025 tarihleri arasında **Varşova/POLONYA** 'da ve online olarak **17** farklı ülkeden (Türkiye:**33** ve diğer Ülkeler:**50**; Toplam:83) akademisyen/araştırmacıların katılımı ile gerçekleşmiştir. Kongre, 16 Ocak 2020 Akademik Teşvik Ödeneği Yönetmeliğine getirilen ‘ Tebliğlerin sunulduğu yurt içinde veya yurtdışındaki etkinliğin uluslararası olarak nitelendirilebilmesi için Türkiye dışından en az 5 ülkeden farklı tebliğ sunan konuşmacının katılım sağlaması ve tebliğlerin yarıdan fazlasının Türkiye dışından katılımcılar tarafından sunulması esastır. ‘ değişikliğine uygun düzenlenmiştir. Bilgilerinize arz edilir. Saygılarımla


Sefa Salih BİLDİRİCİ
HEAD OF İSARC

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POLONYA-LITVANYA TOPLULUĞU İLE MOSKOVA ÇARLIĞI ARASINDA BİR "MEDENİYETLER ÇATIŞMASI" OLARAK LIVONYA SAVAŞI: HUNTINGTON ERKEN MODERN TARİHE BAŞVURDU

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ÖZET

Samuel Huntington'un "Medeniyetler Çatışması" hakkındaki ünlü teorisi 20. yüzyılın sonlarında ortaya çıktı. Burada, Livonya Savaşı'nın Huntington teorisi açısından bir "Medeniyetler Çatışması" olup olmadığını araştırıyoruz. Livonya Savaşı 1558-1583 yılları arasında gerçekleşti. Livonya Savaşı'nın nedenleri için, Livonia ve Baltık kıyılarındaki şehirler de dahil olmak üzere Alman Hansa Birliği'nin, onlar için tehlikeli olduğu için Muscovy ile ticari bağlarını korumayı reddettiği düşünülmelidir. Bundan önce, Batı Avrupalı zengin Hansa kasabalarının Novgorod Cumhuriyeti ile üretken ticari temasları vardı, ancak despotik Muscovy ile temas kurmayı reddettiler. Buna karşılık, Korkunç İvan Livonia'ya saldırdı ve onu yok etti. Moskova birliklerinin vahşeti Batı Avrupa'da tasvir edildi ve kadınların ve çocukların Muskovyalı askerler tarafından nasıl işkence gördüğünü gösterdi ("Zeyttung", Nürnberg, 1561). O zamanlar zaten bir savaş kültürünün ortaya çıktığı Batı ve Kuzey-Orta Avrupa'da meydana gelen savaşlardan farklıydı. Moskova Çarının niyetleri ekonomik değil emperyalistti.

Anahtar kelimeler: Baltık, Ruslar, Livonya, Ivan_Korkunç, Novgorod

THE LIVONIAN WAR AS A "CLASH OF CIVILIZATIONS" BETWEEN THE POLISH-LITHUANIAN COMMONWEALTH AND THE MOSCOVIAN TSARDOM: HUNTINGTON APPLIED TO EARLY MODERN HISTORY

ABSTRACT

Samuel Huntington's famous theory about the "Clash of Civilisations" appeared in the late 20th century, and became a subject of long discussions. However, those who participated in these discourses focused on the current problems of our time and the possible future of our civilisations. Although any theory on the historical development may be verified if it is investigated whether that theory describes the movement of History through centuries, thus, in the past. We here do this: we focus on a case of confrontation of civilisations in the Early Modern Age in Eastern Europe, and our thesis is to demonstrate is the Livonian War was a "Clash of Civilisations" in the aspect of Huntington's theory.

The Livonian War took place btw. 1558-1583. Although it was once viewed as an attempt by the Russian Tsar to gain access to the seaports, it was only one side of the coin, but there was more to it. In our view, the economic-political conflict with the Hansa must be considered, too. For the causes of the Livonian War, it must be considered, that the German Hanseatic League, including cities in Livonia and along the Baltic terrains -such as Riga, Tartu (Dorpat), Tallinn (Revel), Klaipeda (Memel), and others, too- refused to keep commercial ties with Muscovy because it was dangerous for them. Before that, the West European rich Hansa towns had prolific trade contacts with the Republic of Novgorod, but they refused to maintain contact with the despotic Muscovy. (Angermann&Friedland, 2002; Mühle, 1991)

Novgorod used to be a republic, a city-state, run by the Council of rich merchants (the “Veče”, cf. Birnbaum, 1981; Halperin, 1999). In response, Ivan the Terrible attacked Livonia and destroyed it. The brutality of Muscovian troops was depicted in Western Europe, showing how women and children were tortured by Muscovian soldiers (Zeyttung, Nuremberg, 1561). It was different from the wars that took place in Western and North-Central Europe, where a culture of war had already arisen at that time. Ivan the Terrible, the cruel Tsar of Muscovy, destroyed the democratic Republic of Novgorod in the massacre of Novgorod in 1570, in the middle of the time of the Livonian War. Therefore, the intentions of the Moscovian Tsar were not economic but imperial.

Abbreviations of References are given in the two previous studies of the author raising these problems: Földvári (2023) “Martin Berzeviczy, Diplomat...” = <https://www.academia.edu/98803918/> and: Földvári (2023a) “Russian Imperialism in Historical...” = <https://www.academia.edu/109206804/>

Keywords: Baltic, Russians, Livonia, Ivan_The_Terrible, Novgorod

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Z KUŞAĞININ KISA VIDEO KÜLTÜRÜNÜN MÜZİK TÜKETİMİ VE MÜZİK ÜRETİMİNE ETKİSİ: TIKTOK ÖRNEĞİ

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ÖZET

Dijitalleşmenin hız kazandığı günümüzde, TikTok gibi sosyal medya platformları, özellikle Z Kuşağı'nın müzik tüketim ve üretim alışkanlıklarını derinden etkilemektedir. Bu çalışma, TikTok'un müzik endüstrisi üzerindeki dönüştürücü rolünü ve Z Kuşağı'nın bu platformla etkileşimini literatür taraması yöntemiyle incelemektedir. Araştırma kapsamında, TikTok'un kısa formlu video formatı, algoritmik keşif mekanizmaları ve kullanıcı tarafından oluşturulan içeriklerin (UGC) müzik tüketimini nasıl şekillendirdiği analiz edilmiştir. Bulgular, TikTok'un müzik keşfinde birincil bir platform haline geldiğini ve kullanıcıların %78'inin yeni müzikleri ilk kez burada keşfettiğini göstermektedir. Platform, viral şarkıların popülerlik kazanmasını sağlayarak Billboard gibi geleneksel listeleri etkilemekte ve sanatçılar için eşit görünürlük fırsatları sunmaktadır. Ancak, kısa süreli ve yüzeysel etkileşimler, müziğin derinlemesine tüketimini sınırlandırmaktadır. Ayrıca, TikTok'un sanatçıları viral trendlere uyum sağlamaya zorlaması, sanatsal özgünlük ve uzun vadeli kariyer sürdürülebilirliği açısından tartışma konusu olmaktadır. Bu çalışma, TikTok'un müzik endüstrisindeki rolünü anlamak için gelecekte yapılacak araştırmalara yönelik öneriler sunmakta, platformun kültürel, psikolojik ve ekonomik etkilerinin daha kapsamlı incelenmesi gerektiğini vurgulamaktadır.

Anahtar Kelimeler: TikTok, Z Kuşağı, müzik tüketimi, viral müzik, algoritmik keşif, kullanıcı tarafından oluşturulan içerik (UGC)

THE EFFECT OF GENERATION Z'S SHORT VIDEO CULTURE ON MUSIC CONSUMPTION AND MUSIC PRODUCTION: THE TIKTOK EXAMPLE

ABSTRACT

In an era where digitalization is rapidly advancing, social media platforms such as TikTok profoundly influence the music consumption and production habits of Generation Z. This study examines TikTok's transformative role in the music industry and Generation Z's interaction with the platform through a literature review methodology. The research analyzes how TikTok's short-form video format, algorithmic discovery mechanisms, and user-generated content (UGC) shape music consumption patterns. Findings indicate that TikTok has become a primary platform for music discovery, with 78% of users reporting that they first encounter new music there. The platform facilitates the rise of viral songs, impacting traditional charts like Billboard and offering artists equal visibility opportunities. However, the brief and superficial nature of interactions limits in-depth music engagement. Additionally, TikTok's pressure on artists to conform to viral trends raises concerns regarding artistic originality and the long-term sustainability of careers. This study emphasizes the need for further research to comprehensively explore TikTok's cultural, psychological, and economic effects, providing recommendations for future investigations into the platform's role within the music industry.

Keywords: TikTok, Gen Z, music consumption, viral music, algorithmic discovery, user-generated content (UGC)

ÜNİVERSİTELERİN TİYATRO BÖLÜMLERİNDE YER ALAN SAHNE ÇALIŞMASI DERSLERİNDE YÖNETMENLİK ve EĞİTİCİLİK ROLLERİNİN AYRIŞTIRILMASI

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ÖZET

Tiyatro sanatında, hem uygulayıcının hem de alıcının aynı zaman diliminde ve aynı mekanda biraraya gelme gerekliliği, bu sanatı, canlı icrayı zorunlu kılan bir uygulama alanı konumuna getirmektedir. Doğaçlama, İnteraktif Tiyatro vb. deneysel çalışmalar dışındaki klasik-dramatik türdeki uygulamalar için bir ön çalışmaya ihtiyaç duyulmaktadır. Bu da hazırlık ve gösterim aşamalarını beraberinde getirmektedir. Gösterim, seyirciyle buluşma anını ifade etmekle birlikte, o an içerisinde kesintisiz, tekrara kapalı ve tamamen canlı bir performansı içermektedir. Hazırlık aşaması ise tam tersi, seyircinin sürece dahil edilmediği, parçalı ve tekrara dayalı ve de nispeten daha uzun bir çalışma dönemini kapsamaktadır. Tiyatro oyununun gösterime hazır hale gelmesi sürecini içeren hazırlık, yani prova kısmı, dekor, kostüm vb. bir çok tasarımın bir araya getirildiği bir aşamadır. En önemli parçasını ise oyuncuların hazırlık süreçleri oluşturmaktadır. Oyuncuların doğru yönlendirilmeleri dahil tüm süreci kontrol eden, tasarımcıları ortak bir amaç ve ortak bir sahne dilinde buluşturan ve de karar aşamasında son sözü söyleyen ana tasarımcı ise yönetmendir. Prova aşamasında yönetmenlerin oyunculardan temel beklentileri, belli bir eğitimi almış ve istenilen yönlendirmeleri anlayıp, uygulayabilecek seviyede olmalarıdır. Ancak üniversitelerin tiyatro bölümlerinde, Sahne Çalışması dersi kapsamında yapılan oyun provalarında, dersin yürütücüsü bir yandan yönetmen rolünü üstlenirken, bir yandan da eğitici vasfını taşımak zorundadır. Bu durum, hem eğitmeni üstlendiği çift rol yüzünden bir karmaşaya sürüklerken hem de ortaya çıkacak ürünün niteliğini etkilemektedir. Bu soruna bir çözüm örneği teşkil etmesi bakımından, Anadolu Üniversitesi Devlet Konservatuvarı Sahne Sanatları Tiyatro Bölümünde, 2022-2023 ders yılında Sahne Çalışması II ve Oyunculuk II dersleri, seçili bir oyunun hazırlık aşaması için birleştirilmiş ve derslerin öğretim elemanlarından bir tanesi yönetmenliği üstlenirken; diğeri öğrencilerin eğitimlerine odaklanmıştır. Bu çalışma vasıtasıyla, öğrencilerle yıl sonunda yapılan görüşmeler sonucunda, tiyatro bölümlerinde, yönetmenlik ve eğitcilik rollerinin iki farklı uzmanlık alanı olması sebebiyle, ders programları oluşturulurken bunun göz önüne alınması gerekliliği bir öneri olarak sunulmuştur.

Anahtar Kelimeler: Tiyatro, Yönetmen, Tiyatro Eğitmeni, Sahne Çalışması Dersi.

SEPARATION OF DIRECTORSHIP AND TEACHING ROLES IN STAGE STUDY COURSES IN UNIVERSITY THEATRE DEPARTMENTS

ABSTRACT

In the art of theatre, the necessity for both the practitioner and the audience to come together in the same time frame and physical space positions this art form as one that inherently requires live performance. Except for experimental practices such as improvisation and interactive theatre, classical-dramatic productions require a preparatory process. This involves both the rehearsal and presentation phases. While performance refers to the moment of meeting with the audience, it is characterized by a continuous, unrepeatable, and entirely live execution. The preparation phase, on the other hand, is the opposite: it is a segmented, repetitive, and relatively longer process in which the audience is not involved. The rehearsal process, which leads to the performance-ready state of a play, is a phase where various design elements such as set and costume are integrated. The most essential component of this phase is the actors' preparation. The director, as the chief designer who guides the actors, unites all designers under a common purpose and stage language, and has the final say in decision-making, oversees the entire process. During rehearsals, directors primarily expect actors to be trained and competent enough to understand and implement the given directions. However, in university theatre departments, particularly in the context of the Stage Practice course, the instructor often has to assume the dual role of director and educator. This dual responsibility can lead to confusion for the instructor and may affect the quality of the final production. As a solution to this issue, in the 2022–2023 academic year, at Anadolu University State Conservatory's Department of Performing Arts – Theatre Program, the courses Stage Practice II and Acting II were combined to focus on the preparation phase of a selected play. In this model, while one instructor undertook the directorial role, the other concentrated on the students' education. Based on the feedback gathered from the students at the end of the academic year, this study proposes that the distinct nature of directing and teaching, as two different fields of expertise, should be taken into account in curriculum design for theatre departments.

Keywords: Theatre, Director, Theatre Instructor, Stage Study Course.

CIRCULAR DESIGN: RETHINKING WASTE IN THE CREATIVE INDUSTRY**Özlem KAYA**

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ORCID: 0009-0009-4363-0639**ABSTRACT**

The concept of circular design is transforming the creative industry by redefining waste as a valuable resource rather than a byproduct of production. In sectors such as fashion, product design, and visual arts, traditional linear models of creation and consumption have led to significant environmental challenges. Circular design principles advocate for sustainable materials, regenerative production processes, and extended product lifecycles, encouraging a shift toward a more responsible and resource-efficient industry.

This study explores how circular design is being implemented across creative disciplines, examining its impact on material innovation, waste reduction, and business sustainability. By analyzing case studies of brands and artists embracing circular strategies, the research investigates how upcycling, closed-loop systems, and digital design tools contribute to minimizing environmental footprints while fostering creative expression. Furthermore, it addresses the challenges of scalability, cost, and consumer perception in transitioning to circular models.

Through a critical review of literature and industry practices, this study provides insights into the opportunities and limitations of circular design in the creative sector. The findings contribute to discussions on sustainability, innovation, and the future of responsible design, offering guidance for brands and creators looking to integrate circularity into their practices.

Keywords: Circular economy, Sustainable design, Waste reduction, Upcycling, Creative industry, Regenerative production, Ethical innovation.

Introduction

The growing urgency of environmental sustainability has sparked a transformative shift in design philosophies across various industries, with the creative sector being no exception. Traditionally, sectors such as fashion, product design, and architecture have operated within linear economic models grounded in mass production and disposal. This has resulted in significant environmental consequences, including excessive waste generation and the depletion of finite natural resources (EEA, 2017; Ellen MacArthur Foundation, 2014). As global concerns regarding climate change and ecological degradation intensify, there is a

pressing need to adopt new frameworks that challenge the conventional “take-make-dispose” paradigm and instead support sustainable, regenerative systems (Philips, 2014; Forest Stewardship Council, 2024).

This alternative is embodied in the concept of circular design a design methodology that reframes waste as a resource and seeks to extend the lifecycle of products through innovation, material efficiency, and systems thinking (Martynenko, 2021; Evans et al., 2022). Circular design challenges traditional consumption patterns by advocating for the development of products that are not only durable but also repairable, recyclable, and adaptable to evolving needs. As a result, it fosters a more conscious relationship between consumers and products, while advancing sustainable practices across a broad spectrum of creative disciplines (Botha, 2024; Vuletich, 2021).

In industries such as fashion, architecture, and product design, the circular design philosophy enables practitioners to minimize waste, reduce carbon footprints, and optimize resource use—all while maintaining high standards of creativity and innovation (Blanchard, 2024; Julie’s Bicycle, 2018). For example, in fashion, circularity is increasingly applied through slow design, upcycling, and the promotion of closed-loop material flows (Vuletich, 2021). Similarly, in the built environment, circular principles are integrated through design-for-deconstruction and adaptive reuse strategies (NIBS, 2024; Keena et al., 2022). At the intersection of art, craft, and community, circular thinking is also advancing socially embedded practices, as seen in artisan-based approaches that emphasize localism and repair culture (Ratalewska, 2024; Sbordone et al., 2021).

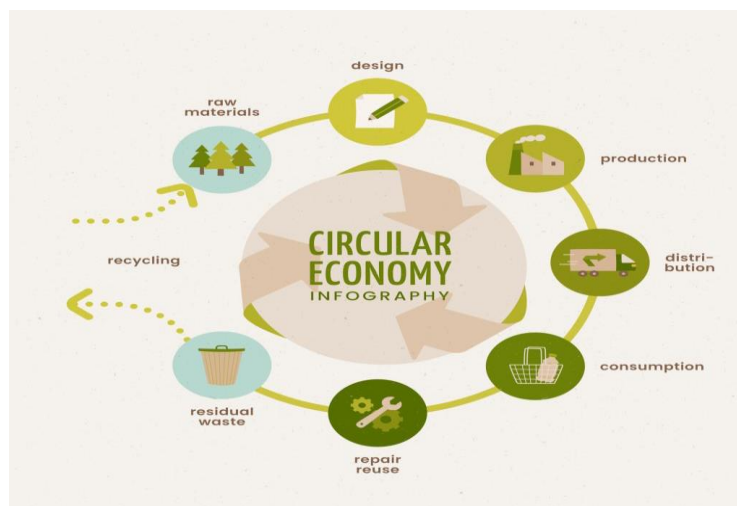


Figure 1. A new economy. Circular design. (Source: <https://stimulo.com/en/a-new-economy-circular-design-circular/>)

Despite its promise, the widespread adoption of circular design faces several systemic barriers. These include the economic costs associated with restructuring production processes, limited infrastructure for recycling and up-cycling, and consumer resistance to shifting consumption behaviors (Camilleri et al., 2023; Ellen MacArthur Foundation, n.d.). Moreover, many businesses still struggle to transition from short-term profit models to long-term circular value creation. These challenges underscore the complexity of moving from linear to circular systems and highlight the need for collaborative efforts between designers, businesses, and policymakers (Evans et al., 2022; Clements, 2018).

This study aims to explore the role of circular design in rethinking waste within the creative industries. By analyzing industry case studies and existing academic literature, it investigates how circular design strategies are currently applied across fashion, product design, and architecture, and how these approaches contribute to ecological and social sustainability. Additionally, the research examines the structural and cultural barriers to circular adoption and proposes actionable strategies to facilitate a more widespread transition. Ultimately, this study contributes to the broader discourse on sustainable and circular design by offering insights for designers, educators, and institutions seeking to embed regenerative principles into creative practice.

Methodology

This study employs a mixed-methods research approach, integrating qualitative and quantitative methodologies to provide a comprehensive analysis of circular design's impact on the creative industry. This approach allows for a nuanced understanding of sustainable practices by combining theoretical exploration with empirical data collection. The study will specifically focus on the application of circular design principles across fashion, product design, and visual arts.

Data Collection Methods: To assess the influence of circular design on waste reduction, sustainability, and innovation, data will be gathered from multiple sources:

Literature Review: A systematic review of academic research, industry reports, policy documents, and white papers related to circular economy principles, sustainable design, and waste management. This will establish a theoretical foundation while identifying key trends, barriers, and best practices.

Design for a Sustainable and Circular

In response to the escalating environmental crisis and the limitations of linear economic models, design has emerged as a critical discipline in facilitating the shift towards a more sustainable and circular economy. The concept of circularity challenges the conventional "take-make-

dispose" system by promoting strategies that prioritize waste prevention, material reuse, and systemic regeneration (Ellen MacArthur Foundation, 2014; Camilleri et al., 2023). Within this paradigm, *design is not merely a tool of aesthetic or functional development, but a foundational driver of socio-ecological innovation* (Evans et al., 2022).

Circular design is fundamentally concerned with shaping products, systems, and services that maintain value over time, support repair and reuse, and minimize environmental impact from conception to end-of-life (EEA, 2017). As Martynenko (2021) and Vuletich (2021) highlight, essential principles of circular design include *material transparency, modularity, and design for disassembly*, enabling products to evolve with user needs while reducing resource input. These strategies are reinforced by Evans et al. (2022), who emphasize the importance of *systemic thinking*, stakeholder participation, and interdisciplinary collaboration in enabling scalable and resilient circular systems.

In the creative industries, circular and sustainable design is manifesting through localized, low-impact practices that integrate cultural heritage with ecological mindfulness. Ratalewska (2024) illustrates how craft and artisan makers are pioneering circular approaches by focusing on *locally sourced materials, slow production cycles, and repair-oriented mindsets*. Similarly, Sbordone et al. (2021) present a case study in creative recycling that not only reduces waste but fosters *social empowerment*, particularly through initiatives focused on women's engagement and awareness.

Fashion, as a high-impact industry, also plays a pivotal role in circular design transitions. Botha (2024) and Vuletich (2021) argue for the adoption of *circular fashion principles*, including up-cycling, ethical sourcing, and consumer co-creation, as strategies to reduce dependency on fast fashion models and promote more sustainable consumption behaviors. Bicycle (2018) echoes this call within the broader cultural sector, advocating for *integrated design approaches* that align ecological objectives with artistic expression and community values.

Beyond the creative sector, the built environment presents significant opportunities for embedding circularity at scale. The National Institute of Building Sciences (2024) and Keena et al. (2022) explore the integration of circular strategies into architecture and construction, such as *designing for deconstruction*, reuse of demolition materials, and adaptive infrastructure planning. These efforts are framed within broader goals of achieving *net-zero carbon emissions* and closing material loops in urban development.

Corporate innovation further underscores the viability of circularity through design. Philips (2014) and Blanchard (2024) provide industry-based examples of how circular design enables *business model innovation*, such as product-as-a-service systems, reverse logistics, and material

recirculation. These models not only address environmental concerns but also open new avenues for value creation and customer engagement.

Thus, “*Design for a Sustainable and Circular*” encapsulates a forward-thinking approach that bridges environmental responsibility, social inclusivity, and economic resilience. It signifies a paradigm where design is leveraged not only for product innovation but for reimagining systems, values, and behaviors that underpin our relationship with the material world. As the literature suggests, such a transition requires *designers to act as system thinkers, facilitators, and change makers*, navigating the complexities of sustainability through creativity, collaboration, and circular principles.

Circular Design in the Creative Industry

Circular design is rooted in the principles of the circular economy, which aims to eliminate waste and continuously circulate resources within a system. This contrasts with the traditional linear economy, which is based on the extraction of resources, mass production, consumption, and disposal of products. The shift from linear to circular models represents a fundamental rethinking of how products are designed, produced, and consumed. In the creative industry, circular design principles advocate for products that are not only more sustainable but also contribute to the long-term health of the environment.

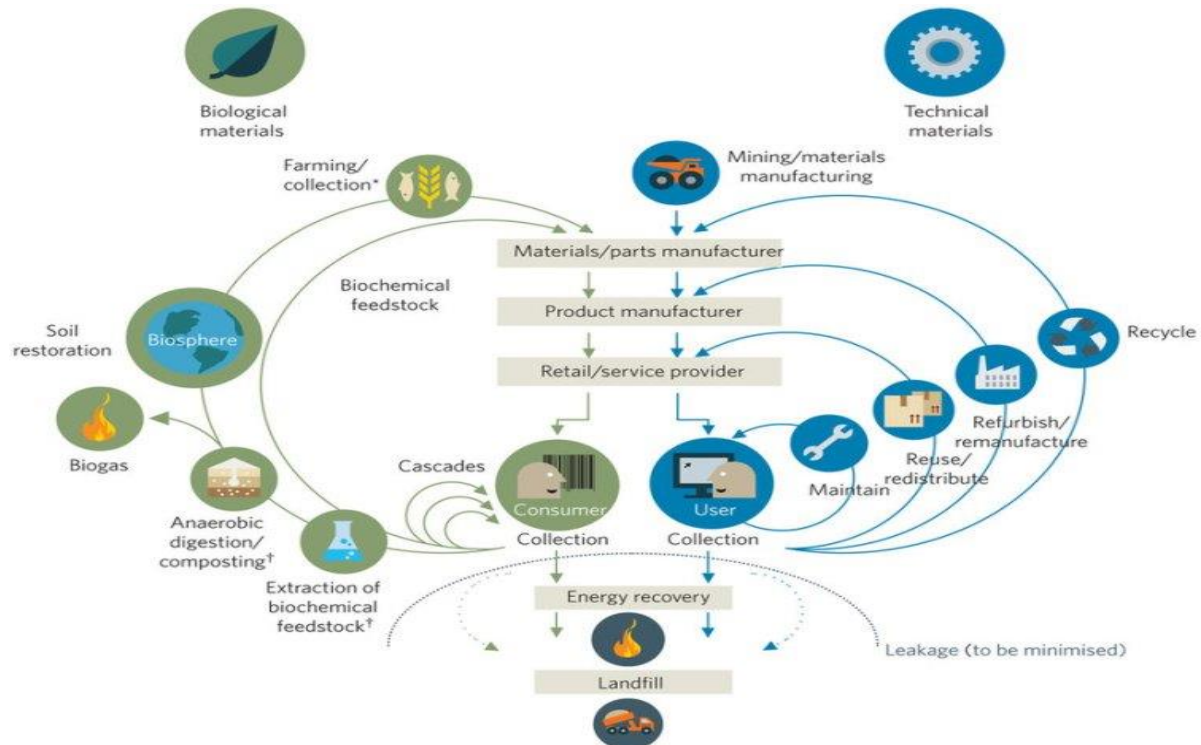


Figure 2. Circular Design Butterfly Diagram Below By EMF. (Source: <https://circulardesigninstitute.ie/what-is-circular-design/>)

The fashion industry has become one of the most prominent sectors to adopt circular design practices. Brands are increasingly focused on designing clothing with sustainable materials, creating garments that can be recycled or up-cycled at the end of their life cycle. By designing for longevity and repairability, fashion designers are addressing the environmental challenges posed by fast fashion, which is responsible for a significant portion of textile waste. Circular fashion also involves adopting practices such as clothing rental, second-hand markets, and garment repair services, which help extend the lifespan of products and reduce the need for new garments (Bicycle, 2022; Kaya, 2023).

Key aspects of circular fashion include

- Design for Longevity and Durability
- Materials and Production Methods
- Extended Use and Reuse
- Repair, Remake, and Recycling
- Closing the Loop (Anonymous, 2025)

Beyond fashion, the broader creative industry is embracing circular design in innovative ways. Product designers, for example, are developing modular products that can be easily repaired or upgraded, rather than discarded (Kaya, 2021). These designs encourage consumers to keep products in use for longer periods, reducing the need for constant replacement. Additionally, the use of biodegradable and recyclable materials in product development has the potential to drastically reduce the environmental footprint of products after their useful life. By designing products for disassembly and recycling, designers can ensure that their creations remain valuable resources rather than becoming waste.

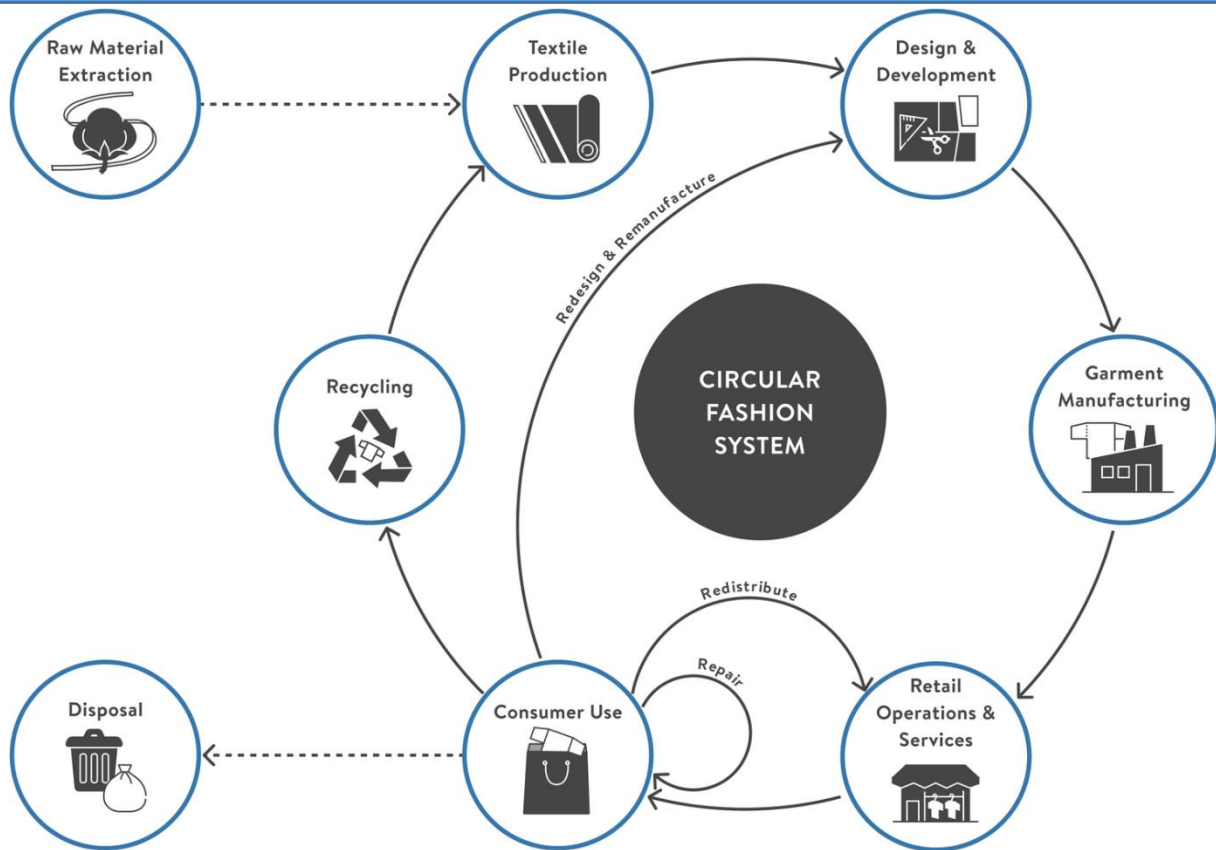


Figure 3. Circularity in Fashion (Source: <https://www.redressdesignaward.com/academy/resources/guide/circularity-in-fashion>)

The architectural sector has also begun incorporating circular design principles into building and construction practices. Green building designs focus on using sustainable, recyclable materials and designing structures that can be disassembled and reused at the end of their lifespan. Circular architecture emphasizes the reuse of materials and the reduction of waste during both the construction and demolition phases, helping to minimize the environmental impact of the built environment (Philips, 2022).

The Role of Circular Design in Waste Reduction

The adoption of circular design has the potential to significantly reduce waste across a variety of sectors. In the fashion industry, the emphasis on recycling and up-cycling reduces the amount of textile waste that ends up in landfills. Brands that implement circular practices not only help reduce waste but also encourage consumers to think differently about their purchases. The use of sustainable fabrics, such as organic cotton, hemp, or recycled polyester, and the incorporation of technologies such as textile-to-textile recycling, has already contributed to reducing the environmental impact of clothing production.

The construction industry also stands to benefit from circular design, particularly in reducing waste generated during demolition and renovation. By using recycled materials and designing buildings that can be easily disassembled and reused, architects and builders can reduce the amount of construction debris that ends up in landfills. Furthermore, the use of energy-efficient and sustainable materials reduces the carbon footprint of buildings, contributing to the fight against climate change.

Circular design can also help address the growing issue of packaging waste. Many companies are now designing products with packaging that is either recyclable, compostable, or reusable. By eliminating single-use plastics and opting for sustainable packaging solutions, businesses can significantly reduce their environmental impact. Additionally, designing products that can be easily returned and reused by consumers further enhances circularity in packaging and waste management.

Barriers and Challenges in Circular Design Adoption

Despite its potential, circular design faces several barriers that hinder its widespread adoption. One of the primary challenges is the high upfront costs associated with transitioning to circular models. Implementing circular systems often requires significant investment in new technologies, materials, and supply chain infrastructures. For many businesses, particularly small and medium-sized enterprises (SMEs), the cost of adopting circular design can be a deterrent, even though the long-term environmental and financial benefits are clear.

Another barrier is the lack of infrastructure to support circular design. In many regions, the recycling and up-cycling systems needed to close the loop in circular processes are still underdeveloped. Without the proper infrastructure, it becomes difficult for businesses to implement effective circular practices, especially when it comes to waste management and material recovery. Furthermore, the absence of a standardized approach to circular design across industries creates confusion, hindering businesses from fully embracing circular principles.

Consumer behavior also plays a significant role in the slow adoption of circular design. While there is growing awareness of environmental issues, many consumers remain unaware of the advantages of circular products, or may be hesitant to adopt them due to perceived higher costs or convenience concerns. This presents a challenge in shifting market demand toward sustainable options and encouraging behaviors that prioritize product longevity, repairability, and recyclability.

Circular design holds immense promise for the creative industry by offering sustainable solutions that address the growing concerns of waste and resource depletion. By adopting circular principles, designers, manufacturers, and consumers can contribute to reducing

environmental impacts and advancing toward a more sustainable future. However, the transition to circularity is not without its challenges. Overcoming barriers related to cost, infrastructure, and consumer engagement will require collaboration across industries, government support, and continued innovation. As circular design continues to evolve, it offers a path toward a more responsible and resource-efficient creative industry, one that not only minimizes waste but also fosters innovation, sustainability, and resilience in the face of global environmental challenges.

Conclusion

The creative industry-long driven by innovation, aesthetics, and cultural influence-now faces the imperative to address its environmental footprint. This research has examined how circular design offers a vital framework for reimagining production and consumption patterns in sectors such as fashion, product design, and the visual arts. By redefining waste as a resource and promoting regenerative approaches, circular design disrupts the conventional linear model and introduces a system where longevity, repairability, and sustainability are foundational rather than optional.

Through a critical review of literature and case studies, the study has demonstrated that circular design is not only a theoretical concept but a growing movement within creative disciplines. Designers, artists, and brands are implementing strategies such as up-cycling, modular design, biodegradable materials, and digital fabrication to reduce environmental impact while expanding the possibilities for creative expression. These practices foster new relationships between makers, materials, and users—encouraging a shift from ownership to stewardship, and from consumption to participation.

However, despite its potential, the widespread implementation of circular design still faces considerable challenges. Economic viability, lack of supportive infrastructure, limited access to sustainable materials, and consumer perceptions all contribute to the slow transition from linear to circular models. These issues are compounded by the fragmented nature of the creative sector, where small-scale operations may lack the resources to adopt circular practices effectively.

Nevertheless, the opportunities presented by circular design are far-reaching. Beyond environmental benefits, circularity opens new avenues for storytelling, brand differentiation, and ethical engagement. It empowers creators to be agents of change, using design as a tool for advocacy, education, and systemic transformation. As shown in this study, the integration of circular principles can lead to more resilient business models, stronger community ties, and an enriched creative process that is deeply connected to social and ecological wellbeing.

In conclusion, circular design represents both a challenge and an opportunity for the creative industry. To fully harness its potential, stakeholders across sectors—including designers, educators, businesses, and policymakers—must collaborate in reshaping systems, building infrastructure, and nurturing a culture of sustainability. As the climate crisis accelerates, the creative industry has a unique role to play in leading the transition toward a more regenerative, inclusive, and circular future. This research contributes to that vision by offering insights into how design can be a catalyst for rethinking waste and fostering long-term environmental stewardship.

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Figure

Figure 1: <https://stimulo.com/en/a-new-economy-circular-design-circular/>

Figure 2: <https://circulardesigninstitute.ie/what-is-circular-design/>

Figure 3: <https://www.redressdesignaward.com/academy/resources/guide/circularity-in-fashion>

THE RELATIONSHIP BETWEEN FASHION BRANDS AND SOCIAL MEDIA**Özlem KAYA**

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ORCID: 0009-0009-4363-0639**ABSTRACT**

The proliferation of social media has significantly influenced the fashion industry, reshaping brand-consumer interactions, marketing strategies, and trend dissemination. Platforms such as Instagram, TikTok, and Facebook have become integral to brand positioning, enabling fashion companies to engage with global audiences in real time. The rise of influencer marketing, user-generated content, and algorithm-driven visibility has further transformed traditional advertising models, shifting consumer behavior and purchasing decisions.

This study examines the impact of social media on fashion brands, focusing on its role in digital marketing, brand perception, and consumer engagement. By analyzing the strategies employed by major fashion companies, the research explores how social media facilitates brand awareness, drives sales, and fosters consumer loyalty. Additionally, it addresses the challenges associated with digital branding, including concerns over authenticity, reputation management, and the ethical implications of fast-fashion promotion in online spaces.

Through a critical review of existing literature and case studies, this study provides a comprehensive understanding of the evolving relationship between social media and the fashion industry. The findings contribute to academic discourse on digital marketing and consumer culture, offering insights into the strategic adaptations brands must undertake to navigate the dynamic social media landscape effectively.

Keywords: Social media marketing, Digital branding, Influencer marketing, Consumer behavior, Fashion industry, Brand engagement, Online reputation management

1. Introduction

The rapid expansion of social media has significantly reshaped the fashion industry, influencing how brands interact with consumers, implement marketing strategies, and distribute trends. Platforms like Instagram, TikTok, and Facebook have become fundamental tools for brand positioning, allowing fashion companies to engage with a global audience in real time. The rise of influencer marketing, user-generated content, and algorithm-driven visibility has revolutionized traditional advertising models, altering consumer behavior and purchasing

decisions. As digital platforms continue to evolve, brands are compelled to develop innovative marketing strategies to maintain relevance in an increasingly competitive industry.

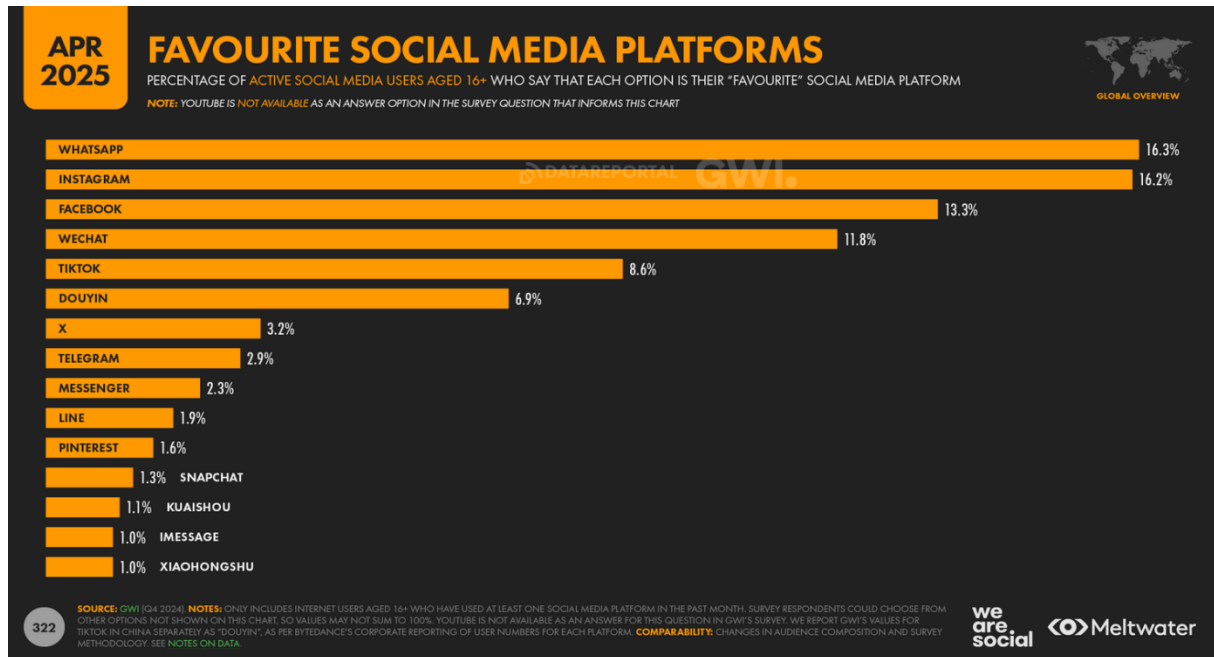


Figure 1. Favourite Social Media Platforms. Source: <https://datareportal.com/social-media-users>

Social media has democratized the fashion industry, allowing both established brands and emerging designers to showcase their work to a vast audience. Unlike traditional advertising channels, social media platforms provide direct engagement between brands and consumers, enabling real-time feedback and personalized experiences. This shift has led to the rise of digital influencers who, without formal connections to major fashion houses, have gained the ability to dictate trends and impact purchasing decisions. Studies highlight that platforms like Instagram and TikTok have become powerful tools for fashion marketing, with visual-centric content shaping brand perception and fostering stronger consumer relationships. Research indicates that nearly 75% of fashion consumers rely on social media for trend discovery, demonstrating its growing impact on shopping behaviors (Bello et al., 2024).

Social media has fundamentally reshaped digital marketing strategies in the fashion industry. According to *IJCRT* (2024), “social media has had a major impact on fashion trends, changing the way we perceive, request, and purchase clothing,” with platforms like Instagram being used to “reach consumers more quickly and cost-effectively to market their collections and gauge interest.

The *Fashion Retail Academy* (2023) further highlights that social media boosts visibility and engagement with consumers: “Social media marketing can benefit fashion brands in many ways including increased brand awareness, higher engagement with target audience ... increased

website traffic and sales. Influencer marketing is identified as “now one of the most popular methods of social media marketing,” especially on Instagram and TikTok.

The Social Shepherd (2023) echoes this trend, noting influencer partnerships and social commerce tools are key strategies: “Working with influencers ... you can ensure that your product is seen and engaged with by potentially thousands of new customers,” and calls Instagram and TikTok “powerful platforms” for fashion marketing.

Consumer behavior has also shifted significantly due to the rise of social media. Fashion consumers are now more informed and influenced by online reviews, influencer recommendations, and peer-generated content. A study conducted in Karachi emphasized that consumers trust social media opinions more than traditional advertising, demonstrating the power of digital engagement in influencing purchase decisions. Moreover, studies have shown that Gen Z and Millennials, who make up a significant portion of fashion consumers, are particularly reliant on social media for product discovery and brand loyalty. This shift in consumer behavior has forced fashion brands to rethink their engagement strategies, incorporating interactive content, live shopping events, and behind-the-scenes storytelling to foster deeper connections with their audience. Furthermore, the immediacy of social media interactions allows brands to respond swiftly to market demands, ensuring a more personalized and interactive shopping experience (Ahmad et al, 2015; Kaya, 2023).

“Social media platforms are now the primary source of information for consumers and one of the most powerful marketing tools for fashion businesses. ... In particular, social media provides an interactive channel of mass communication to amplify marketing strategy for fashion brands” (Chu and Seock, 2020). “legal intervention is essential to curtailing social media’s promotion of fast fashion, which often occurs through brand utilization of various predatory advertising methods. The fast-paced nature of social media not only accelerates fashion trends but also amplifies the environmental and ethical concerns associated with fast fashion consumption.” (McCann, 2024). Consumer trust remains pivotal, as “friends and family are the most trusted sources, followed by fashion brands and influencers, in encouraging sustainable practices” Brands must implement robust digital strategies that maintain transparency and ethical responsibility while engaging with consumers to protect their reputation in the fast-paced social media environment.” (Israfilzade and Hlushchenko, 2024).

Despite the numerous benefits, social media marketing in fashion comes with challenges. Issues such as authenticity, reputation management, and ethical concerns regarding fast fashion have raised significant discussions in the industry. Many brands struggle to balance engaging promotional content with genuine consumer interactions. Furthermore, the rise of fast fashion

brands leveraging social media for aggressive marketing campaigns has led to concerns about sustainability and ethical labor practices. Consumers are becoming more conscious of the environmental impact of their purchases, prompting fashion brands to adopt more transparent marketing strategies and emphasize sustainable fashion initiatives. In response, luxury brands and fast fashion retailers alike have been integrating corporate social responsibility (CSR) messaging into their social media campaigns to align with evolving consumer values. Additionally, the fast-paced nature of social media can lead to controversies or misinterpretations that can damage brand reputation. Scholars argue that brands must implement robust digital strategies that maintain transparency and ethical responsibility while engaging with consumers.

Another key aspect of social media's influence on the fashion industry is the growing prominence of virtual influencers and artificial intelligence (AI)-driven marketing. Brands are increasingly experimenting with AI-generated influencers, such as Lil Miquela, to create highly curated digital campaigns that blur the line between reality and virtual branding. This trend has raised discussions on the implications of authenticity and emotional connection in fashion marketing. Additionally, AI-driven data analytics allow fashion brands to track consumer preferences more accurately, enabling hyper-personalized recommendations and targeted advertising. With advancements in AI and machine learning, social media algorithms will continue to shape how fashion content is disseminated, further impacting brand strategies and consumer engagement (SSRN, 2021; Kaya and Aytaç, 2024).

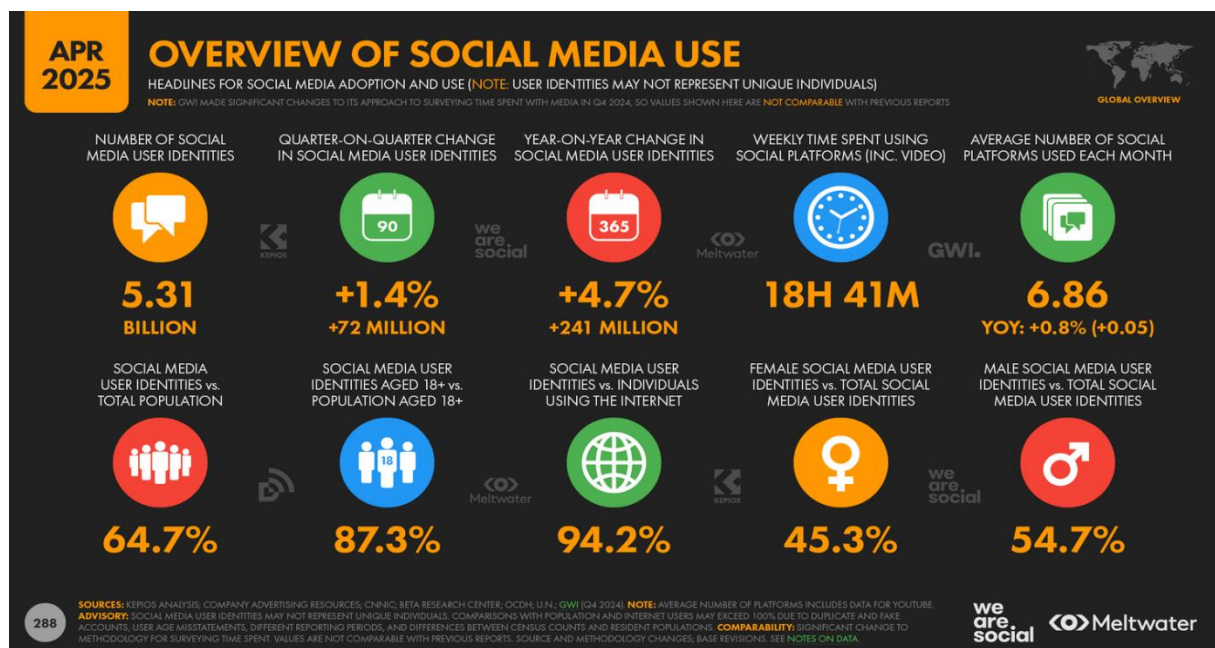


Figure 2. Overview of Social Media Use. Source: <https://datareportal.com/social-media-users>

In conclusion, social media has revolutionized the fashion industry, reshaping brand marketing, consumer engagement, and trend dissemination. While it offers unparalleled opportunities for brand visibility and customer interaction, it also presents challenges that require careful navigation. The integration of AI, influencer marketing, and social commerce has fundamentally altered the traditional fashion landscape, making digital adaptation a necessity for brands aiming to remain competitive. As the digital landscape continues to evolve, fashion brands must continuously refine their strategies to leverage social media's potential effectively while maintaining ethical marketing practices and fostering consumer trust.

2. On Social Media and Fashion Brands

The integration of social media into the fashion industry has significantly transformed how brands communicate, market their products, and engage with consumers. Over the past two decades, digital platforms such as Instagram, TikTok, Facebook, and Twitter have revolutionized traditional brand-consumer interactions, shifting fashion marketing from exclusive, print-based advertising to interactive, real-time engagement (Anonymous, 2025). Social media has not only democratized fashion accessibility but has also redefined trend cycles, consumer purchasing behavior, and the strategies employed by fashion brands to establish their digital presence.

The rise of social commerce, influencer marketing, and algorithm-driven content distribution has enabled brands to target and engage audiences in a highly personalized manner. These platforms offer fashion companies the ability to foster deeper connections with consumers through visual storytelling, interactive campaigns, and data-driven advertising. However, while social media presents significant opportunities for brand growth and market expansion, it also raises challenges regarding authenticity, sustainability, and ethical advertising practices. The proliferation of fast fashion, increased digital consumption, and the role of artificial intelligence in shaping fashion discourse have further complicated the landscape of digital branding.

3. Social Media as a Branding and Marketing Tool

Social media has become an essential branding tool for fashion companies, enabling them to cultivate a distinct identity, connect with their audience, and influence consumer perceptions. Unlike traditional advertising methods, digital platforms provide brands with the ability to directly engage with customers, facilitating a more personalized and interactive marketing experience.

One of the key advantages of social media is its ability to enhance brand visibility and reach a global audience. Fashion brands utilize visually driven platforms such as Instagram and TikTok to create curated content that aligns with their aesthetic and brand identity. High-quality images,

short-form videos, and live-streamed fashion shows have replaced conventional marketing methods, offering consumers an immersive and engaging brand experience. Luxury fashion houses, as well as fast fashion retailers, leverage these digital tools to communicate their brand story and establish a sense of exclusivity or accessibility, depending on their target market.

Additionally, social media enables brands to engage in targeted marketing through data-driven strategies. Algorithms analyze user behavior, preferences, and engagement patterns to optimize content distribution, ensuring that promotional material reaches the most relevant audiences. This level of precision in advertising allows fashion brands to maximize their return on investment, as social media platforms offer highly customizable ad formats, including sponsored posts, interactive shopping features, and influencer collaborations.

Influencer marketing has emerged as one of the most effective strategies for brand promotion on social media. By partnering with influencers who have established credibility within specific fashion communities, brands can enhance their authenticity and expand their reach. Unlike traditional celebrity endorsements, influencers often maintain a more relatable and interactive relationship with their followers, making their recommendations more persuasive. Micro-influencers, who have smaller but highly engaged audiences, are particularly valuable for brands aiming to establish trust and credibility within niche markets.

Moreover, user-generated content has become a fundamental aspect of social media branding. Consumers actively participate in brand storytelling by sharing their own fashion choices, reviews, and experiences with products. Hashtag campaigns, interactive challenges, and customer testimonials serve as organic marketing tools, reinforcing brand identity and fostering a sense of community among consumers. This shift toward participatory marketing has allowed brands to create a two-way dialogue with their audience, strengthening customer loyalty and brand advocacy.

4. The Impact of Social Media on Consumer Behavior

The influence of social media on consumer behavior is profound, shaping purchasing decisions, trend adoption, and brand perceptions. Digital platforms have accelerated the fashion cycle, enabling trends to emerge and fade at unprecedented speeds. The viral nature of social media trends—often driven by influencers, celebrities, and user-generated content—has contributed to the rapid turnover of fashion styles, leading to what is commonly referred to as “micro-trends.”

Social media has also facilitated the rise of impulsive purchasing behaviors through the integration of e-commerce and social commerce features. Platforms such as Instagram and TikTok offer in-app shopping experiences, allowing consumers to purchase products

seamlessly without leaving the app. The convenience of social commerce, combined with real-time reviews and influencer endorsements, has significantly influenced how consumers make purchasing decisions. Limited-time promotions, flash sales, and algorithm-driven recommendations further encourage immediate consumer action, reinforcing a culture of fast consumption.

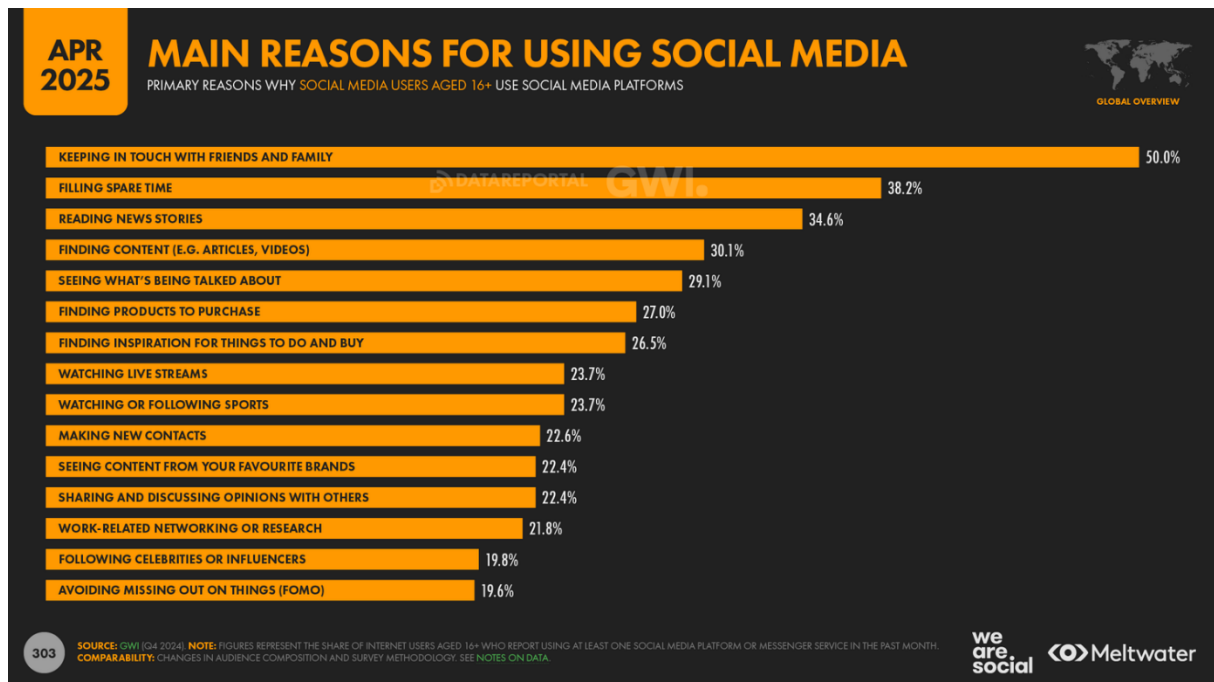


Figure 3. Main Reasons for Using Social Media. Source: <https://datareportal.com/social-media-users>

Beyond purchasing behaviors, social media has also played a crucial role in shaping consumer expectations regarding brand transparency and sustainability. As consumers become increasingly conscious of ethical fashion practices, brands are now expected to provide greater visibility into their production processes, sourcing methods, and sustainability initiatives. Social media serves as a platform for brands to communicate their commitment to corporate social responsibility, addressing concerns related to environmental impact, fair labor practices, and supply chain ethics. While some brands have successfully leveraged this transparency to build stronger consumer trust, others have faced scrutiny and backlash for greenwashing—exaggerating or misrepresenting their sustainability efforts.

Furthermore, social media has reshaped consumer-brand relationships by fostering a sense of inclusivity and accessibility. The traditional gatekeeping structures of the fashion industry—where trends were dictated by designers, fashion editors, and luxury brands—have been disrupted by digital platforms that empower consumers to participate in trend creation. The democratization of fashion through social media has led to increased representation of diverse identities, body types, and cultural influences in mainstream fashion discourse.

5. The Digitalization of Fashion Advertising: AI, Virtual Influencers and Augmented Reality

As social media continues to evolve, the fashion industry has embraced emerging technologies such as artificial intelligence (AI), virtual influencers, and augmented reality (AR) to enhance digital marketing strategies. AI-driven algorithms analyze consumer preferences and behaviors, enabling brands to deliver highly personalized shopping experiences. Predictive analytics and machine learning tools help brands anticipate consumer needs, optimize product recommendations, and refine marketing campaigns for maximum impact.

Virtual influencers—computer-generated personalities designed to engage with audiences on social media—have gained popularity as a novel form of digital advertising. Unlike human influencers, virtual influencers offer brands complete control over their messaging, aesthetic, and online presence. These AI-powered personas, such as Lil Miquela and Chouchoud, have amassed significant followings, collaborating with major fashion brands to promote collections and products. The growing influence of digital avatars in fashion marketing reflects the industry's increasing reliance on technology to drive consumer engagement (Romanescu and Kaya, 2021; Kaya and Romanescu, 2023).

Augmented reality has also emerged as a transformative tool for fashion marketing. AR-powered virtual try-ons allow consumers to visualize how clothing, accessories, and makeup products will look on them before making a purchase. This interactive technology enhances the online shopping experience by reducing uncertainty and increasing consumer confidence in their buying decisions. As AR continues to advance, it is expected to play a more significant role in bridging the gap between digital and physical retail experiences.

- **Gucci: Digital Innovation and Social Media Strategy**

Gucci has emerged as a leader in digital transformation within the luxury fashion industry. Through *social media*, *virtual influencers*, *AI-driven personalization*, and *metaverse initiatives*, the brand has successfully engaged a younger, tech-savvy audience while maintaining its legacy of luxury. Gucci's approach highlights how fashion brands can use social media not only for marketing but also for redefining brand identity in the digital age.

- **How Gucci Uses Social Media**

Gucci utilizes Instagram, TikTok, Twitter, and YouTube as its primary digital marketing channels. Each platform serves a distinct role in Gucci's overall strategy:

Instagram – Showcases high-fashion campaigns, influencer collaborations, and artistic visuals.

TikTok – Engages with Gen Z consumers through viral challenges and interactive content.

Twitter – Used for brand storytelling and campaign teasers.

YouTube – Features behind-the-scenes footage, brand documentaries, and runway shows.

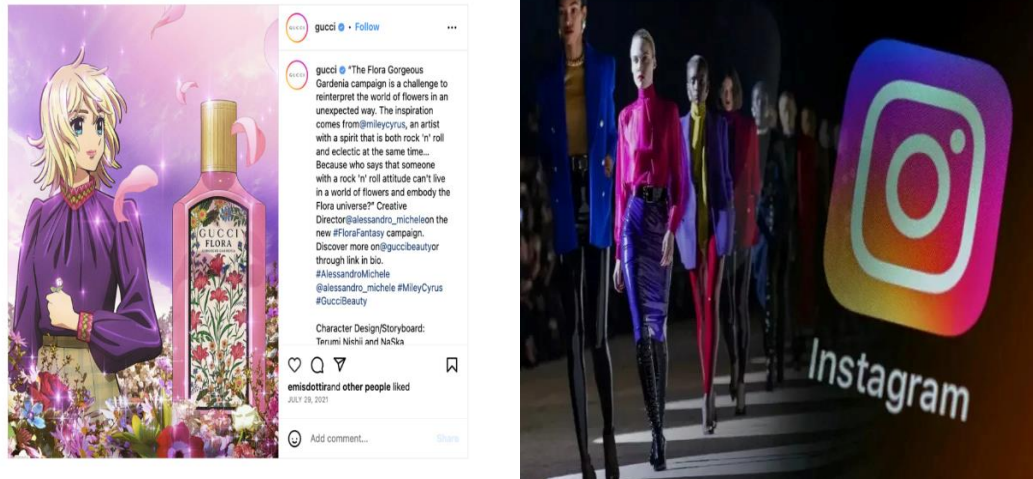


Figure 4. Gucci Social Media (left). Source: <https://digitalagencynetwork.com/gucci-marketing-strategies-and-examples-through-years/>
(Right) <https://fashinnovation.nyc/how-social-media-influences-fashion-trends/>

• Why Gucci Uses Social Media

The brand's primary objectives in leveraging social media include:

Engaging Younger Consumers – Gucci targets Gen Z and millennial audiences who are highly active on social media.

Reinforcing Brand Identity – By embracing digital artistry, Gucci positions itself as an avant-garde luxury brand.

Driving E-Commerce Sales – Social commerce and AI-powered recommendations help convert online engagement into purchases.

Building a Digital Community – Encouraging user-generated content and influencer collaborations fosters brand loyalty.

• Gucci's Digital Strategy

Virtual Influencers: Gucci made headlines by collaborating with **Lil Miquela**, a virtual influencer, for digital campaigns. This AI-generated persona allowed the brand to explore futuristic branding concepts and reach tech-savvy consumers.

Gucci Vault and the Metaverse: Gucci launched **Gucci Vault**, a metaverse-based initiative that includes digital fashion, NFTs, and virtual experiences. The brand was among the first luxury labels to enter the metaverse, showcasing its commitment to technological innovation.

TikTok and Viral Marketing: The **#GucciModelChallenge** became a TikTok sensation, encouraging users to replicate Gucci's signature layered fashion aesthetic. This user-generated content approach helped Gucci stay relevant and engage with younger audiences in an organic way.

Augmented Reality (AR) and AI Personalization: Gucci integrated *AR try-on features* in social media apps, allowing users to virtually try on sneakers and eyewear before making a purchase. Additionally, AI-driven algorithms personalize product recommendations for users, enhancing the online shopping experience.

- **The Impact of Gucci's Social Media Strategy**

Gucci's innovative use of social media has resulted in:

- Increased **brand engagement**, particularly among younger consumers.
- Higher **social commerce conversion rates**, leading to significant e-commerce growth.
- Strengthened **brand identity** as a pioneer in digital fashion and technology-driven luxury marketing.

Gucci's ability to merge *luxury with digital innovation* sets it apart from traditional fashion brands. By leveraging social media, AI, and the metaverse, Gucci continues to push the boundaries of fashion marketing, ensuring its long-term relevance in an increasingly digital world.

6. AI, Virtual Influencers and the Future of Digital Fashion

The future of fashion marketing is being shaped by advancements in artificial intelligence (AI) and digital technology, revolutionizing how brands engage with consumers and streamline operations. Fashion brands are increasingly leveraging AI-driven personalization, virtual influencers, and augmented reality (AR) to create more immersive, personalized, and tech-forward experiences for their customers. These innovations not only enhance brand engagement but also redefine traditional marketing practices in the fashion industry.

7. AI-Driven Personalization

AI technology has transformed the way fashion brands understand and engage with their customers. By analyzing vast amounts of consumer data—from browsing habits and purchase history to social media activity—AI algorithms provide valuable insights into consumer

preferences. This enables fashion brands to offer *personalized recommendations*, ensuring that each interaction feels tailored to the individual. Personalized shopping experiences, such as curated product suggestions and targeted advertisements, increase customer satisfaction and loyalty.

AI also plays a significant role in predictive analytics, where brands anticipate future consumer behavior based on past data. For example, an AI-driven system can predict what styles or trends are likely to resonate with a specific customer segment, allowing brands to optimize inventory, create custom marketing strategies, and boost engagement rates. The use of AI personalization not only enhances customer experience.

8. Content Management and Influencer Marketing in the Digital Era

In the digital age, *content management and influencer marketing* have become essential components of fashion brand strategies. These elements are crucial for maintaining a consistent brand narrative across multiple platforms, engaging consumers, and maximizing reach. With the rise of *social media* and *digital platforms*, managing content effectively and leveraging influencer partnerships have proven to be powerful tools for brands to stay relevant and competitive.

9. Content Management: The Backbone of Brand Consistency

Effective *content management* refers to the planning, creation, and distribution of branded content across various digital platforms. In fashion marketing, this involves curating a visual identity that aligns with a brand's image, story, and values. For fashion brands, maintaining consistency across different digital channels (Instagram, TikTok, YouTube, etc.) is crucial to building recognition and trust with consumers.

The growing complexity of digital channels necessitates a unified approach to content management. Brands now must produce content in a way that adapts to the unique characteristics of each platform while still maintaining a coherent overall message. This requires understanding the *format preferences* of each platform—whether it's short-form videos for TikTok, high-quality images for Instagram, or long-form storytelling for YouTube—and tailoring the content accordingly.

Content management also extends to *SEO optimization and data analytics*, which allow fashion brands to track the performance of their digital assets. With tools like Google Analytics and social media insights, brands can optimize their content strategy, creating posts that not only resonate with audiences but also enhance visibility on search engines and social media feeds.

10. Influencer Marketing: Shaping Consumer Behavior

Influencer marketing has emerged as one of the most powerful strategies for fashion brands looking to connect with their target audience. Influencers-individuals with significant followings on social media platforms-have the ability to shape consumer opinions, drive trends, and promote products in an authentic way that traditional advertising often fails to achieve.

Brands engage influencers who align with their values, target demographic, and aesthetic. These influencers can range from *macro-influencers* (celebrity figures with millions of followers) to *micro-influencers* (individuals with smaller, highly engaged audiences). The key to effective influencer marketing lies in choosing influencers whose followers match the brand's target market, ensuring that campaigns are both relevant and impactful.

Influencers help fashion brands build *authentic connections* with consumers by sharing personal experiences with products, providing styling advice, and offering exclusive access to events or collections. In doing so, influencers act as trusted intermediaries between brands and their audiences. Influencer marketing also thrives in the context of *user-generated content* (UGC), where influencers encourage their followers to create and share content related to the brand, further amplifying its reach.

In addition, influencer marketing strategies have been enhanced with the rise of *AI and data analytics*, enabling brands to measure influencer impact with precision. By tracking engagement rates, conversion metrics, and sentiment analysis, brands can assess the return on investment (ROI) of their influencer partnerships and refine their strategies for future campaigns.

11. The Interaction of Social Media and Digital Platforms

The interaction between *social media and other digital platforms*-including *e-commerce websites, email marketing, mobile apps, and digital advertising*-creates a seamless and integrated experience for consumers. Fashion brands today must manage and optimize their presence across these interconnected digital touchpoints to drive engagement and sales.

- **Social Media and E-Commerce Integration:** Social media platforms are increasingly becoming integrated with e-commerce functionalities, allowing consumers to shop directly through social media posts. Platforms like Instagram and Facebook now offer *shoppable posts*, where users can view product details and make purchases without ever leaving the platform. This integration has significantly blurred the lines between marketing and sales, allowing brands to *convert social media interactions into transactions* seamlessly.

- **Omni-Channel Experience:** For fashion brands, an *omni-channel strategy* is crucial in ensuring a consistent and personalized experience across multiple digital platforms. Consumers may discover a brand on Instagram, read reviews on YouTube, and then make a purchase via the brand's mobile app or website. Coordinating content across these channels ensures that customers receive a *consistent message* at every touchpoint, enhancing brand loyalty and satisfaction. Brands that integrate their social media presence with e-commerce, customer service, and personalized experiences create a *holistic consumer journey* that drives engagement and retention.
- **Email Marketing and Social Media Synergy:** While social media has taken center stage in digital marketing, email marketing remains a highly effective way to nurture customer relationships and drive sales. The integration of *social media and email marketing* strategies has become increasingly popular. Brands can capture email leads through social media campaigns and then use personalized email content to drive further engagement. For example, offering exclusive discounts or early access to collections through email is an effective way to convert social media followers into loyal customers.
- **Mobile Apps and Digital Advertising:** *Mobile apps* and *digital advertising* are powerful tools for reaching consumers who are on-the-go. Fashion brands use apps to engage consumers with loyalty programs, exclusive content, and personalized offers. Apps also facilitate direct communication with customers through push notifications, ensuring that the brand stays top-of-mind.

On the advertising front, *digital ads* across social media and other digital platforms are highly targeted, thanks to AI and machine learning. Brands can reach potential customers based on their behaviors, interests, and demographics, making digital advertising a more precise and effective tool than traditional advertising methods.

- **Interactive and Immersive Experiences:** With the advancement of *augmented reality (AR)* and *virtual reality (VR)*, fashion brands are now offering more interactive and immersive experiences. For example, *virtual try-ons* allow customers to visualize how a piece of clothing or accessory will look on them before making a purchase. This technology is often integrated into both *social media platforms* and *e-commerce websites*, enhancing the user experience and boosting conversion rates.

Brands like Gucci and Balenciaga have already begun experimenting with *virtual fashion shows* and *digital clothing collections*, offering consumers an opportunity to engage with their

products in completely new ways. This not only strengthens brand engagement but also caters to the growing demand for digital self-expression in online spaces.

Conclusion

The integration of social media into the fashion industry has fundamentally reshaped how fashion brands operate, communicate, and grow. This research has demonstrated that social media platforms particularly Instagram, TikTok, and Facebook have become powerful tools for branding, marketing, and customer engagement. Brands now rely heavily on digital presence to cultivate relationships with consumers, amplify trends, and create immersive brand experiences. The success of influencer marketing and user-generated content reinforces the shift from traditional top-down marketing to a more participatory, peer-influenced model of brand communication.

As shown in various case studies and literature, companies like Gucci, SHEIN, and PrettyLittleThing exemplify how digital strategies can significantly increase brand awareness and sales, especially among younger, digitally native audiences. However, the study also underscores the challenges of this evolving landscape. The pressure to maintain constant online visibility can result in content over-saturation, diluted brand identity, and dependence on algorithms that are often unpredictable. Furthermore, concerns around authenticity, greenwashing, and the ethical implications of promoting fast fashion remain pressing issues for both consumers and brands.

The findings suggest that while social media offers unmatched opportunities for fashion marketing, its effectiveness hinges on strategic alignment with brand values, audience expectations, and ethical considerations. Digital branding must go beyond surface-level aesthetics to build genuine trust and long-term loyalty. Brands are now expected to be socially conscious, culturally aware, and actively engaged in dialogue with their audience.

In conclusion, the impact of social media on fashion brands is profound and multifaceted. It demands a rethinking of traditional marketing models and compels fashion companies to be agile, transparent, and forward-thinking. As consumer behavior continues to evolve in this digitally driven age, fashion brands must continuously adapt, leveraging social media not just as a promotional tool but as a space for meaningful interaction and sustainable growth.

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THE PROFIT THAT TOURISTS BRING TO THE STATE**ALIYEV Rovshen Natig**

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ABSTRACT

“A state with a strong economy is capable of anything.”

HEYDAR ALİYEV

Tourism, being one of the words mostly used nowadays as one of the most perspective fields of the last periods at the time, tries to cover many areas of our life. By being one of the most profitable, leading industry, tourism arranges the main source of gross domestic product (GDP), employment, export and taxes. Also, as tourism combines many fields itself, it contributes to these fields. Let's note that, as the other perspective, important fields, the human factor is also on the basis of the tourism. But we consider the rest of people more, people's enjoy, providing their interests higher, offering them the services that they need by always considering their health, spending their time extremely valuable, efficiently, fulfilling their desires maximally and etc., here. Person plays as a role of tourist here at this time. And this tourist tries to use these several fields maximally. Of course, every effort surrounds certain amount. And it causes return of each capital spending to tourism by capitalists. Also, investments, investing to the production and infrastructure of tourism, allow not only to protect and expand the potential of this area, but also to improve the indicators such as quality, competitiveness, productivity and sustainability.

Key Words: tourism, tourist, profit, economy, state, recreation

INTRODUCTION

The achievements of our country in the economic, political, social, cultural and tourism fields in the last ten years have been achieved due to the great efforts of the founder and architect of the Azerbaijani state, the great Heydar Aliyev, and today, the esteemed President Ilham Aliyev, who continues his domestic and foreign policy with dignity.

Decrees of the President of the Republic of Azerbaijan “On measures to accelerate socio-economic development in the Republic of Azerbaijan” in 2003 and “On the State Program for the socio-economic development of the regions of the Republic of Azerbaijan” in 2004 were

important steps towards the development of the country's economy, including the tourism sector. Currently, Azerbaijani tourism is developing on an upward trajectory.

The number of tourists visiting Azerbaijan exceeded one million three hundred thousand in 2008. The 8th International Tourism Exhibition was held at the Heydar Aliyev Sports and Concert Complex in Baku in April, 2009. 78 tourism enterprises from 20 countries participated in the exhibition. The declaration of 2011 year as the "Year of Tourism" in Azerbaijan led to significant results in the development of tourism. The "State Program for the development of resorts in the Republic of Azerbaijan in 2009-2018" creates the basis for the planned development and efficient use of tourism and resort areas in our country.

MATERIALS AND METHODS

By being one of the most profitable, the most leading industry, tourism arranges the main source of gross domestic product (GDP), employment, export and taxes [1, p.11]. Also, as tourism combines many fields itself, it contributes to these fields, too. Investments, investing to the production and infrastructure of tourism allow not only to protect and expand the potential of this area, but also to improve the indicators such as quality, competitiveness, productivity and sustainability [1, p.12]. Especially, the subtle point consists of that, when the expenditure of capital is approached correctly, the tourism sector returns its capital to its investors up to the final amount of the investment, and not only that, it also regularly earns extra. Capital invested in the tourism sector, due to its tourists, justifies the investment, brings income, benefits not only to its own sector, but also to other sectors, the state, and the economy in general. For example, if we consider that a tourist who comes to the country due to tourism spends an average of about 1,000 manats or 1,000 dollars (this amount always depends on the place and time, it can change for each period, here it is simply taken as a common price), then it becomes clear how much capital, measured in millions, enters the country's economy and provides benefits and profits to the country. However, it is not only the state that benefits, but also all citizens of the country working in this field, as well as those who benefit from it in one form or another, which are ordinary people of the country who are far from this field. Here, tourism is like a golden chain, a golden mill, that brings benefits in motion.

A tourist's visit to a country depends on a number of known and unknown factors. Thus, if this area is regularly paid attention to, many areas can be concentrated around it, and by expressing a number of valuable thoughts, ideas, making suggestions, taking into account measured projects and constantly implementing them in a prudent manner, long-term very beneficial results can be achieved for the future of the country. But in this area, the visible side of the Moon is that tourists come to the country and relax. But on the invisible side of

the Moon, there are more things, both hidden and revealed.

These things first start by attracting the tourist's interest in what is being offered. And then, to attract tourists, it is necessary to have a sufficiently high-quality and sufficient, accessible database so that each tourist can have more detailed information about the destination and address and benefit from it. Each tourist has his own different interests, which leads to the diversification of tourism. For example, some tourists are interested only in entertainment centers, some in historical monuments, others in health centers, some in religious areas, others in nature or rural tourism, etc. These can be further increased by counting them.

There should be properly developed plans and programs in tourism, so that both the state, the private sector, and the ordinary citizen get benefit. If one gets benefit and the other is left out, this will ultimately indirectly lead to the loss of a large amount of capital that should enter the country through tourists, especially through them, and will also lead to a visible and tangible weakening of the tourism sector in the future, and in general, it will be contrary to the long-term national interests and development of the country.

Before attracting tourists to the country, the country should have the initial infrastructure in this direction so that the tourist can at least get benefit from the information provided to him at the maximum level. The presence of one and the absence of the other would be the biggest blow to tourism as a whole, especially the service provided with the initial information provided to the tourist or the lack of sufficient inadequacy in this area. Because in an era of information abundance, when information is instantly disseminated, gaining counter-information and counter-propaganda against the tourism sphere will not bring the pride, success, good, tourists, and most importantly, the expected and planned large capital to any country.

It can also be noted that the attempts of states to attract tourists to their countries do not always yield results by basing on this. Thus, sometimes due to major crises occurring globally or regionally in countries, untimely wars, unexpected natural disasters, sudden changes of power, and irresponsible work and activities of incompetent, indecisive, and weak-willed administrators, the previously determined and expected annual statistical indicators may not yield positive results. But despite all this, if the steps taken in the right direction in this area properly managed by leaders, will sooner or later begin to yield positive results.

In general, tourist arrivals in each country regularly change positively or negatively from month to month and year to year. There are also changes depending on the ability of each

country to receive tourists. For example, the percentage increase or decrease in tourist flow by country, tourist arrival indicators and, most importantly, tourism revenues, specifically in figures and statistics, shows itself completely differently in each country. This also depends on many factors. Thus, tourist flow and tourism revenues in each country react differently to every event occurring in the world and in the countries by month and year. If we examine this comparatively based on the annual results of incoming tourists and tourism revenues, then we will see that in some countries, the results of tourist flow and tourism revenues show themselves differently in the final results.

Sometimes 100% (one hundred percent) increase in tourism in one country is not as much as 1% (one percent) increase in another country. Despite, the high percentage tourist flow occurs sometimes, the income earned cannot produce the desired results. Although the tourist flow in another country is less accepted, more profit has been achieved in terms of income. All this indicates that, no matter how easy the tourism sector is understood to be, it goes through many expected and unexpected difficulties before it can produce results. This depends on the great management ability, the potential of tourism in that country, and many other known and unknown processes. For example, for obvious reasons, tourism has been non-existent in Afghanistan and North Korea for many years. Although different processes are taking place in both.

But in Afghanistan, although there has been no tourist flow into the country in recent years, there has been a varying amount of capital inflow from tourism into the country over the years. For example, between 2008 and 2019, this country received \$1 billion 203 million in income from tourism alone, which is thought-provoking. However, it is impossible to say the same about North Korea. Due to the policy pursued by the current government in the country for years, the country is completely isolated from the world, living under a severe totalitarian regime.

Turkmenistan is also partially isolated from the world, so specific statistical information about this country is not known. Because this country is also among the closed countries. Although there is high potential for certain types of tourism here. Such differences in tourism (especially the reflection of incoming revenues in statistics and their causes) can also be seen in the example of other countries. Thus, in many Muslim countries (Tunisia, Algeria, Lebanon, Jordan, Mauritania, Sudan, Oman, Yemen, Saudi Arabia, Egypt, Syria, Djibouti, Morocco, Iraq, Bahrain, Iran, Libya, Kuwait, Western Sahara), processes of achieving so-called democracy, called the “Arab Spring” after 2010, took place, or rather, were brought to these countries by external forces. Which did not show any signs of spring or democracy.

In order to appropriate the rich natural resources of Sudan and other such Muslim countries, events, disasters, and similar processes happened to divide the countries and cause chaos in these countries were organized by Western powers. As a result, the democracy that was promised to these countries did not come, but instead, great disasters, massacres, bombing and looting of cities, hunger, misery, forced migration, large migration flows, and despair were brought.

Thus, although the initial signs of these events began in Sudan, the first mass events took place in Tunisia. This led to the beginning of many Muslim countries being dragged into disaster. In particular, the so-called “Arab Spring”, which was launched under the name of democracy and led to the deaths of thousands of Muslims. All this led to a significant decrease in tourism revenues in these countries for years.

If we look at the development of tourism in Azerbaijan in recent years, we can note that the number of visitors to Azerbaijan increased by 18% in January 2020! The number of foreign citizens visiting Azerbaijan in January 2020 increased by 35 thousand or 18.1% compared to January 2019, reaching 226 thousand people. The largest increase was observed from Russia and Georgia, where the largest number of travelers also came. Thus, the number of arrivals from Russia increased by 12 thousand or 20.5% to 68 thousand, and the number of arrivals from Georgia increased by 8 thousand or 14.6% to 64 thousand. Both the Middle East and Türkiye, we received 24 thousand visitors each, with an increase of 20.8% and 12.1%, respectively. Among the Middle Eastern countries, the largest increases were observed in the number of arrivals from Saudi Arabia (an increase of 321.5% or 5 thousand) and Kuwait (an increase of 73.7% or 1.7 thousand). The number of travelers from Iran increased by 3 thousand or 26.5% compared to 2019, reaching 13 thousand people. The number of travelers from South and Central Asia increased by 43% and 18.4%, respectively, to 8,000 each of them. As in previous months, the number of travelers from India (5,000; a significant increase of 80.2%) and Pakistan (3,000; an increase of 15.6%) dominated the South Asian region.

Starting in 2019, the pandemic that has been happening around the world has begun to show its negative consequences to all countries. Although all countries, including Azerbaijan, had higher expectations from tourism. Because for years, countries have invested millions in this field, in tourism. (So, between 2010 and 2019, Azerbaijan spent 23 billion 877 million dollars on tourism). But, the pandemic crossed out all positive expectations for a while. Since the beginning of 2020, a rapid return to the country has begun. But this can be attributed to tourism or not. Thus, Azerbaijan was among the first countries

to go into large-scale internal lockdowns. The state, especially the direct leadership of the country, took measures at the highest state level to protect its citizens from the pandemic and infections, so it quickly began to transport and return Azerbaijani citizens living abroad, in various regions of the world, as well as compatriots who had acquired citizenship of other countries, to the country on special flights (of course, the principle of voluntariness was also taken as a basis) and tried to protect them, who entered the country from abroad, by placing them in hotels for half a month. It also protected the citizens of the country to prevent the mass spread of the virus. At this time, the occupancy rate in large 4-star and 5-star comfortable hotels reached 100%, and this was fully covered by the state budget. However, it is difficult to accept this situation as tourism. Because people were left in lockdown conditions here. But in any case, even though many enterprises went into lockdown during this difficult period, hotels did not lose their profit for that period. In fact, the vast majority of hotels provided unconditional assistance to the state and citizens during this difficult time.

In 2020, 28.3 percent of those who came to our country were from the Russian Federation, 23.2 percent from Georgia, 20.2 percent from Türkiye, 9.1 percent from Iran, 2.1 percent from Ukraine, 1.6 percent from India, 1.5 percent from Saudi Arabia, 1.1 percent from Kazakhstan, 1.0 percent each from Pakistan, the United Arab Emirates and Turkmenistan, 0.9 percent each from Kuwait and the United Kingdom, 0.8 percent from Belarus, 0.7 percent each from Uzbekistan and Iraq, 0.5 percent from Israel, 0.4 percent each from Germany and Italy, 4.5 percent from other countries, and 0.1 percent from stateless persons. 81.1 percent of the arrivals were men and 18.9 percent were women. In general, the number of arrivals from European Union member states decreased by 5.9 times to 23.0 thousand people, the number of arrivals from Gulf countries decreased by 5.0 times to 110.7 thousand people, and the number of arrivals from CIS countries decreased by 4.2 times to 273.4 thousand people. 70.0 percent of foreigners arriving in our country used railway and automobile transport, 27.6 percent used air transport, and 2.4 percent used sea transport. Compared to 2019, the number of citizens of the Republic of Azerbaijan traveling to foreign countries decreased by 4.8 times to 1,164.6 thousand people. 29.2 percent of the country's citizens traveled to Iran, 26.4 percent to Georgia, 18.9 percent to the Russian Federation, 16.4 percent to Türkiye, and 9.1 percent to other countries. In 2020, 73.2 percent of citizens of the Republic of Azerbaijan traveling abroad used rail and road transport, 23.8 percent used air transport, and 3.0 percent used sea transport.

CONCLUSION

Let's note that since Ilham Aliyev became the President of the Republic of Azerbaijan, tourism spending has continued to increase over the years. As a result, tourism in the Republic of Azerbaijan is developing very rapidly. Thus, the Decree of the President of the Republic of Azerbaijan "On additional measures related to the development of tourism in the Republic of Azerbaijan" dated September 1, 2016 necessitated the rapid development of tourism in the country [3]. However, since the efficiency of investments in the tourism sector in Azerbaijan was low, this had a negative impact on the competitiveness of the country's tourism sector.

In 2018, in accordance with the "Order of the President of the Republic of Azerbaijan on some measures to improve state administration in the field of culture and tourism" dated April 20, 2018 [4], the State Tourism Agency of the Republic of Azerbaijan was established on the basis of the Ministry of Culture and Tourism of the Republic of Azerbaijan. The agency operates in the direction of formulating and implementing a unified state policy in the field of tourism, implementing normative activities in the field of tourism, ensuring state regulation, state control and coordination, coordinating activities between other state bodies, institutions and organizations, as well as individuals and legal entities, including international and non-governmental organizations, for the purpose of developing tourism, organizing the purposeful use of the territories of reserves and ensuring their preservation, and ensuring the protection and promotion of national culinary samples [2].

In order to increase the flow of tourists to the country, the President of the Republic of Azerbaijan signed an Order "On additional measures to accelerate the flow of tourists to the Republic of Azerbaijan" dated February 20, 2017 [5]. This order, consisting of 8 main points, put forward necessary demands and proposals.

We have tried to research the implementation of different projects in the direction of development of this field in our country under the Decree of August 2, 2024. Decree of the President of the Republic of Azerbaijan on the approval of the model regulations of tourism and recreation zones and the amendment of some decrees and orders of the Republic of Azerbaijan in this regard of August 2, 2024 states that, *"the public legal entity "Center of Management and Development of the Zones of Tourism and Recreation" should be formed under the State Tourism Agency of the Republic of Azerbaijan."* This center will deal with the management and development of tourism zones. These works carried out in the Republic of Azerbaijan are the main goal set for the development of tourism.

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TOURISTIC ROUTES IN SITE OF JESUS BAPTISM AND FUTURE PERSPECTIVES- JORDAN-SOUTH LEVANT

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ABSTRACT

The Baptism Site of Jesus Christ (Al-Maghtas), located on the eastern bank of the Jordan River, is considered one of the most important sites in the Mediterranean Basin region. The discovery of the site began in 1996 through the Department of Antiquities under the supervision of the author of this article. Field surveys and archaeological excavations led to the discovery of a large number of historical and archaeological sites dating back to the Roman, Byzantine, and Islamic periods.

The site's significance evolved from local to regional and finally to global importance, culminating in its inclusion on the UNESCO World Heritage List in 2015 with the unanimous approval of all member states. The site transitioned from being a subject of scientific research and evidence-based validation to receiving ecclesiastical recognition.

It was acknowledged by most Christian churches and denominations as the authentic location of the baptism of Jesus Christ on the eastern bank of the Jordan River, which supported its inscription on the UNESCO World Heritage List.

Since then, the team has worked diligently to develop the site for religious tourism, which is a major attraction in Jordan generally, and for this site in particular. Among the key elements of this development are the tourist trails, as visitor movement within the site is one of the most prominent features that provides added value by enabling visitors to explore the site's many landmarks spread across an area of 6 square kilometers.

At the heart of the site lies Wadi Al-Kharrar, a major attraction for eco-tourism due to its abundance of water, vegetation, wildlife, geological diversity, and mild winter climate. The development of tourist trails has taken into consideration sensitive and significant aspects related to the emergence of Christianity from the lowest point on earth, particularly during the Roman era when Christianity began to appear. Excavations have revealed that the first baptisms took place in the area of Tell Mar Elias, where archaeological remains date back to the Roman period, specifically the first century AD—the time during which John the Baptist (Prophet Yahya) and Jesus Christ lived. The Prophet Elijah had also preceded them to this location.

Therefore, Tell Mar Elias must be the starting point for the historical tourist trails, as it contains ruins dating to the Roman era, such as the campsite that revealed remains of structures , caves and pottery shards from the early Roman (Herodian) period, in addition to religious buildings from the late Roman, early Byzantine, and late Byzantine periods.

Thus, the launch of the first tourist trail aligns with the historical context and marks the beginning of habitation in the area as the main site representing early worship and monasticism in the caves still present on the western side of Tell Mar Elias.

Accordingly, the trail must follow the path from the dwelling place of John the Baptist, passing through Wadi Al-Kharrar, where monastic cells are located, and leading to the pilgrims' station— the second main site situated on the southern edge of Wadi Al-Kharrar. This valley stretches for 1,800 meters, ending at the Jordan River. The station includes a large monastery equipped with all necessary facilities for visitors and pilgrims, particularly the main baptism pool and an adjacent dam. The trail then branches north and west to the monk caves overlooking the Jordan River, the shrine of Hajjeh Maryam, and the stables.

The trail continues to the third main site— the Jordan River Churches located on the eastern bank of the river. This complex includes four churches, the base of the column marking the place of Christ's baptism, and the stairway descending to the river channel as it existed during that time.

The tourist trails at the Baptism Site of Christ are unlike those at other sites. Each location has its own story, event, and narrative that visitors can enjoy. This research addresses these comprehensive tourist trails that cover the site and its surroundings, particularly the Christian pilgrimage route extending from the Baptism Site to Ain Salim (a subsequent baptism site), to Al-Mahatta (the sixth mile), to Mount Nebo, and then to Machaerus or Umm Al-Rasas.

Keywords: Architecture, Tourism, Development, Baptism Site, Jordan.

YAPAY ZEKA İLE PERFORMANS GÖREVLERİNİ OTOMATİK PUANLAMADA PUANLAMA ANAHTARI TÜRÜNÜN GÜVENİRLİĞE ETKİSİ

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ÖZET

Araştırmada üretken yapay zeka araçlardan ChatGPT ile performans görevlerini puanlama sürecinde kullanılan puanlama anahtarı türünün, elde edilen puanların güvenilirliği üzerindeki etkisini incelemek amaçlanmaktadır. Puanlama anahtarı türü ve yapay zekâ-uzman kombinasyonunun, elde edilen puanların güvenilirlik düzeylerini nasıl değiştirdiğini anlamak, bu teknolojilerin eğitimde etkin bir şekilde kullanılabilmesi için önemlidir. Araştırmada Nalbantoğlu Yılmaz (2024) tarafından yapılan çalışma verileri izin alınarak kullanılmıştır. Bu doğrultuda bir devlet üniversitesindeki fen bilgisi öğretmen adaylarının Ölçme ve Değerlendirme dersi kapsamında alanları ile ilgili hazırladığı 31 performans görevi dört puanlayıcı tarafından dereceleme ölçeği ve analitik puanlama anahtarı ile ayrı ayrı puanlanmıştır. Bu verilere ek olarak araştırmaya yapay zeka teknolojilerinden ChatGPT-4o puanlayıcı olarak eklenmiştir. Bu kapsamda ChatGPT-4o puanlayıcı gibi roller üstlenmesi sağlanmıştır. Öğretmen adaylarının hazırladığı performans görevleri hem gerçek puanlayıcılar hem de ChatGPT-4o ile iki farklı puanlama anahtarı kullanılarak puanlanmıştır. Elde edilen puanların güvenilirliğini belirlemede genellenebilirlik kuramı kullanılmıştır. Araştırma sonucunda, dereceleme ölçeğinden elde edilen puanların güvenilirliğinin tüm durumlarda analitik puanlama anahtarından elde edilenlere göre daha yüksek olduğu belirlenmiştir. Bu durumda ChatGPT-4o ve/veya puanlayıcıların, dereceleme ölçeğini daha iyi kullandığı ve aynı durum için dereceleme ölçeğinden elde edilen puanların güvenilirliğinin daha yüksek olduğu söylenebilir.

Anahtar Kelimeler: ChatGPT, analitik puanlama anahtarı, dereceleme ölçeği, yapay zeka, performansa dayalı durum belirleme

THE EFFECT OF SCORING KEY TYPE ON RELIABILITY IN AUTOMATIC SCORING OF PERFORMANCE TASKS WITH ARTIFICIAL INTELLIGENCE

ABSTRACT

This study aims to examine the effect of the type of scoring key used in scoring performance tasks with ChatGPT, one of the productive artificial intelligence tools, on the reliability of the scores obtained. Understanding how rubric type and AI-expert combination change the reliability levels of the obtained scores is important for the effective use of these technologies

in education. In the research, the data of the study conducted by Nalbantoğlu Yılmaz (2024) was used with permission. In that study, 31 performance tasks prepared by preservice science teachers at a public university as part of a Measurement and Evaluation course were independently scored by four raters using two different scoring keys: a rating scale and an analytic rubric. In addition to these data, ChatGPT-4o, one of the artificial intelligence technologies, was added to the study as a scorer. In this context, ChatGPT-4o was provided with roles such as rater. The performance tasks prepared by the pre-service teachers were scored by both real raters and ChatGPT-4o using two different scoring keys (rating scale and analytic rubric). Generalizability theory was used to determine the reliability of the obtained scores. As a result of the research, the reliability of the scores obtained from the rating scale is higher than those obtained from the analytic rubric in all cases. In this case, it can be said that ChatGPT-4o and/or raters used the rating scale better and the reliability of the scores obtained from the rating scale for the same situation was higher.

Keywords: ChatGPT, analytic rubric, rating scale, artificial intelligence, performance assessment

1. GİRİŞ

Eğitimde bireylerin üst düzey bilişsel ve devinişsel becerilerini doğru, yansız, ve tutarlı biçimde belirlemede puanlama anahtarları önemli bir yere sahiptir (Brookhart, 2013). Genellikle, performansın ölçülmesinde dereceleme ölçeği, bütüncül ve analitik puanlama anahtarı olmak üzere farklı puanlama anahtarı türleri kullanılabilir. Bütüncül puanlama anahtarı, öğrencilerin genel performansına dair bir değerlendirme sunarken (Moskal, 2000), dereceleme ölçeği ve analitik puanlama anahtarı ise daha detaylı-ayrıntılı bir inceleme sağlamaktadır. Tüm puanlama anahtarı türlerinin kendine özgü avantajları ve sınırlılıkları bulunmakla birlikte, sınıf içi ölçmelerde biçimlendirici değerlendirmelerde dereceleme ölçeği ve özellikle analitik puanlama anahtarının daha ayrıntılı geri bildirim sunması nedeniyle tercih edildiği görülmektedir (Jonsson & Svingby, 2007).

Son yıllarda, yapay zeka teknolojileri eğitimde giderek daha fazla yer bulmaya başlamıştır. Yapay zeka teknolojileri herhangi bir konuda beyin fırtınası yapma, alternatifler önermeye yardımcı olma, verileri analiz etme, gerçek dünya problemlerini çözmede destek sağlama gibi roller üstlenebilir. Bununla birlikte üretken yapay zeka araçlarının ölçme ve değerlendirme sürecine de destek olarak entegre etme ön plana çıkmaktadır. ChatGPT gibi üretken yapay zekâ modelleri, öğrenci çalışmalarını değerlendirerek, öğretmenlerin çok daha kısa sürelerde tutarlı ve doğru geri bildirimler sunmalarına yardımcı olabilir. Ancak, bu teknolojilerin değerlendirme

süreçlerinde etkin ve güvenilir biçimde kullanımı, çeşitli yöntemsel ve ölçme-değerlendirme temelli soruları da beraberinde getirmektedir. Puanlama anahtarı türlerinin ve yapay zekâ sistemleri kombinasyonunun, elde edilen puanların güvenilirlik düzeylerini nasıl şekillendirdiğini anlamak, bu teknolojilerin eğitimde etkin bir şekilde kullanılabilmesi için önemlidir. Bu bağlamda, bu çalışmada ChatGPT'nin performans görevlerini puanlama sürecinde seçilen puanlama anahtarı türünün, elde edilen puanların güvenilirliği üzerindeki etkisini incelemek amaçlanmaktadır. Puanlama anahtarı türü ve yapay zekâ-uzman kombinasyonunun, elde edilen puanların güvenilirlik düzeylerini nasıl değiştirdiğini anlamak, bu teknolojilerin eğitimde etkin bir şekilde kullanılabilmesi için önemlidir. Yapay zekâ teknolojilerinin, özellikle otomatik puanlamada kullanılmasının puanlama anahtarı türüne bağlı olarak nasıl farklı güvenilirlik düzeyleri sunduğunu belirlemek, eğitimde bu teknolojilerin nasıl daha verimli kullanılabileceğine dair değerli bilgiler sağlayacaktır. Araştırmanın sonuçları, puanlama anahtarı seçiminde bir yol haritası oluşturarak, öğretmenlerin ve eğitimcilerin yapay zekâ destekli değerlendirme süreçlerini daha etkin ve güvenilir bir şekilde yönetmelerine olanak tanıyacaktır. Böylece araştırma sonuçlarının yapay zeka ile otomatik puanlamada puanlama anahtarı seçimi için kanıtlar ortaya koyması beklenmektedir.

Çalışma, özellikle öğrenci performanslarına etkili geri bildirim vermede daha detaylı bilgi sunan dereceleme ölçeği ve analitik puanlama anahtarının ChatGPT'nin puanlama tutarlılığı üzerindeki etkilerini karşılaştırarak, yapay zekâ destekli değerlendirme uygulamalarının güvenilirlik temelli boyutlarına katkı sağlamayı hedeflemektedir. Literatürde genelde analitik ve bütüncül puanlama anahtarlarının karşılaştırıldığı çalışmalar (Chen vd., 2022; Imbler vd., 2023; Onkun-Özgür & Karakaya, 2024; Öç, Onkun-Özgür, & Karakaya, 2024; Peeters vd., 2025) bulunmaktadır. Bununla birlikte literatürde, ChatGPT'nin puanlama süreçleriyle bütünleştirildiği çalışmalar (Atasoy & Moslemi Nezhad Arani, 2025; Demir, 2023; Fernández et al. 2024; Jackaria, Hajan, & Mastul, 2024; Manning, Baldwin, & Powell, 2025; Poole & Coss, 2024; Shin & Lee, 2024; Yamashita, 2025; Yang, 2024; Yoon vd., 2023) bulunsa da, puanlama anahtarı türünün, ChatGPT'nin karar verme süreci ve buna bağlı sonuçların güvenilirliği üzerindeki etkisine dair bulgular oldukça sınırlıdır. Yapay zeka puanlamalarında etkili geri bildirim vermede daha detaylı bilgi sunan dereceleme ölçeği ve analitik puanlama anahtarının karşılaştırıldığı başka bir çalışmaya rastlanmamıştır. Bu durum, özellikle performans görevlerinin puanlanmasında yapay zekâ araçlarının hangi tür puanlama anahtarı ile daha uyumlu çalıştığı ve daha güvenilir sonuçlar ürettiği sorularını gündeme getirmektedir. Bu yönüyle çalışma, mevcut literatürdeki önemli bir boşluğu doldurmayı ve yapay zekâ tabanlı

puanlama uygulamalarına yönelik daha sağlam ölçme-değerlendirme temelli yaklaşımlar geliştirilmesine katkı sağlamayı amaçlamaktadır.

Bu araştırmanın temel amacı, üretken yapay zekâ araçlarından biri olan ChatGPT'nin, biçimlendirici değerlendirmeler için performans görevlerini puanlama sürecinde dereceleme ölçeği ve analitik puanlama anahtarı kullanıldığında elde edilen puanların güvenilirlik düzeylerini karşılaştırmalı olarak incelemektir. Bu amaç doğrultusunda ise araştırmada aşağıdaki sorulara yanıt aranacaktır:

Öğretmen adaylarının performanslarının dereceleme ölçeği ve analitik puanlama anahtarı kullanılarak puanlanmasında puanlama anahtarı türüne göre;

1. ChatGPT-4o ve/veya birden fazla puanlayıcı kullanıldığı durumda öğrenci, puanlayıcı, ve kriter etkileşimlerine ait kestirilen varyans bileşenleri nasıldır?
2. ChatGPT-4o'dan elde edilen puanların güvenilirlik katsayısı nasıl değişmektedir?
3. Hem ChatGPT-4o hem de insan puanlayıcıların birlikte kullanıldığı modelde elde edilen puanların güvenilirlik katsayısı nasıl değişmektedir?

2. YÖNTEM

2.1. Çalışma Grubu

Araştırmada, Nalbantoğlu Yılmaz (2024) tarafından yapılan çalışma verisi izin alınarak kullanılmıştır. Araştırmalarda veri toplama güçlükleri nedeniyle veri paylaşımı ve buna bağlı ikincil veri kullanımı veri toplama maliyetini düşürmesi açısından önemli faydalar sağlamaktadır (Tenopir vd., 2011). Bu doğrultuda araştırmanın çalışma grubu, bir devlet üniversitesindeki fen bilgisi öğretmen adaylarının ölçme ve değerlendirme dersi kapsamında alanları ile ilgili hazırladığı 31 performans görevi ve bu görevleri puanlayan 4 puanlayıcıdan oluşmaktadır. Bu verilere ek olarak bu araştırmada puanlayıcı olarak yapay zeka teknolojilerinden ChatGPT-4o puanlayıcı olarak kullanılmıştır. Bu kapsamda ChatGPT-4o puanlamada puanlayıcı rolü üstelenmesi sağlanmıştır. Öğretmen adaylarının hazırladığı performans görevleri hem gerçek puanlayıcılar hem de GPT-4o ile iki farklı puanlama anahtarı kullanılarak (dereceleme ölçeği ve analitik puanlama anahtarı) puanlanmıştır.

2.2. Veri Toplama Aracı

Araştırmada, Nalbantoğlu Yılmaz (2024) tarafından hazırlanan dereceleme ölçeği ve analitik rubrik kullanılmıştır. Her iki puanlama anahtarında 13'er kriter bulunmakta ve 4'lü derece (3-

2-1-0) ile puanlanmaktadır. Her iki puanlama anahtarı öğrenme çıktılarının performans görevine uygunluğu, performans görevinin dikkat çekici bir giriş metninin varlığı ve performans görevi için hazırlanan puanlama anahtarının uygunluğu vb. kriterler içermektedir. Her iki puanlama anahtarı arasındaki temel farklılık analitik puanlama anahtarının dereceleme ölçeğine göre tüm dereceler ya da performans seviyeleri için her bir kriterle ilişkili daha ayrıntılı açıklamaların olmasıdır.

Araştırmada, fen bilgisi öğretmen adaylarının hazırladığı performans görevlerini puanlamada OpenAI tarafından geliştirilen ChatGPT-4o (plus sürümü, Şubat 2025) kullanılmıştır. İlgili yapay zeka botu ile puanlama yapılırken her bir öğretmen adayının hazırladığı performans görevi tek tek sisteme yüklenmiş ve aynı komutla ayrı ayrı puanlama yapılması istenmiştir.

Puanlama güvenilirliğini sağlamak için puanlama öncesinde araştırmada kullanılan puanlama anahtarları ve ölçüt ifadeler ChatGPT'ye verilerek açıklama yapılması istenmiştir. Bu doğrultuda verilen kriterleri algılayıp algılamadığı test edilmiştir. Daha sonra numaralandırılmış performans görevleri Şekil 1'deki gibi bir prompt ile sunulmuştur.

 25.doc
Belge

25 nolu belgedeki ödevi sana verdiğim analitik dosyasındaki 13 kriterle göre detaylandırarak puanlar mısın? puanlamayı objektif yap. ürüne göre karar ver. bir önceki puanlamadan ve ödevden etkilenme.

25 numaralı belgede belirtilen performans görevi, analitik dosyasındaki 13 kriter kullanarak objektif şekilde değerlendirilecektir. Puanlamada ürünün detayları ve ödevde belirtilen gereklilikler dikkate alınacak, önceki değerlendirmelerden bağımsız bir analiz yapılacaktır. Birkaç dakika içinde sonuçları paylaşacağım.

25 Nolu Performans Görevi Değerlendirme Tablosu

Criteria	Score (0-3)	Comments
1 Seçilen kazanım üst düzey bilişsel ya da devinîşsel mi?	3	Kazanım üst düzey bilişsel bir hedef taşıyor ancak biraz daha açıklık gerekebilir.
2 Performans görevi kazanımı ölçmek için uygun mu?	2	Performans görevi kazanımı ölçmek için kısmen uygun; bazı eksiklikler var.
3 Performans görevi giriş kısmında	2	Giriş kısmı genel bir çerçeve çiziyor ancak daha etkili olabilir.

25 numaralı performans görevinin analitik dosyasındaki 13 kriter üzerinden detaylı değerlendirme sonuçları ve açıklamaları tamamlanmıştır. Tabloyu inceleyebilirsiniz. Herhangi bir yorumunuz veya düzeltme talebiniz varsa lütfen belirtin! [\[↩\]](#)

Şekil 1. ChatGPT puanlama prompt örneği

Hem puanlayıcılar hem de GPT4 ile puanlama yapılırken analitik puanlama anahtarındaki derece açıklamalarından etkilenme olmaması için önce dereceleme ölçeği ile puanlama yapılmıştır. Ayrıca ChatGPT ile derceleme ölçeği kullanılarak yapılan ilk puanlamadan iki

hafta sonra tekrar aynı görevler için analitik puanlama anahtarı ile benzer şekilde puanlama yapılmıştır.

2.3. Verilerin Analizi

Araştırmada, ChatGPT-4o ve puanlayıcılardan elde edilen veriler Genellenabilirlik Kuramı ile incelenmiştir. GPT4o ve puanlayıcılar her bir performans görevini iki farklı puanlama anahtarı (dereceleme ölçeği ve analitik rubrik) kullanarak 13 ölçüte göre puanlamıştır. Bu doğrultuda araştırma iki farklı puanlama anahtarı için öğrencilerin ölçüm nesnesi olarak belirlendiği öpxpi (ö: öğrenci, p: puanlayıcı, i: kriter) deseninde yürütülmüştür. Bu doğrultuda araştırmaya toplamda 4030 veri (31x5x13x2) dahil edilmiştir. Araştırmada yükseköğretimde performansın ölçülmesi söz konusu olduğundan mesleki beceriler açısından mutlak değerlendirmeler öne çıkmaktadır. Bu nedenle araştırmada G-kuramı ile elde edilen güvenilirlik katsayılarından mutlak değerlendirmeler için kullanılan Phi katsayısı rapor edilmiştir. Verilerin analizinde ise EduG 6.0 (versiyon 6.0) programı kullanılmıştır.

3. BULGULAR

31 performans görevinin ChatGPT-4o ve puanlayıcılar ile iki farklı puanlama anahtarı kullanılarak ayrı ayrı puanlanmasına ilişkin tüm değişkenlerin tesadüfi olarak belirlendiği öpxpi deseni için kestirilen varyans bileşenleri ve toplam varyansı açıklama yüzdeleri Tablo 1’de verilmiştir.

Tablo 1. öpxpi deseni ile iki farklı puanlama anahtarı kullanılarak kestirilen varyans bileşenleri

	$n_o=31, n_i=13,$ $n_p=1(ChatGPT-4o)$				$n_o=31, n_i=13,$ $n_p=5 (4puanlayıcı+ChatGPT-4o)$			
	Dereceleme Ölçeği		Analitik Rubrik		Dereceleme Ölçeği		Analitik Rubrik	
Varyans Kaynağı	σ^2	%	σ^2	%	σ^2	%	σ^2	%
Öğrenci (ö)	0.04	13.3	0.03	11.1	0.06	8.7	0.05	7.4
Puanlayıcı (p)	-	-	-	-	0.01	1.4	0.09	13.2
Kriter (i)	0.09	30	0.08	29.6	0.02	2.9	0.04	5.9
öp	-	-	-	-	0.16	23.2	0.10	14.7
öi	0.17	56.7	0.16	59.3	0.04	5.8	0.03	4.4
pi	-	-	-	-	0.05	7.2	0.05	7.4
öpi,e	-	-	-	-	0.35	50.7	0.32	47.1

Tablo 1’de puanlayıcı olarak sadece ChatGPT kullanılan durumda, öğrencilere ait varyans bileşeni toplam varyansın dereceleme ölçeğinde %13.3, analitik puanlama anahtarı kullanıldığı durumda ise %11.1’ini açıklamaktadır. Yapay zeka ve tüm puanlayıcıların birlikte puanlama

yaptığı durumda, öğrencilere ait varyans toplam varyansın dereceleme ölçeğinde %8.7 ve analitik puanlama anahtarı kullanıldığında ise %7.4'ünü açıklamaktadır. Dereceleme ölçeği kullanıldığı durumda öğrenci varyansının toplam varyansı açıklama oranının biraz daha yüksek olması ChatGPT'nin ve puanlayıcıların dereceleme ölçeği ile öğrenci özellikleri arası farklılıkları biraz daha fazla ortaya çıkarılabildiği göstermektedir. Bu ölçme uygulamaları bakımından istenilen bir durumdur. Ayrıca öğrenci-kriter ortak etkisine ait kestirilen varyans bileşeninin hem ChatGPT hemde tüm puanlayıcıların bir arada olduğu durumda dereceleme ölçeğinde biraz daha yüksek çıkması bir kriterden diğerine öğrenci performanslarının farklılaştığını göstererek dereceleme ölçeği kullanıldığı durum için yukarıdaki bulguyu desteklemektedir.

Tablo 1'de puanlayıcı ana etkisine ait varyans bileşenleri incelendiğinde, karma durumda (puanlayıcılar+ChatGPT) puanlayıcı ana etkisine ait varyans bileşeni dereceleme ölçeğinde toplam varyansın %1.4'ünü, analitik puanlama anahtarında ise %13.2'sini açıklamaktadır. Puanlayıcı ana etkisi puanlayıcılar arası farklılıkları göstermektedir. Analitik puanlama anahtarı ile yapılan puanlamada bu varyansın daha yüksek olması bu puanlama anahtarı kullanıldığında puanlayıcılar arası farklılığın/değişkenliğin dereceleme ölçeğine göre daha fazla olduğunu göstermektedir. Bununla birlikte öğrenci-puanlayıcı ortak etkileşimine ait varyans bileşeni karma durumda dereceleme ölçeği ile yapılan puanlamada toplam varyansın %23.2, analitik rubrik ile yapılan puanlamada ise %14.7'sini açıklamaktadır. Bu durum, bazı bireylerin durumlarının bir puanlayıcıdan diğerine dereceleme ölçeğinde daha çok değiştiği göstermektedir.

Karma durumda puanlayıcı-kriter etkileşimine ait varyans bileşenleri (0.05) her iki puanlama anahtarında da benzerdir. Puanlayıcıların her iki puanlama anahtarını kullanırken bir kriterden diğerine benzer kararlılıkla puanlama yaptığını göstermektedir.

Farklı puanlayıcı türlerine göre öğretmen adaylarının performanslarının her iki puanlama anahtarı kullanılarak puanlanmasından elde edilen güvenilirlik katsayıları Tablo 2'de verilmiştir.

Tablo 2'de verildiği gibi, öğretmen adaylarının performanslarının uzman tarafından dereceleme ölçeği ve analitik puanlama anahtarı ile puanlanmasında elde edilen Phi katsayıları sırasıyla 0.88 ve 0.80'dir. Aynı durumda sadece ChatGPT ile yapılan puanlamada dereceleme ölçeği ve analitik puanlama anahtarı ile sırasıyla 0.67 ve 0.59 güvenilirlik katsayısı elde edilmiştir.

Tablo 2. Güvenirlik katsayıları

<i>Puanlayıcı</i>	Dereceleme Ölçeği	Analitik Rubrik
	<i>Phi (Φ)</i>	<i>Phi (Φ)</i>
$n_p=1$ (Uzman)	0.88	0.80
$n_p=1$ (ChatGPT-4o)	0.67	0.59
$n_{p\text{-tesadüfi}}=5$ (1 uzman+3 öğretmen adayı+ChatGPT-4o)	0.56	0.52
$n_{p\text{-sabit}}=5$ (1 uzman+3 öğretmen adayı+ChatGPT-4o)	0.89	0.86

 $n_o=31, n_i=13$

Tablo 2'ye göre, puanlayıcı değişkeninin tesadüfi olduğu ve bir uzman, üç öğretmen adayı ve ChatGPT-4o olmak üzere toplamda beş puanlayıcının dereceleme ölçeği ve analitik puanlama anahtarı ile puanlamasında elde edilen Phi katsayıları sırasıyla 0.56 ve 0.52'dir. Puanlayıcı değişkeninin sabit olarak belirlendiği karma durumda toplamda beş puanlayıcının dereceleme ölçeği ve analitik puanlama anahtarı ile puanlamasından elde edilen Phi katsayıları sırasıyla 0.89 ve 0.86'dir. Puanlayıcı değişkeninin tesadüfi olması elde edilen güvenirlilik katsayılarının evrendeki tüm puanlayıcılara genellenebilmesini sağlamaktadır. Puanlayıcı değişkeni sabit olarak belirlendiğinde ise evrendeki tüm puanlayıcılara genelleme amacı güdülmemekle birlikte, sadece çalışmada kullanılan puanlayıcılar için bir güvenirlilik hesaplaması yapılmaktadır. Puanlayıcı değişkeninin tesadüfi ya da sabit olarak belirlendiği tüm durumlarda tüm puanlayıcı türleri için dereceleme ölçeği kullanıldığında daha yüksek güvenirlilik katsayısı elde edildiği söylenebilir. Ayrıca çalışmada kullanılan puanlayıcılardan elde edilen güvenirlilik katsayılarının (dereceleme ölçeği ile 0.89, analitik puanlama anahtarı ile 0.86) yeterli düzeyde olduğu söylenebilir.

4. SONUÇ VE TARTIŞMA

Araştırma sonucunda dereceleme ölçeğinden elde edilen puanların tüm durumlarda (yapay zeka puanlaması, uzman puanlaması, uzman ve yapay zekanın bir arada olduğu model) analitik puanlama anahtarı ile yapılan puanlamaya göre daha yüksek güvenirlilik katsayısı verdiği sonucuna ulaşılmıştır. Ayrıca ChatGPT'nin 4 puanlayıcı ile birlikte puanlayıcı görevi üstlendiği durumda her iki puanlama anahtarı ile elde edilen puanlayıcı değişkenliği incelendiğinde, dereceleme ölçeği kullanılan puanlamada puanlayıcı değişkenliğinin, puanlayıcı puanlamalarındaki farklılığın analitik puanlama anahtarına göre daha az olduğu belirlenmiştir. Bu durumda ChatGPT-4o ve puanlayıcıların dereceleme ölçeğini daha iyi kullandığı ve aynı

durum için dereceleme ölçeğinden elde edilen puanların güvenilirliğinin daha yüksek olduğu sonucuna ulaşılmıştır. Literatürde yapay zeka harici puanlayıcılar için dereceleme ölçeği ve analitik puanlama anahtarları ile yapılan karşılaştırmalarda, dereceleme ölçeğinden daha yüksek güvenilirlik katsayısı elde edildiğine dair bulgular bu araştırma sonuçlarını destekler niteliktedir (Aktaş & Alıcı, 2017; Doğan & Uluman, 2017; Nalbantoğlu Yılmaz, 2024).

Çalışmadaki yapay zeka ile otomatik puanlamada dereceleme ölçeğinden daha yüksek güvenilirlik elde edildiği sonucuna ulaşılmıştır. Bu doğrultuda yapay zekanın puanlayıcı rolleri üstlendiği biçimlendirici değerlendirmelerde iyi hazırlanmış dereceleme ölçeği yaygın kullanılan analitik puanlama anahtarlarına alternatif olabilir. Bu çalışma öğretmen adaylarının hazırladığı performans görevlerini yapay zeka ile puanlarken hangi tür puanlama anahtarının daha yüksek güvenilirlik katsayısı verdiğine odaklanmaktadır. Araştırma sonuçlarının genellenebilirliği açısından farklı performans durumları için çalışma tekrar edilebilir. Araştırma biçimlendirici değerlendirmelerde ve küçük örneklemelerde zamansal açıdan tercih edilmesi sebebiyle analitik puanlama anahtarı ve dereceleme ölçekleri ile sınırlıdır. Başka bir araştırmada bütüncül puanlama anahtarları için ChatGPT'nin uzmanlara göre nasıl puanlamalar yaptığı araştırılabilir.

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İNKLÜZİV TƏHSİLDƏ UŞAQLARIN SOSİALLAŞMASINDA MÜƏLLİM- ŞAĞİRD VƏ ŞAĞİRDLƏR ARASI MÜNASİBƏTLƏRİN TƏŞKİLİ

GÜNEL ARZU QIZI ŞADLİNSKAYA
ADPU-nun Quba filialının baş müəllimi

İnklüziv təhsil - təhsilin hər bir insan, hər bir vətəndaş üçün əlçatan olmasını nəzərdə tutan, hər kəsin təhsil almaq hüququnu təmin edən və hər bir şəxsin fərqli ehtiyaclarına əsaslanan əlverişli təhsil üsuludur. Belə təhsil üsulu xüsusilə sağlamlığında psixi və fiziki problemləri olan, qüsuru olan uşaqların, xüsusi qayğıya ehtiyacı olan uşaqların təhsilə cəlb edilməsini təmin edir. Bu təhsil üsulu fiziki və əqli qüsurlu uşaqların öz bacarıqlarına çatmaq, istedadlarını nümayiş etdirmək, qabiliyyətlərini üzə çıxarmaq imkanlarını dəstəkləyir və onları təmin edir. Bu təhsil sistemi sağlamlığında qüsuru olan uşaqlarda özünə inam yaradır və digər qüsursuz olan uşaqlarla bərabərhüquqlu olmalarını təmin və təşkil edir.

İnklüziv təhsil yalnız xüsusi qayğıya ehtiyacı olan uşaqların təhsilə cəlb olunması deyil, həmçinin müxtəlif mədəniyyətlərə malik, həyat tərzlərinə görə bir birindən fərqlənən, başqa dillərdən olan, başqa ölkələrdən gələn, miqrant ailələr, yer dəyişmələri olan hərbi ailələrinin uşaqları da inklüziv təhsilə qoşula bilərlər (1.s. 152).

“İnklüziv təhsil hər bir şagirdin fiziki, əqli, emosional, sosial, linqvistik və ya digər vəziyyətlərindən asılı olmayaraq hər bir şagirdin əsas təhsil hüquqnaməlik olduğu inancından irəli gəlir (2, s. 4.).

İnklüziv təhsilə cəlb olunmuş uşaqların təhsil keyfiyyətinin yüksəldilməsində mühüm amillərdən biri onların sosial fəaliyyəti, geniş dünyagörüşü, həyatda fəal mövqe tutması – bir sözlə sosailləşməsi xüsusi əhəmiyyət kəsb etməkdədir. İnklüziv uşaqların ailədən başlamış sosailləşməsi, məktəb təhsili illərində, sonrakı dövrlərdə də daha sistemli şəkildə davam etdirilməlidir.

Sosiallaşma, sosial münasibətlər dedikdə insanın başqa insanlarla ünsiyyət və münasibətləri, ictimai yerlərdə, müxtəlif kollektivlərdə qruplarda, komandalarda insanlarla ünsiyyəti, rəftarı müxtəlif müsabiqələrdə iştirak etməsi, cəmiyyət içində düzgün davranış və rəftarı, qəbul edilmiş ünsiyyət mədəniyyətiə sahib olması ən vacib və mühüm məqamardan hesab edilir.

İnklüziv təhsilə cəlb olunmuş uşaqların sosailləşməsində uşaqların fəal sosial münasibətlərə qoşulması, müxtəlif fəaliyyət növlərində, müsabiqə və müzakirələrdə, idman yarışlarında iştirak etməsi və bu pedaqoji proseslərdə müəllim- şagird münasibətləri, şagird- şagird münasibətləri xüsusi əhəmiyyət kəsb edir.

“Xüsusi qayğıya ehtiyacı olan uşaqların təlim- tərbiyə vəzifələrindən biri onların cəmiyyətə adaptasiyası, kollektiv ünsiyyət və münasibətlərinin təmin edilməsidir (3, s. 10).

Ümumiyyətlə ünsiyyət və münasibətlər heç də asan məsələ olmayıb, həmişə müəyyən çətinliklərlə, problemlərlə, gözlənilməz hadisələrlə mövcud olmuşdur. Bu cəhətdən insanlarla ünsiyyət və münasibətlərin qurulması, xüsusilə inklüziv uşaqlarla sağlamlığı normal uşaqların ünsiyyət və münasibətlərinin təşkili çox diqqət və məsuliyyət tələb edən psixopedaqoji məsələdir.

Məlum olduğu kimi şagirdlər vaxtlarının çox hissəsini məktəbdə müəllimlərlə, sinif yoldaşları ilə keçirirlər. Müəllimin şagirdlər üzərində böyük nüfuza malik olması, şagirdlərlə ünsiyyət və münasibətləri, həmçinin şagirdlərarası münasibətlərə də təsir göstərir. Müəllim – şagird münasibətlərinin düzgün qurulması təhsilin keyfiyyətinə, şagirdlərin şəxsiyyətinin formalaşmasına, onların mədəni və mənəvi səviyyələrinin yüksəlməsinə qüvvətli təsir göstərən amillərdəndir.

Inklüziv təhsildə əsas işlər müəllim və şagird ünsiyyət və münasibətlərindən başlayır. Bu cəhətdən müəllimin səriştəliliyi, yaradıcı fəaliyyəti, xüsusi qayğıya ehtiyacı olan uşaqlarla işləyə bilmək qabiliyyəti yüksək dərəcədə olmalıdır. Xüsusi qayğıya ehtiyacı olan uşaqlarda inklüziv təlim mühitinə adaptasiya prosesi gətirdiyi kimi, həmin siniflərdə dərs deyən müəllimlərdə də bu pedaqoji proses baş verməlidir.

Müəllim tədris edəcəyi materialın inklüziv şagird tərəfindən necə və hansı dərəcədə qavranılacağını yaxşı bilməlidir. O inklüziv şagirdlərin potensial imkanlarını, qabiliyyətlərini yaxşı bilməlidir. Müəllim elə pedaqoji yanaşma etməlidir ki, inklüziv şagird dərs prosesində fəal və təşəbbüskar olsun. Müəllim sağlamlıq imkanları məhdud olan şagirdlərlə bağlı narahatlığını hər hansı formada hiss etdirmiş olarsa, bu, təhsilalanın dərs prosesindəki fəaliyyətinə mənfi təsir göstərir, bu kateqoriyadan olan şagirdə həddindən artıq diqqət ayrılması isə onlarda dərs prosesindən heç zaman yüksək nəticə ala bilməyəcəyi fikrini formalaşdırır və müəllimdən asılılığa səbəb ola bilər.

Müəllimin şagirdlərlə düzgün ünsiyyət və münasibətləri şagirdlərin özünə inamını, özünə güvən hissini artırır, onlarda təlimə məsuliyyətli münasibət, motivasiya, bilik qazanmağa stimül, maraq və məhəbbət yaradır

Müəllim-şagird münasibətləri sağlam, inam, hörmət və sevgi çərçivəsində qurulmalı, sinifdə tam səmimiyyət, diqqət və qayğı hökm sürməlidir. Belə olan halda müəllim sinfi rahatlıqla idarə edir, şagirdlər də sinifdə özlərini rahat hiss edirlər.

Müəllim şagirdlərinə bilik və bacarıqlar qazandırdığı kimi, şagirdlərlə ünsiyyət və münasibətlərində onlara nümunə olmalı, insanlara qarşı sevgi, hörmət, mərhəmət, dostluq, tolerantlıq, nizam-intizam kimi anlayışlar və keyfiyyətlər qazandırılmalıdır.

İnklüziv uşaqlarla ünsiyyət və münasibətlər xüsusi diqqət tələb edir. Müəllim sağlamlıq imkanları məhdud olan şagirdləri dəstəkləmək, fəallaşdırmaq üçün ən səmərəli yolu seçməli və onları cəmiyyətə yararlı vətəndaş kimi, bir şəxsiyyət kimi hazırlamağı bacarmalıdır.

Müəllim sağlamlıq imkanları məhdud olan uşaqlarla ünsiyyət və münasibətlərdə bir neçə istiqamətdə onlara dəstək ola bilər:

1. Sosial istiqamət – ünsiyyət və münasibətlərin əsasını təşkil edir. Bu cəhətdən müəllim ünsiyyət və münasibətlərində söhbətin sosial cəhətinə, inklüziv uşaqlarda həyatı baxış və dünyagörüşünün formalaşmasına diqqət yetirməlidir.

2. Ünsiyyət və münasibətlərdə emosionallıq, jest və mimikilardan yerində istifadə etmək söhbətin daha canlı, mənalı olmasına səbəb olacaqdır. Sağlamlıq imkanları məhdud olan şagirdlərin hər birinin emosional dəstəyə ehtiyacı daha çox olur. Çünki özünün başqalarından daha zəif olduğunu iddia edən təhsilalan daim özünə qapanır və ünsiyyət qurmaqda çətinlik çəkir. Müəllim belə vəziyyətlərdə şagirdlərə emosional dəstək göstərməli, onlarda yaranmış neqativ halları aradan qaldırmalıdır.

3. Ünsiyyət və münasibətlərdə uşaqlarda öz güvən və inam hissələrinin, istedad və bacarıqlarının inkişaf etdirilməsinə xüsusi diqqət yetirilməlidir.

4. Ünsiyyət və münasibətlərdə sağlamlıq imkanları məhdud olan uşaqlarla digər uşaqların arasında düzgün səmimi, qarşılıqlı münasibətlərin yaradılmasına diqqət yetirilməlidir. Bu prosesdə müəllimlərin psixoloqla və valideynlərlə birgə fəaliyyət göstərməsi də çox vacibdir.

Müəllimlər tədris prosesi zamanı sağlamlıq imkanları məhdud olan təhsilalanlarda öyrənmə bacarıqlarına inam formalaşdırılmalıdır. Bu cür inam formalaşmış şagirdlər artıq özlərini zəif hiss etmədiklərinə görə onlarda özünəinam formalaşacaq. Sağlamlıq imkanları məhdud olan şagirdlər üçün ən önəmli məsələ onlarda kommunikativ və konstruktiv bacarıqların formalaşdırılmasıdır. Müəllim təkcə belə şagirdlərlə deyil, bütün siniflə kollektiv şəkildə iş aparmalıdır. Bu zaman ətrafdakıların sağlamlıq imkanları məhdud şagirdlərə olan münasibətini tənzimləmək mümkün olacaqdır.

Şagirdlər də məktəbdaxili münasibətlərdə, şagirdlərarası ünsiyyət və münasibətlərdə müəllimlərini özlərinə rol-model seçməli, onlardan nümunə götürməlidirlər. Müəllimin geyimi, hərəkətləri, danışığı, həmkarlarına və şagirdlərinə yanaşma tərzini şagirdlərin, o cümlədən inklüziv uşaqların daim diqqət mərkəzindədir.

İnklüziv təhsil müəllimin valideynlərlə daim əlaqədə olmasını tələb edir. Çünki tədris prosesində yaradılmış dəstəkləyici mühitin evdə də davam etdirilməsi müühm əhəmiyyət kəsb edir.

Bu zaman təhsilverənlər valideynlərdən şagirdin ehtiyacları ilə bağlı daha geniş məlumat ala bilir və tədris prosesində həmin məlumatlardan yararlanı bilər. Valideynlərlə təkcə kollektiv şəkildə deyil, məqsədyönlü şəkildə fərdi və qrup şəkildə də iş aparılmalıdır. Müəllim valideynlərin psixologiyasında yaranan çatışmazlıqları aradan qaldırmağa dəstək olmalı və sağlamlıq imkanları məhdud olan uşaqların cəmiyyətdə özünə yer tutması üçün valideyn və ailə imkanından əlverişli şəkildə istifadə etməyi bacarmalıdır.

Təcrübə və müşahidələrdən məlum olur ki, sağlamlıq imkanları məhdud olan şagirdlərin digər şagirdlərlə ünsiyyətində müəyyən çətinliklər və problemlər yaranı bilər. Bu çətinliklər, ilk növbədə, onlarda olan qüsurlar və çatışmazlığın yaratdığı çətinliklərdir. Bu problem müəllimlərin diqqətindən qaçmamalı və belə vacibli problem aradan qaldırılmalıdır.

İnklüziv uşaqlarla sosial yönümlü işin təşkilində şagirdlər arası münasibətlərdə bir sıra pedaqoji, psixoloji və sosial tələblərə də əməl edilməlidir:

1. Uşaqların sosial fəaliyyətində humanizm və demokratizm tələbi bütün insanlara diqqət və qayğı ilə yanaşmağı, mərhəmət göstərməyi, xüsusilə uşaqlara sevgi və məhəbbət göstərməyi və həmçinin onların ünsiyyət tələbatının yerinə yetirilməsini, digər insanlarla fəal işgüzar münasibətlərdə olmasını, hüquqlarının qorunmasını və digər bu kimi tələblərin yerinə yetirilməsini nəzərdə tutur.

2. Hər bir şəxsin ehtiyaclarına və fərdi xüsusiyyətlərinə uyğun olaraq yanaşma tələbi insana bir insan və bənzərsiz, təkrarsız bir şəxsiyyət kimi yanaşmanı ifadə edir. Şəxsiyyət yanaşması istedadlığa, açılmamış qabiliyyət axtarışını əhatə edir. İnklüziv uşaqlarda çox yüksək istedad və qabiliyyət ola bilər ki, sosial iş prosesində, şagirdlər arası münasibətlərdə uşaqların istedad və qabiliyyətləri üzə çıxarılmalı və onlar da inkişaf etdirilməlidir.

3. Şagirdlər arası ünsiyyət və münasibətlərdə qarşılıqlı hörmət və səmimiyyət, etimad və etibarlılıq sosiallaşmanın mühüm tələblərindən hesab edilir. Bu tələb həmçinin ünsiyyət və münasibətlərdə etik normalara əməl edilməsi deməkdir.

4. Ünsiyyət və münasibətlərdə həmçinin cinsi fərqlərin, yaş və fərdi xüsusiyyətlərin, şəxsi ehtiyacların, sağlamlıq məhdudiyyətlərinin nəzərə alınması sosial tələblər sırasındadır.

5. Şagirdlərarası ünsiyyət və münasibətlərdə həmçinin empatiya, duyğusal açıqlıq, rəhmdillik, tolerantlıq, qarşılıqlı hörmət sosiallaşmanın mühüm tələblərindən hesab edilir.

Əlbəttə, şagirdlər arası münasibətlər çox yönlü pedaqoji, psixoloji və sosial prosesdir. Sosiallaşmanın bu əlverişli imkanlarından həmişə səmərəli və yaradıcılıqla istifadə edilməlidir.

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İNKLÜZİV TƏHSİLDƏ UŞAQLARIN SOSİALLAŞMASINDA MÜƏLLİM- ŞAGİRD VƏ ŞAGİRD LƏR ARASI MÜNASİBƏT LƏRİN TƏŞKİLİ XÜLASƏ

Xüsusi qayğıya ehtiyacı olan uşaqların təlim- tərbiyə vəzifələrindən biri onların cəmiyyətə adaptasiyası, kollektiv ünsiyyət və münasibətlərinin təmin edilməsidir.

İnklüziv uşaqlarla ünsiyyət və münasibətlərinin təşkili çox diqqət və məsuliyyət tələb edən psixopedaqoji məsələdir. Müəllimin şagirdlər üzərində böyük nüfuza malik olması, şagirdlərlə ünsiyyət və münasibətləri, həmçinin şagirdlər arasındakı münasibətlərə də təsir göstərir və şagirdlər arasındakı ünsiyyət və münasibətlər qurulur. Bu münasibətlər inklüziv uşaqların sosiallaşmasına və təhsilinin uğurla davam etməsinə mühüm təsir göstərir.

Açar sözlər: İnklüziv təhsil, sosiallaşma, ünsiyyət və münasibətlər, müəllim- şagird münasibətləri, şagirdlər arasındakı münasibətlər.

ORGANIZATION OF TEACHER-STUDENT AND STUDENT RELATIONSHIPS IN THE SOCIALIZATION OF CHILDREN IN INCLUSIVE EDUCATION**SUMMARY**

One of the educational and upbringing tasks of children with special needs is their adaptation to society, ensuring collective communication and relationships.

Organizing communication and relationships with inclusive children is a psychopedagogical issue that requires great attention and responsibility. The teacher's great influence over students, communication and relationships with students, also affect relationships between students, and communication and relationships are established between students. These relationships have a significant impact on the socialization of inclusive children and the successful continuation of their education.

Keywords: Inclusive education, socialization, communication and relationships, teacher-student relationships, relationships between students.

ОРГАНИЗАЦИЯ ОТНОШЕНИЙ УЧИТЕЛЬ-УЧЕНИК И ОБЩЕНИЯ МЕЖДУ УЧЕНИКАМИ В СОЦИАЛИЗАЦИИ ДЕТЕЙ В ИНКЛЮЗИВНОМ ОБРАЗОВАНИИ

РЕЗЮМЕ

Одной из задач образования детей с особыми потребностями является обеспечение их адаптации к обществу, коллективному общению и взаимоотношениям.

Организация общения и взаимоотношений с инклюзивными детьми — психолого-педагогическая проблема, требующая большого внимания и ответственности. Большое влияние учителя на учеников, его общение и отношения с учениками, также влияют на отношения между учениками, и между учениками устанавливаются общение и отношения. Эти отношения оказывают существенное влияние на социализацию инклюзивных детей и успешное продолжение их образования.

Ключевые слова: инклюзивное образование, социализация, общение и отношения, между учитель и ученик, между ученической общения и отношения.

OKUL ÖNCESİ DÖNEMDE İNGİLİZCE ÖĞRETİMİNDE SCRATCH'IN ETKİLİLİĞİ: DENEYSEL BİR ÇALIŞMA

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ÖZET

Bu çalışma, okul öncesi düzeyindeki çocukların yabancı dil becerilerini desteklemek amacıyla Scratch programının etkisini incelemektedir. Araştırma, 31 deney ve 29 kontrol grubu olmak üzere toplam 60 öğrenci üzerinde gerçekleştirilmiştir. Çalışmanın odağı, çocukların İngilizce kelime ezberleme ve "daily routines" (günlük rutinler) ile ilgili sorulara cevap verme düzeylerini değerlendirmektir.

Deney grubundaki çocuklara 4 haftada 5 gün boyunca Scratch programı kullanılarak dersler verilmiştir. Bu süreçte, çocukların kendi sesleri ve figürleri kullanılarak oluşturulan İngilizce günlük ifade kalıpları Scratch programına entegre edilmiş ve eğitim bu dijital ortamda sürdürülmüştür. Kontrol grubundaki öğrenciler ise aynı süre boyunca geleneksel materyaller ve sınıf içi aktiviteler ile, özellikle flash kartlar kullanılarak eğitim almıştır. Deney ve kontrol gruplarının İngilizce kelime bilgisi, uygulama öncesinde sözlü olarak ölçülmüş, öğretmenler tarafından kaydedilmiştir. Araştırmada, her iki gruba da ilk defa karşılaşacakları yeni kelimeler ve ifade kalıpları öğretilecek şekilde bir ders planı oluşturulmuştur. Derslerde toplam 10 adet "daily routines" kalıp kelimesi ve 10 adet soru kalıbı öğretici materyal olarak kullanılmıştır. Araştırmanın sonucunda, deney grubundaki çocukların Scratch programı aracılığıyla öğretildiği kelime ve kalıpları daha fazla sayıda hatırladıkları ve sorulara kontrol grubundaki çocuklara göre daha doğru cevap verdikleri gözlemlenmiştir. Bu bulgular, okul öncesi düzeyindeki yabancı dil eğitiminde Scratch programının etkili bir araç olarak kullanılabileceğini göstermektedir.

Anahtar Kelimeler: Okul öncesi eğitim, Scratch programı, yabancı dil eğitimi, dijital öğrenme, görsel-işitsel materyaller

THE IMPACT OF SCRATCH PROGRAMMING ON PRESCHOOLERS' ENGLISH LANGUAGE LEARNING: A QUASI-EXPERIMENTAL APPROACH

ABSTRACT

This study examines the effectiveness of the Scratch program in supporting foreign language skills in preschool children. The research was conducted with a total of 60 students, comprising

31 in the experimental group and 29 in the control group. The primary focus of the study is to assess children's ability to memorize English vocabulary and respond to questions related to “daily routines.”

Children in the experimental group received instruction five days a week using the Scratch program. During this process, English daily routine expressions were integrated into Scratch using the children's own voices and animated characters. Instruction was delivered within this digital environment. Meanwhile, students in the control group received instruction for the same duration using traditional materials and classroom activities, particularly with flashcards. The English vocabulary knowledge of both groups was assessed orally before the intervention and recorded by teachers. A lesson plan was developed in which both groups were introduced to new words and sentence structures they had not previously encountered. A total of 10 vocabulary items and 10 question patterns related to daily routines were used as instructional content.

The findings revealed that children in the experimental group remembered more vocabulary items and expressions and responded more accurately to questions compared to those in the control group. These results suggest that the Scratch program can be used as an effective tool in preschool foreign language education.

Keywords: Preschool education, Scratch program, foreign language education, digital learning, audiovisual materials

GİRİŞ

Erken çocukluk dönemi, bireyin dil gelişiminin en hızlı ve en esnek olduğu dönemlerden biridir (Kuhl, 2010). Bu dönemde edinilen dil becerileri, yalnızca ana dil gelişimi açısından değil, aynı zamanda yabancı dil öğrenimi açısından da büyük önem taşır. Yapılan araştırmalar, 3-6 yaş aralığındaki çocukların fonolojik farkındalıklarının yüksek olması nedeniyle yabancı dildeki sesleri kolayca ayırt edebildiklerini ve bu sesleri doğru telaffuz edebildiklerini göstermektedir (Nikolov & Djigunović, 2011). Bu nedenle okul öncesi dönemde yabancı dil öğretiminin başlatılması, hem akademik hem de kültürel açıdan çocukların çok yönlü gelişimini destekleyen stratejik bir yatırımdır (Garton & Copland, 2019).

Geleneksel sınıf içi materyallerin ötesine geçerek çocuklara yabancı dili öğretmede teknolojinin sunduğu olanaklar her geçen gün daha fazla önem kazanmaktadır. Özellikle erken yaş gruplarına yönelik dijital araçlar, öğrenme sürecini hem eğlenceli hem de kalıcı hale getirmektedir (Yelland, 2005). Bu bağlamda, Scratch Jr. gibi kodlama temelli görsel-işitsel platformlar, çocukların hem teknolojik okuryazarlıklarını hem de dilsel becerilerini eş zamanlı

olarak geliştirebilecek potansiyele sahiptir (Bers, 2018). Yapılan çalışmalar, çocukların kendi seslerini ve görsellerini kullanabildikleri ortamlarda daha fazla içsel motivasyon geliştirdiklerini ve öğrendiklerini daha uzun süre hatırlayabildiklerini ortaya koymaktadır (Papadakis vd., 2021).

Scratch Jr., temel düzeyde kodlama becerileri kazandırmanın yanı sıra, çocuklara anlatı oluşturma, karakter canlandırma ve duygusal ifade gibi birçok bilişsel ve sosyal beceri kazandırma amacıyla tasarlanmış bir dijital ortamdır (Resnick vd., 2009). Özellikle okul öncesi dönemde dil öğretimi sürecine entegre edildiğinde, çocukların öğrenme sürecine aktif katılımını artırmakta ve öğrenmeyi deneyimsel hale getirmektedir. Öğrenmeye yönelik bu tür yapılandırmacı yaklaşımlar, Piaget (1954) ve Vygotsky'nin (1978) kuramlarıyla da uyumludur. Vygotsky'nin "yakınsak gelişim alanı" kavramı uyarınca, çocuğun kendi başına yapamayacağı ancak rehberlik altında başarabileceği görevler arasında dijital dil öğrenme uygulamaları önemli bir araç olabilir.

Türkiye'de okul öncesi dönemde yabancı dil eğitimi henüz yaygınlaşma aşamasındayken, bu yaş grubuna yönelik teknoloji destekli öğretim modelleri üzerine yapılan akademik çalışmalar oldukça sınırlıdır (İnal & Özdemir, 2022). Bu durum, dijital araçların pedagojik potansiyelinin yeterince araştırılmadığını ve uygulamada nasıl etkili bir şekilde kullanılabileceğine dair ampirik verilerin eksik olduğunu göstermektedir. Bu bağlamda, mevcut araştırma, Scratch programı aracılığıyla okul öncesi dönemde İngilizce öğretiminin etkilerini değerlendirmek üzere tasarlanmıştır.

Bu çalışmanın temel çıkış noktası, erken yaşta başlayan dil öğreniminin teknolojiyle desteklenmesi durumunda daha etkili ve kalıcı olabileceği varsayımdır. Araştırma, çocukların İngilizce kelime öğrenme ve "daily routines" temalı sorulara cevap verme becerileri üzerinde Scratch destekli öğretimin etkisini karşılaştırmalı olarak incelemeyi amaçlamaktadır. Elde edilen bulguların, okul öncesi eğitim politikalarının dijital dönüşümüne katkı sunması beklenmektedir.

KURAMSAL ÇERÇEVE

Bu araştırmanın kuramsal temeli, özellikle okul öncesi dönemde yabancı dil öğretiminde teknolojinin etkilerini açıklayabilecek üç temel yaklaşıma dayanmaktadır: Yapılandırmacı Öğrenme Kuramı, Çoklu Ortam Öğrenme Kuramı ve Sosyo-Kültürel Öğrenme Kuramı.

1. Yapılandırmacı Öğrenme Kuramı

Yapılandırmacı kuram, öğrenmenin aktif, deneyime dayalı ve bireysel anlam inşa süreçleriyle gerçekleştiğini savunur (Piaget, 1954). Bu yaklaşıma göre çocuklar, çevreleriyle etkileşim içinde bilgi yapılandırır ve öğrenme, pasif bilgi aktarımından ziyade etkin katılım ve

keşfetme yoluyla gerçekleşir. Scratch Jr. gibi dijital programlar, çocuklara karakter seçme, ses kaydetme ve hikâye oluşturma gibi yapılandırmacı deneyimler sunarak bu süreci desteklemektedir (Bers, 2018).

Bu araçlar, çocuklara yalnızca dilsel girdiler sunmakla kalmaz, aynı zamanda bu girdileri kendi anlatıları içerisinde kullanmalarını teşvik eder. Böylece öğrenme, bireysel deneyimle birleşerek daha kalıcı hale gelir. Yapılandırmacı kurama göre dijital ortamlar, çocuğun kendi bilgi üretimini sağlayan araçlar olduğunda etkili öğrenme gerçekleşir (Hsin, Li & Tsai, 2014).

2. Çoklu Ortam Öğrenme Kuramı

Mayer'in (2005) geliştirdiği çoklu ortam öğrenme kuramı, bilginin sözel ve görsel biçimlerde birlikte sunulmasının, öğrenmeyi daha etkili kıldığını öne sürer. Özellikle okul öncesi çağındaki çocuklar, soyut kavramları görsel-işitsel araçlar yardımıyla daha kolay anlayabilmektedir (Moreno & Mayer, 2007). Scratch, çocuklara kelimeleri animasyonlar, ses kayıtları ve etkileşimli karakterlerle sunarak Mayer'in çoklu ortam ilkelerini doğrudan pratiğe dökmektedir.

Örneğin, “wake up” ifadesinin bir karakterle ilişkilendirilmesi ve çocuğun kendi sesiyle bu ifadeyi kodlaması, hem görsel hem işitsel hafızanın birlikte çalışmasını sağlar. Bu durum öğrenmenin hem anlık kavranmasını hem de uzun vadede hatırlanmasını kolaylaştırır (Clark & Mayer, 2016).

3. Sosyo-Kültürel Öğrenme Kuramı

Lev Vygotsky'nin (1978) sosyo-kültürel öğrenme kuramı, bireyin öğrenme sürecini sosyal bağlam ve araçlarla şekillendirdiğini savunur. Bu kurama göre, bireylerin gelişimi kültürel araçlarla (dil, semboller, dijital araçlar vb.) ve sosyal etkileşimlerle gerçekleşir. Scratch gibi dijital platformlar, çocuğun bilişsel gelişimini destekleyen birer “psikolojik araç” olarak değerlendirilebilir (Vygotsky, 1978).

Scratch'in sunduğu olanaklar çocukların bireysel yaratım süreçlerine katkı sunarken, aynı zamanda öğretmen ve akran etkileşimleriyle zenginleşen öğrenme ortamları oluşturur. Çocukların kendi karakterlerini yaratması ve dilsel ifadeleri modellemesi, Vygotsky'nin “yakınsak gelişim alanı” (ZPD) kavramı ile de örtüşmektedir. Bu yaklaşım, çocuğun yetişkin desteğiyle gerçekleştirdiği görevlerin zamanla bağımsız olarak yapılabileceğini vurgular (Kozulin, 2003).

Bu üç kuram, dijital teknolojilerle desteklenen yabancı dil öğrenme ortamlarının neden etkili olabileceğini hem pedagojik hem psikolojik olarak açıklamaktadır. Scratch programı, çocuğun kendi bilişsel, sosyal ve kültürel süreçlerini etkin biçimde bir araya getirebileceği bir öğrenme alanı sunarak bu kuramsal temellerle bütünleşmektedir.

ARAŞTIRMANIN AMAÇLARI

Yabancı dil öğretiminin erken yaşlarda başlamasının, çocukların dil gelişimine olumlu katkılar sağladığı çeşitli araştırmalarla ortaya konmuştur (Kuhl, 2010; Nikolov & Djigunović, 2011). Bununla birlikte, teknoloji destekli öğrenme araçlarının bu süreçte nasıl ve ne ölçüde etkili olduğu henüz yeterince açıklığa kavuşmamıştır. Bu bağlamda, bu araştırmanın temel amacı, okul öncesi dönemde Scratch programı aracılığıyla yürütülen İngilizce öğretiminin, çocukların kelime bilgisi ve ifade kalıplarını kullanma becerileri üzerindeki etkisini değerlendirmektir.

Araştırmanın alt amaçları şunlardır:

1. Scratch programı ile desteklenen dijital öğretimin, okul öncesi dönemdeki çocukların İngilizce kelime öğrenme düzeyine etkisi nedir?
2. Deney ve kontrol grubu öğrencileri arasında “daily routines” (günlük rutinler) temalı İngilizce ifade kalıplarını anlama ve doğru yanıt verme düzeylerinde anlamlı bir fark var mıdır?
3. Teknoloji destekli öğretim sürecinde çocukların motivasyon ve öğrenmeye katılım düzeyleri öğretmen gözlemlerine göre nasıl değişmektedir?

Araştırmanın Önemi

Erken çocukluk döneminde sunulan kaliteli yabancı dil eğitimi, çocukların sadece dilsel yeterliklerini değil, aynı zamanda bilişsel esneklik, problem çözme, kültürel farkındalık ve iletişim becerilerini de desteklemektedir (Garton & Copland, 2019). Bu bağlamda, dijital teknolojilerin erken yaşta yabancı dil öğretiminde nasıl kullanıldığı, çağdaş eğitim araştırmalarının temel sorularından biri haline gelmiştir (Yelland, 2005).

Scratch programı, çocukların hem bilişsel hem de dilsel gelişimlerini destekleyici etkileşimli ortamlar sunan ve okul öncesi döneme uygun olarak geliştirilen görsel programlama araçlarından biridir (Bers, 2018). Bu araştırma, Türkiye bağlamında, Scratch’ın okul öncesi düzeyde İngilizce öğretimi üzerindeki etkilerini deneysel olarak inceleyen az sayıdaki çalışmadan biri olması açısından önem taşımaktadır.

Ayrıca çalışma, öğretmenlerin teknoloji destekli öğretim ortamlarına yönelik tutumlarını geliştirmeleri, sınıf içi uygulamalarda dijital araçları pedagojik amaçla nasıl entegre edeceklerine dair yol haritaları oluşturmaları açısından da öğretici niteliktedir. Eğitim politikaları açısından değerlendirildiğinde ise, Milli Eğitim Bakanlığı’nın okul öncesi müfredatında yer alan dijital okuryazarlık ve erken yaşta dil eğitimi hedeflerine doğrudan katkı sağlayacak veriler üretmektedir.

Sonuç olarak, bu çalışma sadece akademik literatüre değil; uygulayıcılara, program geliştiricilere ve eğitim karar vericilere somut öneriler sunabilecek özgün ve güncel bir katkı niteliğindedir.

YÖNTEM

Araştırma Modeli

Bu araştırma, ön test-son test kontrol gruplu yarı deneysel desen ile yürütülmüştür. Yarı deneysel desenler, kontrol edilebilir eğitim ortamlarında müdahale programlarının etkisini ölçmek için sıklıkla tercih edilmektedir (Creswell, 2012). Araştırmada, deney grubuna Scratch programı ile dijital destekli İngilizce öğretimi uygulanırken, kontrol grubuna ise geleneksel yöntemlerle aynı içerikler sunulmuştur. Müdahale öncesi ve sonrası her iki grubun performansları karşılaştırılarak, Scratch programının yabancı dil öğretimine etkisi analiz edilmiştir.

Çalışma Grubu

Araştırmanın çalışma grubunu, 2024–2025 eğitim öğretim yılında İstanbul’da özel bir anaokuluna devam eden toplam 60 okul öncesi öğrenci oluşturmaktadır. Bu öğrencilerden 31’i deney grubunda, 29’u ise kontrol grubunda yer almıştır. Gönüllülük esasına dayalı olarak belirlenen çocuklar, yaş ve gelişim düzeyi bakımından benzer özellikler göstermektedir. Gruplar, öğretmen ve okul yöneticilerinin iş birliğiyle homojen dağılım gözetilerek oluşturulmuştur. Cinsiyet dağılımı, gelişimsel değerlendirmeler ve sınıf öğretmenlerinin gözlemleri doğrultusunda gruplar arasında denge sağlanmıştır.

Veri Toplama Araçları

Araştırmada hem nicel hem de nitel veri toplama teknikleri kullanılmıştır. Kullanılan başlıca araçlar şunlardır:

- **İngilizce Kelime Tanıma Testi (Sözlü):** Araştırma kapsamında belirlenen “daily routines” temasına ait 10 temel İngilizce kelimenin çocuklar tarafından hatırlanma düzeyi sözlü olarak ölçülmüştür.
- **İfade Kalıbı Anlama Testi:** Çocuklara 10 farklı soru kalıbı sözlü olarak yöneltilmiş ve doğru yanıt verme durumları kaydedilmiştir.
- **Öğretmen Gözlem Formları:** Her ders sonunda öğretmen tarafından öğrencilerin motivasyon, katılım ve tepki düzeylerine ilişkin yapılandırılmış gözlem formları doldurulmuştur.

Tüm sözlü değerlendirmeler öğretmen tarafından doğrudan bireysel uygulanarak, öğrencilerin doğal tepkileri gözlemlenmiştir.

Veri Toplama Süreci

Veri toplama süreci, dört hafta boyunca haftada beş gün olmak üzere toplam 20 günlük bir uygulama sürecini kapsamaktadır:

- **Deney Grubu:** Scratch Jr. Programı aracılığıyla tasarlanan içeriklerle İngilizce dersleri almıştır. İçerikler, “wake up”, “brush your teeth”, “go to school” gibi günlük rutin temalı kalıplardan oluşmuştur. Çocuklar, bu ifadeleri kendi sesleriyle seslendirmiş, karakterleri canlandırarak animasyonlar oluşturmuştur.
- **Kontrol Grubu:** Aynı içeriklerle flash kartlar, posterler ve sınıf içi kitap etkinlikleri kullanılarak öğretim yapılmıştır. Bu gruba teknoloji desteği sadece dinleme ve fiillerin okunuşları ile sağlanmıştır.

Her iki gruba da ders öncesi ön test ve dersler tamamlandıktan sonra son test uygulanmıştır. Testlerde kullanılan kelime ve sorular her iki grup için aynı düzeydedir.

Verilerin Analizi

Toplanan nicel veriler SPSS 26.0 paket programı kullanılarak analiz edilmiştir. Verilerin analizine geçilmeden önce normallik varsayımının sağlanıp sağlanmadığını belirlemek için Shapiro-Wilk testi uygulanmış ve verilerin normal dağılıma uygun olduğu tespit edilmiştir. Deney ve kontrol grupları arasında anlamlı fark olup olmadığını belirlemek amacıyla bağımsız örneklemeler için t-testi uygulanmıştır. Anlamlılık düzeyi $p < .05$ olarak belirlenmiştir. Araştırmada ayrıca öğretmen gözlem formları tematik analiz yöntemi ile çözümlenmiş, öğrencilerin motivasyon ve katılım düzeyleri nitel olarak betimlenmiştir (Miles & Huberman, 1994). Bu çalışmada nitel veriler, deneysel desene sahip nicel bulguları derinleştirmek ve desteklemek amacıyla kullanılmıştır.

Geçerlik ve Güvenirlik

- **İçerik Geçerliği:** Geliştirilen ölçme araçları, İngilizce öğretimi ve okul öncesi eğitim alanında uzman akademisyenler tarafından incelenmiş ve içerik geçerliği sağlanmıştır.
- **Uygulayıcı Güvenirliği:** Öğretmenlerin uygulama sürecine dair tutarlılıklarının sağlanması amacıyla her grupta aynı öğretmenlerle süreç yürütülmüştür.
- **Gözlemci Tutarlılığı:** Gözlem formlarında yer alan ifadelerin farklı öğretmenler tarafından kodlanması sonucu %90 üzerinde kodlayıcılar arası uyum elde edilmiştir.

Bu önlemlerle birlikte, araştırmanın güvenilirliği ve geçerliği yüksek düzeyde korunmaya çalışılmıştır.

BULGULAR

1. Alt Amaca İlişkin Bulgular: İngilizce Kelime Öğrenme Düzeyine Etkisi

Scratch programı destekli öğretimin çocukların İngilizce kelime öğrenme düzeyine ilişkin deney grubu ön test- son test arasındaki farklılıkları gösteren İlişkili t-testi sonuçları Tablo 1’de verilmiştir.

Tablo 1. Deney Grubu Öğrencilerinin Ön Test ve Son Test İngilizce Kelime Bilgisi Puanları (İlişkili t-testi)

Gruplar	N	$\bar{x}$	ss	Sh $\bar{x}$	t	Sd	p
Öntest	31	5.30	1.20	-			
Sontest	31	8.60	1.10	-	7.45	30	< .001

($t(30) = 7.45, p < .001$).

Deney grubundaki öğrencilerin İngilizce kelime bilgisi ön test ve son test puanları karşılaştırıldığında, anlamlı bir farklılık olduğu görülmüştür. Ön test puan ortalaması $\bar{X} = 5.30$, SD = 1.20; son test puan ortalaması ise $\bar{X} = 8.60$, SD = 1.10 olarak hesaplanmıştır. İlişkili örneklemeler için yapılan t-testi sonucunda, öğrencilerin son test puanlarında anlamlı bir artış olduğu belirlenmiştir ($t(30) = 7.45, p < .001$). Bu bulgu, Scratch programı ile desteklenen dijital öğretimin, deney grubundaki okul öncesi öğrencilerin İngilizce kelime öğrenme düzeyini anlamlı biçimde artırdığını göstermektedir.

Tablo 2. Deney ve Kontrol Grubu Öğrencilerinin Son Test İngilizce Kelime Bilgisi Puanları (Bağımsız Örneklemeler t-Testi Sonuçları)

Gruplar	N	$\bar{x}$	ss	Sh $\bar{x}$	t	Sd	p
Deney Grubu	31	8.60	1.10	-			
Kontrol Grubu	29	6.20	1.40	-	4.97	58	< .001

($t(58) = 4.97, p < .001$).

Deney ve kontrol gruplarının son test İngilizce kelime bilgisi puanları karşılaştırıldığında, deney grubunun puan ortalaması $\bar{X} = 8.60$, SD = 1.10; kontrol grubunun ise $\bar{X} = 6.20$, SD = 1.40 olarak hesaplanmıştır. Bağımsız örneklemeler için yapılan t-testi sonucunda, iki grup arasında deney grubu lehine istatistiksel olarak anlamlı bir fark bulunmuştur ($t(58) = 4.97, p < .001$). Bu bulgu, Scratch destekli dijital öğretimin, geleneksel öğretim yöntemlerine kıyasla öğrencilerin İngilizce kelime öğrenme düzeylerini daha etkili biçimde geliştirdiğini göstermektedir.

2. Alt Amaca İlişkin Bulgular: İfade Kalıplarını Anlama Düzeyi

Scratch programı destekli öğretimin çocukların İngilizce ifade kalıplarını anlama ve doğru şekilde yanıtlama becerilerine etkisinin deney ve kontrol gruplarında farklılıklarını gösteren bağımsız örneklem t testi sonuçları Tablo 2’de gösterilmiştir.

Tablo 3. Deney Grubu Öğrencilerinin İngilizce İfade Kalıpları Ön Test ve Son Test Puanları (İlişkili Örneklem t-Testi Sonuçları)

Deney	N	$\bar{x}$	ss	Sh $\bar{x}$	t	Sd	p
Öntest	31	6.40	1.10	-			
Sontest	31	9.20	0.80	-	8.62	30	< .001

Deney grubundaki öğrencilerin İngilizce ifade kalıplarını anlama ve doğru şekilde yanıtlama becerilerine ilişkin ön test ve son test puanları karşılaştırıldığında, ön test puan ortalaması $\bar{X} = 6.40$, $SD = 1.10$; son test puan ortalaması ise $\bar{X} = 9.20$, $SD = 0.80$ olarak hesaplanmıştır. İlişkili örneklem t-testi sonucunda, öğrencilerin son test puanlarında anlamlı bir artış olduğu belirlenmiştir ($t(30) = 8.62$, $p < .001$). Bu bulgu, Scratch destekli öğretimin, öğrencilerin İngilizce ifade kalıplarını anlama ve doğru şekilde kullanma becerilerini anlamlı düzeyde geliştirdiğini göstermektedir.

Tablo 4. Deney ve Kontrol Grubu Öğrencilerinin İngilizce İfade Kalıpları Son Test Puanları (Bağımsız Örneklem t-Testi Sonuçları)

Gruplar	N	$\bar{x}$	ss	Sh $\bar{x}$	t	Sd	p
Deney Grubu	31	9.20	0.80	-			
Kontrol Grubu	29	7.50	1.30	-	6.21	58	< .001

($t(58) = 6.21$, $p < .001$).

Deney ve kontrol gruplarının İngilizce ifade kalıplarına ilişkin son test puanları karşılaştırıldığında, deney grubunun puan ortalaması $\bar{X} = 9.20$, $SD = 0.80$; kontrol grubunun ise $\bar{X} = 7.50$, $SD = 1.30$ olarak hesaplanmıştır. Bağımsız örneklem t-testi sonucunda, iki grup arasında deney grubu lehine istatistiksel olarak anlamlı bir fark bulunmuştur ($t(58) = 6.21$, $p < .001$). Bu sonuç, Scratch destekli öğretimin, okul öncesi öğrencilerin İngilizce ifade kalıplarını anlama ve doğru yanıt üretme becerilerini geleneksel öğretime kıyasla daha etkili şekilde geliştirdiğini ortaya koymaktadır.

3. Alt Amaca İlişkin Bulgular: Katılım ve Motivasyon Düzeyi

Scratch destekli öğretimin okul öncesi öğrencilerin öğrenmeye katılım ve motivasyon düzeyine etkisine ilişkin bulgular Tablo 5’te gösterilmiştir.

Tablo 5. Teknoloji Destekli Öğretim Sürecinde Çocukların Motivasyon ve Katılım Düzeylerine İlişkin Tematik Analiz Sonuçları (Öğretmen Gözlemlerine Dayalı)

Tema	Alt Kategoriler	Örnek Gözlem Cümlesi	Frekans (f)
Artan Katılım	Etkinliğe aktif katılım, gönüllü söz alma	"Scratch etkinliklerinde çocukların neredeyse tamamı gönüllü olarak etkinliğe katılıyor, söz almak için yarışıyorlardı."	12
Artan Duygusal Motivasyon	Merak, heyecan, öğrenme isteği	"Derse başlarken çocuklar heyecanla hangi karakterle ne yapacaklarını merak ediyorlardı."	9
Teknolojiye İlgi ve Dikkat Artışı	Ders süresince odaklanma, etkileşimli materyallere yönelme	"Bilgisayar başında dikkat süreleri daha uzun oldu, genelde çabuk sıkılan çocuklar bile etkinliği sonuna kadar takip etti."	11

Tablo 5’te görüldüğü üzere, teknoloji destekli öğretim sürecine ilişkin öğretmen gözlemleri doğrultusunda yapılan tematik analizde en sık gözlemlenen tema, **artan katılım** olmuştur ($f = 12$). Bu temayı sırasıyla **teknolojiye ilgi ve dikkat artışı** ($f = 11$) ve **artan duygusal motivasyon** ($f = 9$) izlemiştir. Öğretmen gözlemleri, Scratch programı ile yürütülen dijital etkinliklerin çocukların etkinliklere gönüllü ve istekli katılımını artırdığını, derslere yönelik ilgilerini pekiştirdiğini ve dikkat sürelerinde belirgin bir iyileşme sağladığını göstermektedir. Kodlama temelli etkileşimli içeriklerin, geleneksel etkinliklere kıyasla daha fazla heyecan, merak ve motivasyon yarattığı anlaşılmaktadır.

TARTIŞMA

Deney grubundaki çocukların ifade kalıplarını anlama ve uygun şekilde yanıtlama becerilerinin kontrol grubuna göre anlamlı biçimde yüksek olması, dijital öğrenme ortamlarının dil öğretiminde anlamlı fark yarattığını göstermektedir. Scratch Jr. programı ile sunulan içerikler; çocuklara günlük yaşamla ilişkilendirilebilecek etkileşimli, kişiselleştirilmiş ve sesli dil girdileri sağlamıştır. Bu durum, **Vygotsky’nin (1978)** sosyo-kültürel öğrenme kuramı bağlamında değerlendirildiğinde, çocukların dijital araçları birer "psikolojik aracı" olarak kullanarak dilsel ifadelere daha derinlikli anlam yükleyebildiklerini düşündürmektedir.

Ayrıca bu bulgu, **Mayer’in (2005)** çoklu ortam öğrenme ilkeleriyle de tutarlıdır. Özellikle **kişiselleştirme ilkesi** kapsamında, çocukların kendi seslerini kullanarak karakterlerine konuşma yazmaları hem işitsel hem görsel olarak bilgi işlemeyi desteklemiştir. Bu süreç, öğrenilen yapıların bellekte daha güçlü bir temsil oluşturmaya katkı sunmuştur.

Benzer şekilde, **Clark & Mayer (2016)** tarafından yapılan çalışmalar, öğrenme ortamlarında anlatıcının sesiyle özdeşlik kurmanın bilişsel katılımı artırdığını savunmaktadır. Bu bağlamda, çocukların karakterle özdeşleşerek öğrenmeleri, Scratch'ın pedagojik işlevini güçlendirmiştir. **Papadakis vd. (2021)** da küçük yaş grubundaki çocuklarda bu tür dijital araçlarla yapılan öğretimin dil becerilerine olumlu katkılar sağladığını belirtmiştir.

Sonuç olarak, bu alt amaç kapsamında elde edilen bulgular, Scratch gibi programların yalnızca kelime düzeyinde değil, **işlevsel ve bağlamsal dil yapılarının kazandırılmasında da etkili** olduğunu göstermektedir. Bu da dijital öğrenme ortamlarının, erken çocuklukta yapılandırılmış dil girdileriyle harmanlandığında geleneksel yöntemlerden daha üstün performans yaratabileceğine işaret etmektedir.

Bu araştırma, Scratch programı destekli dijital öğretimin okul öncesi dönemdeki çocukların İngilizce kelime öğrenme düzeyleri ile ifade kalıplarını anlama ve doğru yanıtlama becerilerine etkisini incelemiştir. Ayrıca, öğretmen gözlemleri aracılığıyla çocukların motivasyon ve derse katılım düzeyleri de nitel olarak değerlendirilmiştir. Bulgular genel olarak, dijital oyun temelli öğrenmenin çocukların dil gelişimi ve sınıf içi etkileşimlerine olumlu katkı sunduğunu ortaya koymaktadır.

Deney grubunda yer alan öğrencilerin ön test ve son test puanları arasındaki anlamlı fark, dijital ortamda sunulan içeriklerin çocukların kelime dağarcığını geliştirmede etkili olduğunu göstermektedir. Bu bulgu, oyun temelli öğrenmenin çocukların bilişsel süreçlerini harekete geçirdiğini ve öğrenmeyi kalıcı hale getirdiğini savunan çalışmaları desteklemektedir (Hirsh-Pasek vd., 2009; Zosh vd., 2018). Özellikle Scratch gibi etkileşimli ve görsel araçların kullanımı, küçük yaş gruplarındaki çocukların dikkatini çekmekte ve öğrenmeye karşı içsel motivasyonlarını artırmaktadır (Resnick vd., 2009).

Araştırmada ifade kalıplarına yönelik elde edilen bulgular da benzer şekilde, deney grubu lehine anlamlı farklar ortaya koymuştur. Bu durum, etkileşimli dijital içeriklerin yalnızca kelime öğretimi değil, aynı zamanda yapısal dil kalıplarının anlaşılmasında da etkili olduğunu göstermektedir. Özellikle görsel-işitsel destekli ve problem çözme odaklı dijital etkinliklerin, çocukların anlamlı bağlamlar içinde dili kullanmalarını kolaylaştırdığı bildirilmektedir (Neumann, 2018; Couse & Chen, 2010).

Nitel bulgular da nicel verileri desteklemektedir. Öğretmen gözlemleri, çocukların Scratch etkinlikleri sırasında motivasyonlarının arttığını, etkinliklere gönüllü katılım sağladıklarını ve dikkat sürelerinde gözle görülür bir iyileşme olduğunu ortaya koymuştur. Bu bulgular, teknoloji destekli öğretimin çocukların derse yönelik tutumlarını olumlu yönde etkilediğine işaret eden önceki çalışmalarla örtüşmektedir (Papadakis vd., 2021; Marsh vd., 2017).

Ayrıca öğretmen gözlem verileri, çocukların dijital araçlar kullanırken daha yüksek düzeyde odaklandıklarını ve bu etkinliklerin öğrenmeye yönelik duygusal bağlılıklarını artırdığını göstermektedir. Bu sonuç, Vygotsky'nin sosyal etkileşim yoluyla öğrenme kuramıyla da uyumludur; çocuklar, dijital ortamda sunulan materyallerle etkileşim kurarak öğrenme süreçlerini daha aktif hale getirmektedir (Vygotsky, 1978).

Sonuç ve Öneriler

Bu araştırma, Scratch programı destekli dijital öğretimin okul öncesi çocukların İngilizce dil öğrenme sürecine önemli katkılar sunduğunu ortaya koymuştur. Elde edilen bulgular hem kelime bilgisi hem de ifade kalıpları açısından deney grubu lehine anlamlı gelişmelere işaret etmektedir. Ayrıca nitel veriler, bu öğretim sürecinin çocukların motivasyon, dikkat süresi ve katılım düzeylerini artırdığını göstermektedir.

Bu doğrultuda, şu sonuçlara ulaşılmıştır:

1. Scratch tabanlı dijital öğretim, çocukların İngilizce kelime öğrenme becerilerini anlamlı düzeyde geliştirmektedir.
2. İngilizce ifade kalıplarını anlama ve doğru yanıt üretme becerileri, dijital destekli öğrenme ortamlarında daha etkin biçimde gelişmektedir.
3. Öğrenciler dijital içeriklere karşı daha yüksek motivasyon göstermekte, öğrenmeye daha istekli ve dikkatli katılmaktadır.
4. Nitel bulgular, nicel verileri destekler niteliktedir ve öğretmen gözlemleri aracılığıyla öğrenme sürecine dair derinlikli bilgiler sunmaktadır.

Öneriler:

- Okul öncesi dönemde dijital oyun temelli araçlar (özellikle Scratch gibi programlama temelli uygulamalar) müfredata entegre edilmeli ve öğretmenlerin bu araçları etkili kullanabilmesi için hizmet içi eğitimler verilmelidir.
- Dil öğrenimi başta olmak üzere, diğer alanlara da uyarlanabilecek dijital içeriklerin pedagojik yönden zenginleştirilmesi teşvik edilmelidir.
- Gelecek araştırmalarda daha uzun süreli uygulamalarla kalıcılık ve transfer etkisi incelenebilir; ayrıca farklı yaş gruplarındaki etkiler karşılaştırmalı olarak ele alınabilir.

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OKUL ÖNCESİ DÖNEMDE HELİKOPTER EBEVEYNLİK YAKLAŞIMINA DAİR VELİ ALGILARI: NİTEL BİR İNCELEME

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ÖZET

Bu araştırma, okul öncesi dönemde çocuk sahibi olan velilerin "helikopter ebeveynlik" kavramına yönelik farkındalıklarını, bu tür ebeveynlik davranışlarına karşı tutumlarını ve çocuklarının gelişimi üzerindeki etkilerine ilişkin görüşlerini incelemektedir. Bu çalışma, okul öncesi dönemde çocuk sahibi ebeveynlerin helikopter ebeveynliğe ilişkin algılarını incelemek amacıyla nitel bir durum çalışması olarak tasarlanmıştır. Araştırma kapsamında, 2024-2025 eğitim öğretim döneminde İstanbul'da özel ve devlet anaokullarına devam eden 27, 4-6 yaş arası çocukların ebeveynleriyle yarı yapılandırılmış görüşmeler gerçekleştirilmiştir. Elde edilen veriler tematik analiz yöntemiyle değerlendirilmiş ve helikopter ebeveynliğin okul öncesi çocukların bağımsızlık, öz düzenleme ve problem çözme becerileri üzerindeki olası etkileri tartışılmıştır.

Araştırma bulguları, ailelerin helikopter ebeveynlik kavramına yönelik farklı görüşler benimsediğini ortaya koymuştur. Ailelerin bir kısmı, helikopter ebeveynliğin doğru bir kavram olduğunu kabul etmekle birlikte, çoğunluğu bu tür ebeveynlik davranışlarını gereksiz ve aşırı korumacı bulduklarını ifade etmiştir. Bazı ebeveynler, çocuklarını yetiştirmenin zor ve stresli bir süreç olduğuna ve bu sebeple fazla korumacı davranmanın kaçınılmaz olduğuna inandıklarını belirtmişlerdir. Bunun yanı sıra, ailelerin bir kısmı, helikopter ebeveynliği bir tür doğuştan gelen koruma içgüdüsü olarak yorumlamakta, dünyaya duydukları güvensizlikten dolayı çocuklarını dış dünyadan korumaya yönelik davranışların evrensel bir insan davranışı olduğunu savunmuşlardır.

Bazı ebeveynler, helikopter ebeveynlik kavramını yanlış anladıklarını, yalnızca çocuklarının her anını kontrol etmekle sınırlı tutarak çocuk gelişimi üzerindeki olumsuz etkilerinden habersiz olduklarını ifade etmişlerdir. Bu görüşlerin birçoğu, çocukları dışarıdaki potansiyel tehlikelere karşı korumak adına aşırı müdahale etmeyi savunmuş ve özgürlüğü kısıtlayan ebeveynlik davranışlarını, çocukların güvenliğini sağlamanın bir yolu olarak değerlendirmiştir. Sonuç olarak, araştırma, helikopter ebeveynlik kavramının ebeveynler arasında farklı şekillerde algılandığını ve bu tür ebeveynlik davranışlarının çocukların sosyal ve duygusal gelişimleri

üzerindeki potansiyel olumsuz etkilerinin daha geniş bir çerçevede ele alınması gerektiğini ortaya koymaktadır. Ayrıca, ebeveynlerin korumacı davranışlarının, çocukların bağımsızlık, öz düzenleme ve problem çözme becerilerini olumsuz yönde etkileyebileceği vurgulanmaktadır.

Anahtar Kelimeler: Helikopter ebeveynlik, okul öncesi eğitim, ebeveyn tutumları, bağımsızlık, öz düzenleme

PARENTAL PERCEPTIONS OF HELICOPTER PARENTING IN EARLY CHILDHOOD: A QUALITATIVE STUDY

ABSTRACT

This study explores the awareness, attitudes, and perceptions of parents with preschool-aged children regarding the concept of helicopter parenting and its potential effects on their children's development. Designed as a qualitative case study, the research aims to investigate how parents perceive and interpret helicopter parenting behaviors in the context of early childhood. The data were collected through semi-structured interviews conducted with 27 parents of children aged 4 to 6 attending public and private preschools in Istanbul during the 2024–2025 academic year. The data were analyzed using thematic analysis, and the possible influences of helicopter parenting on children's independence, self-regulation, and problem-solving skills were examined. The findings revealed that parents held varying perspectives on the concept of helicopter parenting. While some acknowledged the concept as valid, the majority viewed such parenting behaviors as unnecessary and overly protective. Several parents described parenting as a difficult and stressful process, stating that being overprotective often feels inevitable. Additionally, some interpreted helicopter parenting as an instinctive protective response, suggesting that behaviors aimed at shielding children from the outside world stem from a general sense of distrust and are universal human reactions. Other parents admitted to misunderstanding the concept, associating it merely with constant supervision and remaining unaware of its potentially negative impacts on child development. Many participants defended their over-involvement as a means of protecting their children from perceived dangers and justified restrictive parenting behaviors as necessary for ensuring safety. In conclusion, the study indicates that helicopter parenting is perceived differently among parents and highlights the need to address its potential adverse effects on children's social and emotional development. It also emphasizes that overprotective behaviors may negatively impact children's independence, self-regulation, and problem-solving abilities.

Keywords: Helicopter parenting, preschool education, parental attitudes, independence, self-regulation

GİRİŞ

Modern ebeveynlik anlayışı, çocuğun gelişimsel ihtiyaçlarına daha duyarlı ve bilinçli bir yaklaşım benimsemeyi amaçlasa da, bazı durumlarda bu hassasiyetin aşırıya kaçtığı gözlemlenmektedir. Son yıllarda literatürde sıkça tartışılan kavramlardan biri olan *helikopter ebeveynlik*, çocukların yaşamlarına aşırı derecede müdahale eden, onları sürekli izleyen ve yönlendiren ebeveyn davranışlarını tanımlamak için kullanılmaktadır (Segrin vd., 2012). Bu tür bir ebeveynlik tutumu, her ne kadar çocuğun güvenliğini sağlamaya yönelik iyi niyetli bir çabanın ürünü gibi görünse de, çocuğun bireysel gelişimini, bağımsızlık kazanımını ve problem çözme becerilerini sekteye uğratma riski taşımaktadır (Padilla-Walker & Nelson, 2012).

Helikopter ebeveynlik, çocukların karşılaşılabileceği tüm zorlukları ortadan kaldırma çabasıyla ortaya çıkan, ancak uzun vadede çocuğun gelişimsel yeterliliklerini sınırlandıran bir tutumdur. Bu bağlamda, çocuklar deneyim yoluyla öğrenme fırsatlarını kaçırmakta; risk alma, karar verme, hata yapma ve sonuçlarıyla başa çıkma gibi temel yaşam becerilerini geliştirme olanağından mahrum kalmaktadırlar (Lythcott-Haims, 2015). Özellikle okul öncesi dönem, çocukların bağımsızlık geliştirmeye başladığı ve çevresiyle etkileşim içinde temel öz düzenleme becerilerini kazandığı kritik bir dönemdir (Bronson, 2000). Bu nedenle, bu dönemde ebeveynlik tutumlarının çocuk gelişimi üzerindeki etkileri çok daha belirgin ve belirleyici olmaktadır.

Türkiye bağlamında, hızlı kentleşme, artan güvensizlik algısı ve rekabetçi eğitim sisteminin yarattığı baskılar nedeniyle ebeveynler arasında korumacı davranışların yaygınlaştığı gözlenmektedir (Önder & Gülay Ogelman, 2016). Ancak, helikopter ebeveynliğin okul öncesi dönemdeki çocuklar üzerindeki etkileri henüz yeterince derinlemesine ele alınmamıştır. Bu bağlamda, ebeveynlerin bu kavrama dair algılarını, tutumlarını ve uygulamalarını anlamak; çocukların bağımsızlık, öz düzenleme ve problem çözme becerileriyle olan ilişkisini ortaya koymak oldukça önemlidir.

Araştırmanın Amacı ve Alt Amaçlar

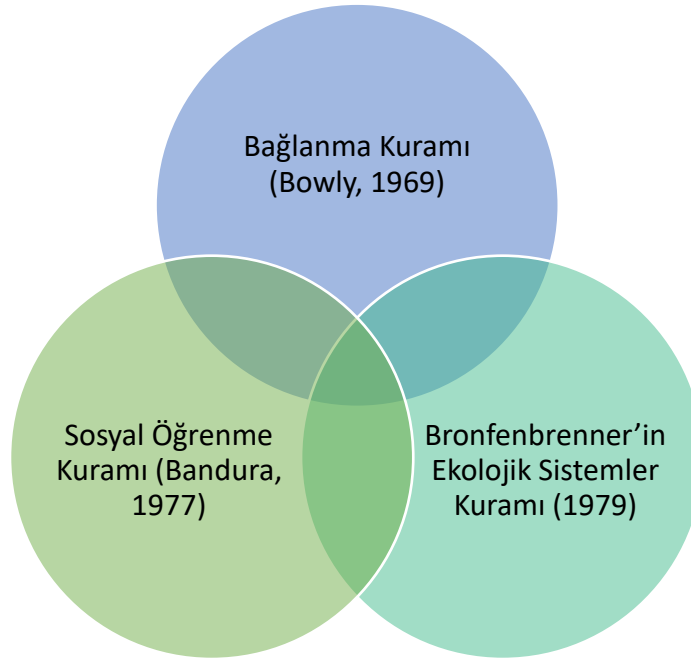
Bu araştırmanın temel amacı, okul öncesi dönemde çocuk sahibi ebeveynlerin “helikopter ebeveynlik” kavramına yönelik farkındalıklarını, bu ebeveynlik tarzına ilişkin tutumlarını ve söz konusu ebeveynlik davranışlarının çocuklarının gelişimine dair algılanan etkilerini incelemektir. Araştırma, özellikle helikopter ebeveynliğin çocukların bağımsızlık, öz düzenleme ve problem çözme becerileri üzerindeki yansımalarını anlamayı hedeflemektedir.

Bu genel amaç doğrultusunda araştırmanın alt amaçları aşağıdaki şekilde belirlenmiştir:

1. Ebeveynlerin “helikopter ebeveynlik” kavramına ilişkin farkındalık düzeyleri nasıldır?
2. Ebeveynler, helikopter ebeveynliği nasıl tanımlamakta ve bu davranış biçimine yönelik nasıl bir tutum sergilemektedir?
3. Ebeveynler, kendi ebeveynlik pratiklerinde helikopter ebeveynliğe ait hangi davranışları sergilediklerini düşünmektedir?
4. Helikopter ebeveynlik davranışlarının, çocukların bağımsızlık kazanımı, öz düzenleme ve problem çözme becerileri üzerindeki etkilerine dair ebeveyn görüşleri nelerdir?

Kuramsal Çerçeve

Helikopter ebeveynlik olgusu, çocuğun gelişimsel özerkliğini sınırlandıran ve onun bireysel yetkinlik kazanımını engelleyebilecek nitelikteki aşırı müdahaleci ebeveynlik davranışları olarak tanımlanmaktadır (Segrin vd., 2012). Bu davranış biçimi, hem bireysel psikoloji kuramları hem de gelişimsel ekoloji kuramlarıyla açıklanabilecek çok boyutlu bir yapıdır.



Şekil 1. Kuramsal Temeller

Şekil 1’de görüldüğü üzere araştırmanın kuramsal temellerinden biri olan Bowlby’nin bağlanma kuramı, çocuğun sağlıklı gelişimi için güvenli bir bağlanma figürüne ihtiyaç duyduğunu öne sürmektedir. Ancak bu bağlanmanın aşırı korumacılık düzeyine ulaşması, çocuğun kendi başına karar verme, problem çözme ve duygularını yönetme gibi becerilerinin

gelişimini olumsuz etkileyebilir (Ainsworth vd., 1978). Helikopter ebeveynlik, güvensiz–kaygılı bağlanma stilleriyle ilişkili bir kontrol biçimi olarak değerlendirilmektedir.

Bandura'ya göre çocuklar, davranışları gözlem ve model alma yoluyla öğrenirler. Aşırı müdahaleci ebeveynlik, çocuğun çevresiyle doğrudan etkileşim kurmasını ve deneyimleyerek öğrenmesini engeller. Bu durum, çocuğun öz düzenleme, karar alma ve hata yaparak öğrenme gibi becerilerinin gelişimini sınırlayabilir.

Bronfenbrenner'in Ekolojik Sistemler Kuramı (1979)'na göre çocuğun gelişimi, mikro düzeyden makro düzeye kadar birçok sistemin etkisi altında şekillenir. Helikopter ebeveynlik, çocuğun mikrosisteminde yer alan ebeveynin, çocuğun doğal etkileşim alanlarına aşırı müdahalesiyle ortaya çıkar. Bu durum, çocuğun mesosistem (aile–okul etkileşimi), eksosistem (ebeveyn iş stresi, çevresel kaygılar) ve makrosistem (toplumsal değerler, medya, güvenlik algısı) düzeyindeki gelişimini de dolaylı olarak etkileyebilir (Bronfenbrenner & Morris, 2006). Bu kuramsal yaklaşımlar, helikopter ebeveynlik olgusunu yalnızca bireysel tercihler düzeyinde değil, aynı zamanda çevresel, kültürel ve toplumsal dinamiklerle ilişkili olarak anlamlandırmayı mümkün kılmaktadır. Dolayısıyla bu çalışmada, ebeveynlerin görüşleri yalnızca davranışsal eğilimler bağlamında değil, aynı zamanda içinde bulundukları bağlamsal koşullar ışığında ele alınmaktadır.

Araştırmanın Önemi

Helikopter ebeveynlik kavramı, özellikle son yıllarda hem akademik literatürde hem de toplumsal tartışmalarda giderek daha fazla görünür hale gelmiştir. Bu ebeveynlik biçiminin çocuk gelişimi üzerindeki etkilerine dair yapılan çalışmaların büyük bir kısmı ergenlik ve üniversite dönemi gençlerine odaklanmakta; okul öncesi döneme yönelik araştırmalar ise oldukça sınırlı kalmaktadır (Odenweller vd., 2014; Love & Murdock, 2012). Bu açıdan, okul öncesi çağıdaki çocukların gelişimsel ihtiyaçları bağlamında helikopter ebeveynliğin etkilerini anlamaya yönelik bir çalışma, alan yazına önemli katkılar sunmaktadır.

Okul öncesi dönem, bireyin temel yaşam becerilerinin temellendiği, özellikle bağımsızlık, öz düzenleme ve problem çözme gibi sosyal-duygusal gelişim alanlarının hızla şekillendiği kritik bir gelişim evresidir (Denham, 2006). Bu dönemde çocukların çevreyle doğrudan etkileşim kurmaları, karar almayı ve hata yaparak öğrenmeyi deneyimlemeleri, sağlıklı bir gelişim için elzemdir. Ancak helikopter ebeveynlik yaklaşımı, bu süreçleri gölgeleyerek çocuğun gelişimsel ilerleyişini sınırlayabilir.

Bu araştırma, okul öncesi çocuklara sahip ebeveynlerin helikopter ebeveynliğe dair farkındalıklarını, tutumlarını ve bu davranışın gelişimsel yansımalarına ilişkin görüşlerini inceleyerek, hem kuramsal hem de pratik düzeyde önemli katkılar sunmayı hedeflemektedir.

Araştırmanın bulguları, erken çocukluk eğitimi alanında çalışan öğretmenler, rehberlik uzmanları ve eğitim politikası geliştiricileri için ebeveynlik tutumlarının çocuk gelişimi üzerindeki etkilerine dair daha bütüncül bir perspektif sunabilir. Aynı zamanda ebeveyn eğitim programlarının yapılandırılmasında kullanılabilecek özgün veriler sağlaması açısından da değer taşımaktadır.

Bu çalışmanın, özellikle Türkiye bağlamında giderek artan ebeveyn kaygısı, toplumsal güvensizlik ortamı ve performans odaklı eğitim anlayışının etkisiyle şekillenen ebeveynlik pratiklerini anlamaya ve dönüştürmeye katkı sağlayacağı düşünülmektedir.

Yöntem

Araştırma Modeli

Bu araştırma, nitel araştırma yöntemlerinden durum çalışması (case study) deseniyle yürütülmüştür. Durum çalışması, belirli bir olgunun doğal bağlamı içerisinde derinlemesine incelenmesini amaçlayan bir yöntemdir (Yin, 2018). Bu çalışmada helikopter ebeveynlik olgusunun, okul öncesi dönemde çocuk sahibi ebeveynlerin algı, tutum ve deneyimleri bağlamında çok yönlü olarak ele alınması hedeflenmiştir. Nitel yaklaşımın sağladığı esneklik ve derinlik, ebeveynlerin kendi yaşam bağlamlarında helikopter ebeveynliğe yükledikleri anlamları açığa çıkarmada etkili olmuştur.

Çalışma Grubu

Araştırmanın katılımcılarını, 2024–2025 eğitim öğretim yılında İstanbul’da özel ve devlet anaokullarına devam eden 4–6 yaş arası çocukların 27 ebeveyni oluşturmaktadır. Katılımcılar, maksimum çeşitlilik örnekleme yöntemiyle seçilmiştir. Örneklem seçiminde ebeveynlerin sosyoekonomik durumları, çocuk sayısı, eğitim düzeyleri ve çalışıp çalışmama durumları dikkate alınmıştır. Bu sayede farklı demografik özelliklere sahip ailelerin helikopter ebeveynlik anlayışına ilişkin çeşitli bakış açıları elde edilmiştir.

Katılımcılar arasında 19 anne ve 8 baba yer almakta; yaşları 28 ile 46 arasında değişmektedir. Etik ilkeler gereği, katılımcıların kimlikleri gizli tutulmuş, görüşmelerde kullanılan kodlar (örneğin, K1, K2...) ile veri raporlaması yapılmıştır.

Veri Toplama Süreci

Veriler, araştırmacı tarafından geliştirilen **yarı yapılandırılmış görüşme formu** aracılığıyla toplanmıştır. Görüşme formu, literatür taraması ve uzman görüşleri doğrultusunda oluşturulmuş; pilot uygulama sonrası gerekli düzenlemeler yapılarak nihai haline getirilmiştir. Görüşme formunda yer alan sorular, ebeveynlerin helikopter ebeveynliğe dair farkındalıklarını, tutumlarını, ebeveynlik pratiklerini ve çocuklarının gelişimi üzerindeki etkileri nasıl algıladıklarını ortaya çıkarmaya yöneliktir.

Görüşmeler 2024 Ekim – Aralık ayları arasında, yüz yüze ve çevrim içi ortamda gerçekleştirilmiş olup, her bir görüşme ortalama 25–35 dakika sürmüştür. Katılımcıların izniyle ses kaydı alınmış ve görüşmeler sonrasında yazılı dökümleri yapılmıştır.

Veri Analizi

Toplanan nitel veriler, tematik analiz yöntemi kullanılarak çözümlenmiştir (Braun & Clarke, 2006). Verilerin analizi altı aşamada gerçekleştirilmiştir:

- (1) Verilere aşinalık,
- (2) İlk kodların oluşturulması,
- (3) Temaların belirlenmesi,
- (4) Temaların gözden geçirilmesi,
- (5) Temaların tanımlanması ve adlandırılması,
- (6) Raporlamanın yapılması.

Kodlama sürecinde iki araştırmacı bağımsız olarak veri setini analiz etmiş ve kodlar karşılaştırılmıştır. Kodlayıcılar arası uyum oranı %92 olarak hesaplanmıştır. Bu oran, Miles & Huberman'ın (1994) güvenilirlik kriterlerine göre yeterli düzeydedir. Elde edilen temalar “farkındalık”, “tutum”, “ebeveynlik davranışları” ve “gelişimsel etkiler” ana başlıkları altında raporlanmıştır.

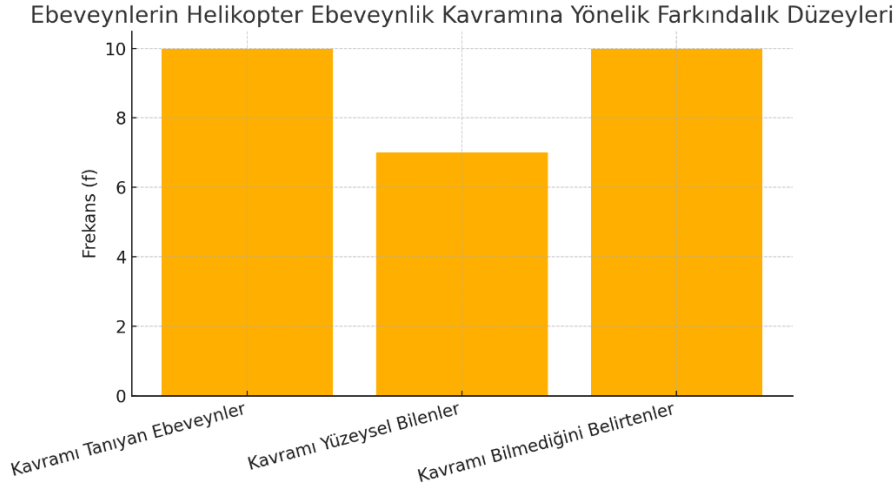
Etik İlkeler

Araştırma süreci, 1964 tarihli Helsinki Bildirgesi ve sonraki güncellemelerinde belirtilen etik ilkeler doğrultusunda yürütülmüştür. Katılımcılara araştırmanın amacı, süresi, yöntemleri ve gizlilik koşulları hakkında ayrıntılı bilgi verilmiş; yazılı ve sözlü olarak aydınlatılmış onamları alınmıştır. Tüm katılımcıların kimlik bilgileri anonimleştirilmiş ve veriler yalnızca bilimsel amaçlarla kullanılmıştır. Katılımcılar, diledikleri zaman çalışmadan çekilme hakkına sahip oldukları konusunda bilgilendirilmiştir.

Bulgular

1.Ebeveynlerin “Helikopter Ebeveynlik” Kavramına İlişkin Farkındalık Düzeyleri

Şekil 2’ de ebeveynlerin helikopter ebeveynlik kavramına ilişkin farkındalık düzeylerine ilişkin bulgular gösterilmiştir.



Şekil 2. Helikopter Ebeveynlik Kavramına Yönelik Ebeveyn Farkındalığı Temaları

Şekil 2’de görüldüğü üzere katılımcıların yaklaşık üçte biri ($f = 10$), helikopter ebeveynlik kavramını literatürdeki anlamına yakın şekilde tanımlayabilmiştir. Bu kişiler genellikle “çocuğun her anını kontrol etme”, “fazla koruyuculuk” gibi ifadelerle kavrama açıklık getirmiştir. Örneğin K7 şöyle demiştir:

“Benim anladığım, helikopter ebeveynlik çocuğu kendi haline hiç bırakmamak demek. Sürekli başında olmak.”

Diğer bir grup katılımcı ise ($f = 7$) kavramı duymuş olsa da anlamını tam bilmediğini ifade etmiştir. K3:

“Adını duydum ama tam ne anlama geliyor bilmiyorum. Sanırım çok fazla korumakla ilgili bir şey.”

Kalan 10 ebeveyn ise bu kavramı hiç duymadığını açıkça belirtmiştir. Bu bulgu, toplumda kavramsal farkındalığın yaygın olmadığını göstermektedir.

2. Ebeveynlerin Helikopter Ebeveynliğe Yönelik Tutumları

Tablo 1’de Ebeveynlerin helikopter ebeveynliğe yönelik tutumlarına ilişkin bulgular gösterilmiştir.

Tablo 1. Helikopter Ebeveynliğe Yönelik Ebeveyn Tutumu Temaları

Tema	Alt Kodlar	Frekans (f)
Olumsuz Tutum	Aşırı korumacı, gelişimi engelleyici, sağlıksız	13
Karmaşık / Tereddütlü Tutumlar	Bazen gerekli, duruma göre değişir, çelişkili ifadeler	9
Olumlu Tutum	Koruma içgüdüğü, çocuğa zarar gelmesin, kontrol güven verir	5

Ebeveynlerin helikopter ebeveynliğe ilişkin tutumları çeşitlilik göstermektedir. Katılımcıların büyük çoğunluğu ($f = 13$), bu tutumun çocuk gelişimi açısından zararlı olabileceğini vurgulayarak **olumsuz bir yaklaşım** sergilemiştir. Bu ebeveynler, aşırı müdahaleci davranışların çocukların bireyselleşmesini, özgüvenini ve sorun çözme becerilerini olumsuz etkilediğini belirtmiştir. Örneğin K12 şu ifadeyi kullanmıştır:

“Çocuk her düştüğünde hemen müdahale edersen, kendi kendine kalkmayı öğrenemez. Biraz mesafe gerekiyor.”

Ancak bazı katılımcılar ($f = 9$) bu konuda **ikircikli bir yaklaşım** sergilemiş ve helikopter ebeveynliğinin bazı durumlarda gerekli olabileceğini, özellikle günümüz koşullarında çocuğu yalnız bırakmanın riskli olduğunu ifade etmiştir. K19’un yorumu bunu yansıtmaktadır:

“Bazen çocukları çok kontrol ettiğimiz oluyor ama bu dönemde başka türlü olmuyor. Dışarı güvensiz.”

Buna karşılık 5 katılımcı, **olumlu tutumlar** sergileyerek bu tür ebeveynliği bir “koruma içgüdüğü” olarak değerlendirmiş ve çocuklarının zarar görmesini engellemenin öncelikli hedefleri olduğunu belirtmiştir. K8 şöyle demiştir:

“Ben çocuklarımı hep göz önünde tutarım. Bu çağda başka türlü mümkün değil. Onları ancak ben koruyabilirim.”

Bu bulgular, ebeveynlerin helikopter ebeveynliğe yönelik tutumlarında farkındalık düzeylerinin önemli rol oynadığını; sosyal koşullar, güvenlik algısı ve ebeveynlik stresi gibi değişkenlerin tutumları şekillendirdiğini ortaya koymaktadır.

3. Ebeveynlerin Helikopter Ebeveynlik Davranışlarına Dair Uygulama Pratikleri

Tablo 2’de Ebeveynlerin helikopter ebeveynlik davranışlarına dair uygulama pratiklerine ilişkin bulgulara gösterilmiştir.

Tablo 2. Ebeveynlerin Helikopter Ebeveynlik Davranışlarına İlişkin Uygulama Pratikleri

Tema	Alt Kodlar	Frekans (f)
Aşırı Müdahale	Sürekli düzeltme, yönlendirme, çocuğun hatasına izin vermeme	11
Sürekli Takip	Çocuğun okul, oyun, ev içi her hareketini izleme	9
Kararları Çocuk Adına Alma	Giyinme, oyun, arkadaş seçimi gibi kararları ebeveynin vermesi	7
Özgürlük Tanıma / Müdahale Etmeme	Kontrollü serbestlik, bireysel tercih alanı bırakma	6

Tablo 2’de Ebeveynlerin helikopter ebeveynlik davranışlarını günlük yaşamda nasıl uyguladıklarını ortaya koyan bu bulgular, farklı düzeylerde müdahale biçimlerini gözler önüne sermektedir. En sık gözlenen uygulama teması “aşırı müdahale” olarak belirlenmiştir ($f = 11$). Katılımcıların büyük bir kısmı, çocuklarının hatalar yapmasını engellemek adına sık sık müdahale ettiklerini kabul etmiştir. Örneğin K15 şöyle demiştir:

“Bir şey yanlış yapacaksa hemen düzeltiyorum. Yoksa üzülür, üzülmesini istemem.”

İkinci sırada yer alan “sürekli takip” teması ($f = 9$), ebeveynlerin çocuklarını gün boyunca takip etme ve gözlemlene eğiliminde olduklarını göstermektedir. Bu durum, hem fiziksel ortamda hem dijital ortamda yoğun kontrol davranışlarını kapsamaktadır. K21’in ifadesi bu durumu özetlemektedir:

“Kameradan okulda ne yapıyor bakıyorum. Evde de yalnız kalmaz. Sürekli yanındayız.”

“Kararları çocuk adına alma” teması ($f = 7$) ise çocuğun kişisel tercih geliştirmesine fırsat tanımayan, çocuğun adına karar alma eğilimini yansıtmaktadır. Özellikle okul öncesi dönemde çocuğun kendi kararlarını verebilme becerisi gelişirken, bu tür tutumlar gelişimsel risk taşımaktadır.

Bununla birlikte, bazı ebeveynler ($f = 6$) çocuklarına kontrollü bir serbestlik alanı tanımaya çalıştıklarını ifade etmişlerdir. Bu grup, müdahalenin dozunu ayarlamaya çalıştığını belirtmiş ve çocuğun kendi kararlarını vermesine olanak tanımanın önemine dikkat çekmiştir. Örneğin K5 şunu belirtmiştir:

“Kendi seçsin istiyorum. Oyuncaklarını da, arkadaşlarını da. Sadece yönlendirme yaparım.”

Bu bulgular, ebeveynlik uygulamalarında helikopter davranışlarının farkında olmadan ne kadar sık tekrarlandığını ve bazı ebeveynlerin müdahaleyi korumacılıkla karıştırdığını ortaya koymaktadır.

4. Helikopter Ebeveynlik Davranışlarının Çocukların Gelişimsel Becerileri Üzerindeki Etkilerine Dair Ebeveyn Görüşleri

Tablo 3'te

Tablo 3. Helikopter Ebeveynliğin Gelişimsel Etkilerine Yönelik Ebeveyn Görüşleri

Tema	Alt Kodlar	Frekans (f)
Bağımsızlık Gelişiminin Engellenmesi	Kendi başına hareket edememe, özgüven eksikliği	13
Öz Düzenleme Becerilerinin Zayıflaması	Sabırsızlık, bekleyememe, anında müdahale beklentisi	10
Problem Çözme Becerilerinin Azalması	Hata yapmaktan kaçınma, yardım isteme alışkanlığı, denemeden vazgeçme	8
Etki Görmediğini Düşünenler	Bu davranışların gelişime zarar vermediğini düşünen ebeveynler	4

Ebeveyn görüşlerine göre helikopter ebeveynlik davranışlarının çocukların gelişimsel becerileri üzerindeki etkileri, özellikle bağımsızlık kazanımı, öz düzenleme ve problem çözme alanlarında belirginleşmektedir. Katılımcıların önemli bir bölümü ($f = 13$), sürekli müdahale edilen çocukların bağımsız hareket etme becerilerinin zayıfladığını, özgüvenlerinin yeterince gelişemediğini ifade etmiştir. Örneğin K6 şöyle belirtmiştir:

“Her şeye ben karar veriyorum. Kıyafetini bile ben seçiyorum. Sonra kendi başına bir şey yapmakta zorlanıyor, çekingen davranıyor.”

Benzer şekilde, öz düzenleme becerilerinin zayıflaması ($f = 10$) teması da dikkat çekicidir. Bu ebeveynler, çocuklarının beklemekte zorlandıklarını, sabırsız davrandıklarını ve sürekli olarak ebeveyn müdahalesini beklediklerini ifade etmişlerdir. K10'un yorumu bu durumu özetlemektedir:

“Sürekli yanındayız. Bir şey yaparken durup düşünmüyor. Hemen bizden yardım bekliyor.”

Problem çözme becerilerinin azalması ($f = 8$) da sıkça dile getirilen bir diğer etkidir. Ebeveynler, çocukların bir sorunla karşılaştığında alternatif çözüm yolları aramak yerine yardım isteme eğiliminde olduklarını ifade etmişlerdir. K14 şöyle demiştir:

“Oyuncağı bozulduğunda tamir etmeyi denemiyor bile. Hemen gelip ‘anne yap’ diyor.”

Öte yandan, bazı katılımcılar ($f = 4$) bu tür müdahalelerin çocukların gelişimlerine zarar vermediğini düşündüklerini ifade etmişlerdir. Bu gruptaki ebeveynler, çocuklarını korumanın gelişimsel risk oluşturmadığını savunmuştur. K18’in yorumu dikkat çekicidir:

“Çocuğun bir ihtiyacı varsa ben karşılamalıyım. O daha çocuk, sorumluluk almak için erken.”

Bu bulgular, helikopter ebeveynliğin çocuk gelişimi üzerindeki etkilerine dair ebeveyn görüşlerinin farkındalık düzeylerine ve ebeveynlik yaklaşımlarına göre değiştiğini göstermektedir. Özellikle aşırı korumacılığın, çocuğun öz yeterlik duygusu ve baş etme becerileri üzerinde sınırlayıcı etkiler yarattığı söylenebilir.

Tartışma ve Sonuç

Bu araştırmada elde edilen bulgular, okul öncesi dönemde çocuk sahibi ebeveynlerin helikopter ebeveynlik kavramına yönelik farkındalıklarının sınırlı olduğunu ve bu davranış biçiminin çocukların gelişimsel becerileri üzerinde çeşitli olumsuz etkiler yaratabileceğini göstermektedir. Katılımcıların üçte biri kavramı tanırken, diğer katılımcıların büyük bölümü kavramı ya yüzeysel bilmekte ya da hiç tanımamaktadır. Bu durum, literatürde helikopter ebeveynliğin toplumsal farkındalık açısından yeterince yer bulmadığına dair tespitlerle örtüşmektedir (Padilla-Walker & Nelson, 2012).

Elde edilen tutum verileri incelendiğinde, ebeveynlerin çoğunluğunun helikopter ebeveynliği aşırı korumacı ve sağlıksız bir yaklaşım olarak değerlendirdiği görülmektedir. Bu bulgu, Segrin ve Flora'nın (2019) çalışmalarıyla uyumlu olup, helikopter ebeveynliğin çocukların psikolojik dayanıklılığını zayıflattığını ortaya koymaktadır. Ayrıca, tutumların çelişkili olabildiği ve ebeveynlerin bazen davranışlarını rasyonelleştirdiği gözlemlenmiştir.

Davranışsal pratiklere ilişkin bulgular, özellikle "aşırı müdahale" ve "sürekli takip" temalarının öne çıktığını göstermektedir. Bu bulgular, Grolnick (2013) ve Odenweller vd. (2014) tarafından vurgulanan ebeveyn kontrolünün, çocukların öz-yeterlilik gelişimi üzerindeki kısıtlayıcı etkileriyle tutarlıdır. Araştırmaya katılan ebeveynlerin önemli bir kısmı, çocuklarının kararlarını kendilerinin almasına izin vermediklerini belirtmiş; bu durum çocuğun özgürlük alanını daraltan bir ebeveynlik modeli olduğunu göstermiştir.

Helikopter ebeveynliğin gelişimsel etkileri bağlamında elde edilen veriler, özellikle bağımsızlık, öz düzenleme ve problem çözme becerilerinin olumsuz yönde etkilendiğini ortaya koymaktadır. Bu bulgu, Baumrind'in ebeveynlik stillerine ilişkin kuramı çerçevesinde değerlendirildiğinde, otoriter ve müdahaleci ebeveynliğin çocuğun bireysel gelişimini engellediği görüşünü desteklemektedir. Ayrıca, Bandura'nın (1986) sosyal öğrenme kuramı doğrultusunda, çocuğun model aldığı ebeveyn davranışlarının bireysel yeterlik algısı üzerinde doğrudan etkili olduğu da düşünülebilir.

Sonuç olarak, bu araştırma, okul öncesi dönemde helikopter ebeveynlik davranışlarının hem ebeveyn tutumları hem de çocukların gelişimsel becerileri üzerinde belirgin etkileri olduğunu ortaya koymakta; farkındalık artırıcı eğitim ve rehberlik çalışmalarının önemini vurgulamaktadır.

Sonuç

Bu araştırma, helikopter ebeveynliğin okul öncesi dönemde çocukların gelişimsel özellikleri üzerindeki etkilerini ebeveyn görüşlerine dayalı olarak incelemiştir. Araştırma sonucunda ebeveynlerin önemli bir kısmının bu kavrama yeterli düzeyde aşina olmadığı; ancak farkında olan ebeveynlerin çoğunun bu yaklaşımı olumsuz olarak değerlendirdiği görülmüştür. Ayrıca, helikopter ebeveynlik davranışlarının en çok aşırı müdahale, sürekli takip ve karar alma üzerinden gözlemlendiği; bu davranışların ise çocukların bağımsızlık, öz düzenleme ve problem çözme becerilerini olumsuz yönde etkilediği ortaya konmuştur.

Öneriler

Eğitim ve Farkındalık Çalışmaları: Helikopter ebeveynlik konusunda okul öncesi döneme yönelik ebeveyn bilgilendirme seminerleri, rehberlik faaliyetleri ve medya yoluyla farkındalık artırıcı programlar düzenlenmelidir.

Aile Rehberliği: Anaokulu öğretmenleri ve psikolojik danışmanlar, çocukların gelişimsel ihtiyaçlarına uygun ebeveynlik modelleri hakkında ailelere bireysel rehberlik sunmalıdır.

Politika ve Program Geliştirme: Milli Eğitim Bakanlığı ve ilgili kurumlar, ebeveyn eğitime yönelik geliştirilecek ulusal programlarda “bağımlı değil, destekleyici ebeveynlik” ilkelerini ön planda tutmalıdır.

Gelecek Araştırmalar: Bu çalışma nitel bir desenle gerçekleştirilmiş olup, nicel araştırmalarla desteklenerek daha geniş örneklemelerde benzer konular araştırılabilir. Ayrıca çocukların doğrudan gözlemlendiği veya öğretmen görüşlerinin de dâhil edildiği çok boyutlu çalışmaların yapılması önerilmektedir.

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DİN SOSYOLOJİSİ BAĞLAMINDA MUHAFAZAKÂRLIK VE DİN**Dr. Kazım KANDEMİR**

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Muhafazakârlık, Batı'da Aydınlanmanın bir ürünü olarak doğmuş ve süreç içerisinde olgunlaşmış bir ideoloji olarak karşımızda durmaktadır. Bu bağlamda muhafazakârlık düzenin devamlılığını sağlamak gayesiyle birtakım değerleri içinde barındıran bir kavram olarak da öne çıkmaktadır. Muhafazakârlık bu değerlerin bazılarını mesafeli yaklaşırken, bazılarını da benimsemiş ve özümsemiştir. Muhafazakârlığın benimseyip özümsemediği değerlerden biri de dindir. Bu çalışmanın amacı din sosyolojisi perspektifinden muhafazakârlığın dinle ilişkisini doküman analizi yöntemiyle irdelemek, incelemek ve tartışmaktır. Bu çerçevede çalışmada ilk öncelikle muhafazakârlık kavramının kökenine değinilmiş, muhafazakârlığın oluşum ve gelişim süreci detaylandırılmaya çalışılmıştır. Ardından muhafazakârlığın ideolojik yapısı üzerinde durulmuş, ideoloji olması açısından muhafazakârlığa ilişkin öne sürülen yaklaşımlardan bahsedilmiştir. Bunun yanında çalışmada muhafazakârlığın farklı biçimleri ele alınmış, muhafazakârlığın “Kıta Avrupası Muhafazakârlığı”, “İngiliz Muhafazakârlığı” ve “Amerikan Muhafazakârlığı” şeklindeki kategorik ayrımlarına değinilmiştir. Çalışmanın sonunda ise muhafazakârlığın dinle ilişkisi irdelenip tartışılmıştır. Elde edilen sonuçlara göre çalışmada muhafazakârlığın dincilik anlamına gelmediği sonucuna varılmıştır. Ayrıca muhafazakârlık dini bireysel bir arınma, manevi bir deneyim ve motivasyon kaynağı olarak görmekle birlikte, aynı zamanda toplumsal bağları güçlendiren bir olgu olarak da görmektedir. Dolayısıyla devlet, ekonomi ve mülkiyet toplumun fiziki yönünü, din ise canını ve ruhi yönünü oluşturup şekillendirmektedir. Muhafazakârlara göre dinden yoksun bir toplum canından ve ruhundan da yoksunlaşmak üzere olan bir canlıyı andırmaktadır. Bu anlamda din muhafazakârlığa göre birleştirici ve bütünleştirici bir unsurdur. Zira dinin söz konusu işlevini takdir etmek için muhafazakâr bir bireyin dindar olması da gerekmemektedir.

Anahtar kelimeler: Muhafazakârlık, ideoloji, muhafazakârlığın biçimleri, din

CONSERVATISM AND RELIGION IN THE CONTEXT OF THE SOCIOLOGY OF RELIGION**ABSTRACT**

Conservatism emerged in the West as a product of the Enlightenment and has matured over time into a well-defined ideology. In this context, conservatism stands out as a concept that encompasses certain values with the aim of ensuring the continuity of order. While

conservatism approaches some of these values with a degree of skepticism, it has adopted and internalized others. One of the values that conservatism has embraced and internalized is religion. The purpose of this study is to examine, analyze, and discuss the relationship between conservatism and religion from the perspective of the sociology of religion through document analysis. Within this framework, the study first addresses the origins of the concept of conservatism and seeks to detail the process of its formation and development. It then focuses on the ideological structure of conservatism and presents various approaches put forward regarding conservatism as an ideology. In addition, the study discusses different forms of conservatism and highlights the categorical distinctions of “Continental European Conservatism”, “British Conservatism” and “American Conservatism”. In the final section of the study, the relationship between conservatism and religion is examined and discussed. Based on the findings, it is concluded that conservatism does not equate to religious fundamentalism. Furthermore, while conservatism regards religion as a means of personal purification, spiritual experience, and a source of motivation, it also views it as a phenomenon that strengthens social bonds. Therefore, the state, economy, and property constitute and shape the physical aspect of society, while religion forms its soul and spiritual dimension. According to conservatives, a society deprived of religion resembles a living being that is about to be deprived of its soul and spirit. In this sense, religion, according to conservatism, is a unifying and integrating element. Indeed, appreciating this function of religion does not require a conservative individual to be religious.

Keywords: Conservatism, ideology, forms of conservatism, religion

1. GİRİŞ

Liberalizm ve sosyalizmle beraber muhafazakârlık, Türkiye’deki siyasi oluşumlara koşut olarak son dönemde birçok çalışmaya konu olmuştur. Literatürdeki çalışmaların çoğu muhafazakârlığı bireyler ve siyasi oluşumlar üzerinden incelemiş ve bu çalışmalar muhafazakârlığı konu alan çalışmaların çoğunluğunu meydana getirmiştir. Bu bağlamda inanç ve pratikleriyle bireyin görüşlerini ve yaşamını etkileyerek ona istikamet veren, “toplumun ruhunu” inşa edip toplum için bir motivasyon kaynağı olan din kurumunu muhafazakârlık çerçevesinde müstakil bir çalışmayla inceleyip değerlendirmek önemli görülmektedir.

Muhafazakârlık, bazı toplumsal kurumları önemsemekte ve onları kendi düşüncelerine dayanak olarak görmektedir. Bunlar aile, gelenek, otorite, düzen, mülkiyet ve din gibi toplumsal kurumlardır. Muhafazakârlık din kurumunun toplumun bilinç dünyasını oluşturan en önemli kurumlardan biri olarak nitelendirmektedir. Öyle ki din, toplumun manevi iklimini

oluşturmakta ve ona motivasyon kaynağı olmaktadır. Muhafazakârlık dinden yoksun bir toplum modelini toplumun motivasyon kaynağından yoksun olacağını düşünerek uygun görmemektedir.

Bu çalışmanın amacı din sosyolojisi perspektifinden muhafazakârlığın dinle ilişkisini doküman analizi yöntemiyle irdelemek, incelemek ve tartışmaktır. Bu çerçevede çalışmada ilk öncelikle muhafazakârlık kavramının kökenine değinilmiş, muhafazakârlığın oluşum ve gelişim süreci detaylandırılmaya çalışılmıştır. Ardından muhafazakârlığın ideolojik yapısı üzerinde durulmuş, ideoloji olması açısından muhafazakârlığa ilişkin öne sürülen yaklaşımlardan bahsedilmiştir. Bunun yanında çalışmada muhafazakârlığın farklı biçimleri ele alınmış, muhafazakârlığın “Kıta Avrupası Muhafazakârlığı”, “İngiliz Muhafazakârlığı” ve “Amerikan Muhafazakârlığı” şeklindeki kategorik ayrımlarına değinilmiştir. Çalışmanın sonunda ise muhafazakârlığın dinle ilişkisi irdelenip tartışılmıştır

2. MUHAFAZAKÂRLIK KAVRAMI

Muhafazakârlık Latince kökenli bir kelime olup “conserve” kelimesinden türemiş “koruma”, “muhafaza etme” ve “sahip çıkma” anlamında kullanılan bir kavramdır. Muhafazakârlık kavramı ilk olarak Fransız siyaset yazınlarında kullanılmış, “Ancient Regime (Devrimden Önceki Dönem)” değerlerini ve siyaset anlayışını yeniden inşa etmeyi amaçlayan düşünürler tarafından dile getirilmiştir (Vural, 2007: 16). Nitekim Fransa’da 1818’de neşredilen yöresel gazetelerden birine “Muhafazakâr” adı verilmiş, İngiltere’de 1832 yılında kurulan bir parti de “Muhafazakâr Parti” adıyla anılmıştır. Sonraki dönemlerde siyasi ve ideolojik bir kimliğe bürünen muhafazakârlık; değişime kapalı, mevcut olanın korunması taraftarı olan bir siyasi duruş olarak ifade edilmiştir. Bu noktada muhafazakârlık aile, eğitim, din gibi geleneksel kurumları öne çıkaran, bu kurumların dönüşüme uğratılmasının risk oluşturacağını belirten bir ideolojik tutumdur (Uluçakar, 2018: 352). Dolayısıyla muhafazakârlığın Fransız Devrimi’ne karşı olup devrimin düşünsel alt yapısını belirlediği düşünülen Aydınlanma düşünürlerinin tezlerine yönelik eleştirilerin meydana getirdiği bir ideoloji biçimi olarak ortaya çıktığı öne sürülmektedir (Kandemir, 2025: 16).

Muhafazakârlık esasında modernlik karşıtı bir düşünce hareketi olmasından dolayı onun tümüyle gelenekçiliği benimsediği vurgulanmaktadır (Burke, 2016: 10-11). Bunun yanında muhafazakârlık geleneğe yönelirken seçici davranmaya özen göstermiştir. Nitekim gelenek yarar sağlamakla birlikte tutarlı bir bütün oluşturmalıdır. Bu seçici davranma modeliyle ve gerçekçi olarak düzenlenmiş bir gelenek tasarımıyla geleneksel toplumsal yapının yenilenmesi mümkün olacaktır (Hobsbawm, 2006, s. 309). Böylece muhafazakârlık modernitenin kendisine,

onun dönüştürdüğü toplumsal ilişki biçimlerine ve sebep olduğu belirsizliklere karşı sistemli bir eleştiriyi ifade etmektedir (Özipek, 2003: 144).

Muhafazakârlık çağdaş siyasetin düşünce yapısına etki eden üç önemli düşünce birikiminden biridir. Bunlar on altıncı yüzyıldan itibaren Avrupa’da temayüz eden “muhafazakârlık, liberalizm ve sosyalizm” deneyimleridir. Bu düşünce gelenekleri yirminci yüzyılda Avrupa siyasetini bütünüyle kuşatmış bulunmaktaydı. Yirminci yüzyılda mevcut düşünce geleneklerinden biri olan sosyalizm sarsılma sürecine girmiş, muhafazakârlık ve liberalizm ise iktisat ve siyaset başta olmak üzere geniş bir yelpazede etkinlik kazanmaya başlamıştır. Bunun sonucunda çağdaş dünyada muhafazakârlık “felsefi muhafazakârlık” ve “siyasi muhafazakârlık” olmak üzere iki ana çizgide ilerleme göstermiştir. Her ne kadar bunlar iki farklı muhafazakârlık biçimi olarak görülse de her ikisinin arasında etkileşimlerin ve geçişliliklerin varlığından bahsetmek mümkündür. Nitekim siyasi muhafazakârlığın genel çerçevesini “felsefi muhafazakârlık” belirlemiştir (Çaha, 2004: 16-17).

Muhafazakârlığın felsefi dayanağı on sekizinci yüzyılda Aydınlanma ile meydana gelen toplumsal değişim ve dönüşümden kaynaklanmaktadır. Siyasi dayanağını ise Fransız Devrimi’yle başlayan köklü değişimler, radikal ayrımlar ve sosyal yapıdaki dönüşümler belirlemiştir. Bu noktada muhafazakârlık bir ideoloji olarak tanımlanmıştır (Pir, 2023: 126). Öyle ki, Kekes (1998: 1-3) bir ideoloji olarak muhafazakârlığı şu şekilde özetlemektedir:

“Muhafazakârlık doğal olarak ideolojik bir yapıya sahiptir. Çeşitli muhafazakâr akımlar incelendiğinde, bu akımların toplumun iyiye yönlendirilmesi yolunda mücadele verdikleri görülecektir. Bir toplumun ancak ve ancak o toplumu oluşturan insanların iyi, ahlaklı ve erdemli olmasıyla iyiye yürüyeceğini düşündüğümüzde muhafazakâr politikaların hedefinin, toplumun; erdeme, ahlaka ve iç-huzura kavuşturulması olduğunu söyleyebiliriz”.

Muhafazakârlık Manheim tarafından da ideoloji olarak görülmüştür. Çünkü muhafazakârlık belirgin bir tarih ve toplumsal olayla ilişkili olması nedeniyle ideolojiyle bağlantılı durumdadır. Nitekim liberalizm burjuva ideolojisine, sosyalizm proleter ideolojiye, muhafazakârlık ise aristokrat ideolojiye dayanmaktadır. Özellikle erken dönem muhafazakârlarının çoğu seçkinlerden, zenginlerden, mevki sahibi kişilerden ve fabrika sahiplerinden meydana gelmektedir (Safi, 2005: 13).

İdeoloji olması açısından muhafazakârlığa ilişkin üç temel yaklaşım öne sürülmektedir. Bu yaklaşımlardan ilki “tarihsel-türsel (özgücü)” görüşüdür. Bu görüşe göre muhafazakârlık, Fransız Devrimi’ne tepki olarak ortaya çıkmıştır. Aristokrat ve ruhani (klerikal) bir karşı çıkışla Sanayi Devrimi’nden sonra önemsenmeyen tarımsal ve feodal yapılara dönüşü ifade etmektedir. Geleceğe dair projeksiyon tutmaktan uzak olan bu görüş “siyasal romantizm” şeklinde tezahür

etmekte ve Ortaçağ'a bağlı olmaktan ödün vermemektedir. Bir diğer yaklaşım ise “evrenselci-antropolojik yorum”dur. Bu yaklaşıma göre muhafazakârlık evrensel değerlere ve kavramlara sadakati esas almaktadır. Muhafazakârlık bu yaklaşımda insanlığın tutum, davranış ve düşüncelerinde genelleştirilen bir kavram olarak görülmekte, toplumun tüm tabakaları için sosyal ve siyasal bir gereklilik olarak vurgulanmaktadır. Üçüncü yaklaşım “duruma özgü yorum” şeklinde adlandırılmaktadır. Burada muhafazakârlık duruma göre farklı olay ve olguların sonucunda belirginleşen ve dönemsel olarak ortaya çıkan bir yapıdadır. Bu noktada kendi etkinlik sahasını artırmak gayesiyle liberalizmle arasında uyum gösterme gayretini ortaya koymaktadır (İnce, 2010: 26-29).

3. MUHAFAZAKÂRLIĞIN FARKLI BİÇİMLERİ

Bir ideoloji olarak muhafazakârlık yukarıda belirtilen hususları içermekle birlikte genel anlamda muhafazakâr düşünce deneyimi içerisinde konumlanan fakat birbirinden ayrılan farklı anlayışları ve uygulamaları barındırmaktadır. Aydınlanma Çağı'ndan bugüne muhafazakârlık çeşitli zamanlarda ve dönemlerde ayrı özellikler gösteren biçimler kazanmıştır. Bu bağlamda muhafazakârlık “Kıta Avrupası Muhafazakârlığı”, “İngiliz Muhafazakârlığı” ve “Amerikan Muhafazakârlığı” şeklinde kategorik ayrıma tabi tutulmuştur (Safi, 2005: 20).

3.1. Kıta Avrupası muhafazakârlığı

Muhafazakâr düşünce Kıta Avrupası'nda devrime yol açan değişim ve dönüşüme karşı başkaldırı niteliği taşımaktadır. Devrimci Fransız modernleşmesi tepkisel nitelikli bir muhafazakârlığın ortaya çıkmasını sağlamıştır. Bu yönüyle Fransız muhafazakârlığı epistemolojik bir çizgide ilerlemeyi yeterli görmeyerek siyasal bir duruş geliştirmiştir. Dini, geleneği, devleti, otoriteyi reddeden liberal bireycilik ve hümanist aydınlanmacılık gibi tüm yapıların karşısında durmuştur. Nitekim kiliseyle mücadeleye girişen Fransız İhtilali'ne karşı Fransız muhafazakârları da mücadeleye girişmiştir. Dolayısıyla Fransız muhafazakârlığı daha pragmatist ve daha konjonktürel bir özellik göstermiştir. Fransız muhafazakârlığının öncülüğünü Fransız İhtilali karşıtlığıyla bilinen Joseph de Maistre yapmaktadır. De Maistre'nin muhafazakârlık düşüncesi bütünüyle karşıtlığın bir ürünü olup devrimci anlayışlara meydan okumayı gaye edinmektedir. (Çaha, 2004: 17-18).

Kıta Avrupası'nda gelişmiş olan muhafazakâr düşüncenin bir diğer türü ise Alman muhafazakârlığıdır. Alman muhafazakârlığı, muhafazakârlığın tüm özelliklerini taşımakla birlikte akıl ve ilerleme fikrine de açık bir çizgide bulunmaktadır. Alman muhafazakârlığının öncüsü birtakım itirazlarla birlikte devlet ve otoriteye önem vermesiyle bilinen Hegel'dir. Hegel devleti toplumsal hayatın en önemli parçası görmekle beraber otorite ve hiyerarşi temeline dayanan bir muhafazakâr düşüncenin oluşmasını sağlamıştır (Çaha, 2004:18). Hegel ilerleme

düşüncesini Aydınlanmacı düşünürler gibi akla ve devrime değil millete ve tarihe mal olan diyalektik düşüncenin özüne dayandırmıştır (Çaha, 2001: 102).

Muhafazakârlık genellikle bağlı olduğu tarihsel ve kültürel altyapı üzerinden gelişme kaydetmektedir. Nitekim Almanya’da milliyetçilik birikiminin geç oluşması bu durumu etkilemiş, klasik muhafazakârlıktan farklı olarak Alman muhafazakârlığı birtakım tasarımlar ve çıkarımlar yoluyla geleneği sürdürmeye çabalamıştır. Dolayısıyla muhafazakârlığın temelini oluşturan “hâlihazırda var olan” durum Alman muhafazakârları tarafından “sonradan” oluşturulmuştur. Bu bağlamda Alman muhafazakârlığı, Fransız ve İngiliz muhafazakârlığı gibi koyu gelenekselliğe sahip değildir. Bu durum Schmitt tarafından “muhafazakârlığın çarpıtılması” olarak nitelendirilmiştir. Klasik muhafazakârlığın tarihsel birikimden doğan yapısı yukarıdaki ifadenin sebebini teşkil etmektedir. Sonuç olarak Alman muhafazakârlığı dizayn edilmiş bir yorum biçimi şeklinde işlev görmektedir (Hazan, 2016: 17).

3.2. İngiliz muhafazakârlığı

İngiliz muhafazakârlığı liberal düşüncüyü esas alan, parlamenter devrim yapısını özümseyen, geleneksel değerleri korumakla birlikte reform düşüncesine kapalı olmayan muhafazakârlık biçimidir (Bora, 2008: 62). 1830’larda İngiliz siyaset anlayışına eklemlenen muhafazakârlık, Edmund Burke’nin 1790’da kaleme aldığı “Fransız Devrimi Üzerine” düşünceler adlı eseriyle şeklini almıştır. Eserinde belirttiği şekliyle Burke’nin muhafazakârlık düşüncesi Fransız Devrimi’yle ilgili düşüncelerin bir bakıma genişletilmiş halidir (Nisbet, 2007: 50).

Burke eserinde toplumsal reforma yönelik gerçekleştirilmesi ve gerçekleştirilmemesi gereken şeyleri sıralayarak değişime karşı olmadığını savunmuştur. Burke devletin kendisini değiştirecek kuralları benimsemeden kendisini koruyamayacağını vurgulamış, gelenek tarafından topluma kazandırılan şeylerin korunması gerektiğini de dile getirmiştir. Eski sistemden vazgeçilmesinden öte tarihsel kazanımlara sahip çıkılmasını önermektedir. Bu doğrultuda toplumların geleneksel kurumlarını, kanunlarını ve geleneklerini korumaları gerektiği düşüncesindedir (Dural, 2006: 63).

İngiliz muhafazakârlığının en belirgin özelliği geleneksel yasalara önem vermesidir. Bu muhafazakârlık biçimi vatanseverliği ve otoriteyi öne çıkarmakta; kadın hakları, etnik yapıların uyumu ve boşanma gibi hususlarda toplumsal değişimlere karşı eleştirel yaklaşmaktadır. Tarihsel mirasın kurumlara meşruiyet kazandırdığını savunarak geleneğe sıkı sıkıya bağlanmaktan geri durmamaktadır. “Monarşi” ve “Lordalar Kamarası” gibi köklü kurumlara bağlılık göstermektedirler. İngiliz muhafazakârlığı “siyaset gün içindir” diyerek iktidarı elde etmek için gerekli değişim ve dönüşümü gerçekleştirmeyi amaçlamaktadır (Helvacı ve Demirtepe, 1998: 96).

İngiliz muhafazakâr düşüncesi liberalizm çizgisinde ilerlemiştir. Örneğin “İngiliz Muhafazakâr Parti” üyeleri siyasi faaliyetlerini liberal siyasi oluşumlarda sürdürmüşlerdir. İngiltere’de muhafazakârlıkla liberalizmi bir araya getiren en temel nokta her ikisinin de “kendiliğinden” meydana gelen toplumsal, siyasal ve ekonomik değişimleri benimsemeleridir. Bu bağlamda İngiliz muhafazakârlığı liberal düşüncenin savunduğu özgürlükleri özümsemekte, geleneksel kurumlara sahip çıkmayı demokrasinin ve özgürlüğün önünde engel görmemektedir. Bu yönüyle İngiltere’deki muhafazakârlık düşüncesi liberal değerlerle uzlaşmayı esas almaktadır (Bidik, 2007: 101-102).

3.3. Amerikan muhafazakârlığı

Amerikan muhafazakârlığı, liberal düşünce yapısını esas alan muhafazakârlık biçimidir. Liberalizmin sürdürülebilmesi için muhafazakârlığın dine, aileye ve geleneğe yönelik anlayışı Amerikan muhafazakârlığı tarafından özümsemiştir. Nitekim Vierreck Amerikan muhafazakârlığını gelenek karşıtı olarak görmemektedir. Bunun yanında Amerikan muhafazakârlığı Avrupa’daki sağ oluşumların destekleyicisi olmayıp devletin otoritesini ve denetimini kabul etmemektedir. Fakat yasaların bağlayıcı olduğunu düşünmektedir. Amerikan muhafazakârlarının büyük çoğunluğu da Amerika’daki muhafazakârlığın “liberal-muhafazakâr” eksenli olduğu düşüncesinde birleşmektedir (Kandemir, 2025: 30).

Amerika’daki muhafazakârlığı diğerlerinden ayıran yön, geleneğin ve muhafazakâr yönelimlerin Avrupa’da olduğu gibi iç içe olmayıp ayrı konumlara sahip olmasıdır. Zira Amerikan geleneği her zaman liberal bir gelenek niteliğine sahip olmuştur. 1970’lerde siyaset sahasında yer bulan muhafazakâr ideoloji, Amerika’nın modern tarihinde kısıtlı bir etkiye sahip olmuştur. Amerika’da muhafazakârlık sol siyaset tarafından temsil edilmiş, Kıta Avrupa’sında görüldüğü gibi sürekliliğini sosyalizm eleştirisine dayandırmıştır (Güler, 2016: 20).

Amerika’daki muhafazakârlıkta düzen ve değişimin hızı oldukça önemli görülmektedir. İstikrarı öteleyeceğinden büyük değişimlere ve dönüşümlere karşı olunması gerekmektedir. Muhafazakârlığın temel yaklaşımı olan gelenek olgusuna yeni muhafazakârlıkta da değer verilmektedir. Devlet dış tehditlere karşı savunma, içerde de düzeni sağlama işlevi görmektedir. Devletin temel görevi hayatı, özgürlükleri ve mülkiyeti güvence altına almaktır. Nitekim mülkiyet ve güvence kavramları bir bütündür ve birbirinden ayrılması mümkün değildir (Vural, 2011: 56-57). Amerikan muhafazakârlığı 1960’lı ve 1970’li yıllarda gelişme kaydetmiş, fakat Avrupa’daki gibi devrim karşıtlığı yönünde ilerlememiştir. Bu noktada Fransız ve Amerikan Devrimi’nin birbirinden farklı olduğu gerçeği görünür olmuştur (Beneton, 2011: 84).

4. ÇALIŞMANIN YÖNTEMİ

Çalışmada yöntem olarak doküman analizi yöntemi kullanılmıştır. Doküman analizi çalışmanın amacına uygun olarak kaynakları toplama, okuma, notlandırma ve analiz etme aşamalarını kapsamaktadır. Bu anlamda doküman analizi yazılı ya da dijital kaynaklardan yola çıkarak bir araya getirilen materyallerin ve kaynakların incelenmesi sürecidir. Bir başka ifadeyle doküman analizi yazılı metin özelliği taşıyan birincil kaynakları derlemek, irdelemek ve değerlendirmektir (Sak vd., 2021: 230).

5. MUHAFAZAKÂRLIK VE DİN İLİŞKİSİ

Din en basit ifadesiyle aşkın olana saygının tezahürü şeklinde tanımlanmaktadır. Bu tanım her ne kadar doğru görünse de dinin bireysel yönünü vurguladığından dolayı eksik bir tanım olarak karşımızda durmaktadır. Zira dinin substantif (özel) yönü olmakla birlikte fonksiyonel (işlevsel) yönü de bulunmaktadır. Bu bakımdan din bireylerin tutum ve davranışlarında yönlendirici olan semboller ve değerler sistemidir. Böylece din “sosyal” ve “işlevsel” bir kurum olarak tezahür etmektedir. Din inanç ve pratikleriyle bireyin görüşlerini ve yaşamını etkileyerek ona istikamet vermektedir. Nitekim din grup içi ilişkilerden grup dışı ilişkilere kadar her türlü sosyal birlikteliklere rengini vermektedir. Dolayısıyla insanlık tarihi boyunca din inanç ve uygulamalarıyla tüm toplumsal kurumları etkisi altına almayı başarmış güçlü bir kurum olma vasfını yitirmemiştir (Işık, 2023: 34).

Muhafazakârlık birtakım toplumsal kurumları referans kaynağı olarak görmektedir. Bu referanslar aile, gelenek, otorite, düzen, mülkiyet ve din gibi temel referans kaynaklarıdır. Bu referanslar içerisinde din toplumun omurgasını oluşturan en önemli kurumlardan biridir. Nitekim din “toplumun ruhunu” inşa etmekte, toplum için bir motivasyon kaynağı oluşturmaktadır. Dolayısıyla devlet, ekonomi ve mülkiyet toplumun fiziki yönünü, din ise canını ve ruhi yönünü oluşturup şekillendirmektedir. Muhafazakârlara göre dinden yoksun bir toplum canından ve ruhundan da yoksunlaşmak üzere olan bir canlıyı andırmaktadır (Çaha, 2004: 22-23).

Muhafazakâr düşünce toplumun sürdürülebilir oluşunun sağlam bir otoriteyle mümkün olacağını düşünmektedir. Bu bağlamda muhafazakâr düşünce otoritenin esasının sözleşmeyle değil sadakatle gerçekleşeceğini öngörmektedir. Muhafazakârların bakış açısına göre hakiki otorite aşkın ve kudretli niteliklere sahip olmalıdır. Öyle ki, toplumsal düzenin sürekliliğini sağlayan otorite ilahi kaynaklıdır. Otoriteden yoksun bir toplum öngörülemezliğine göre din, toplumdaki ahengi gerçekleştiren en temel referans kaynağıdır. Nitekim otorite emniyet ve meşruiyet unsuru olduğundan yapısından ötürü biriciktir ve parçalanamaz durumdadır (Çaha, 2001: 109).

Muhafazakâr düşünce dini içtenlikle bağlanılan bir gerçeklik olarak görmektedir. Buna göre din ve ibadet özgürlüğü kanunlarla teminat altına alınmalı, fakat bu özgürlük tehlikeli sonuçlar doğuracağından siyasete alet edilmemelidir. Nitekim “siyaset” ve “vaaz kürsüsü” birbiriyle zıt kavramlardır. Muhafazakârlık genellikle dinin işlevselliğine dikkat çektiğinden dolayı dinin ölçülü, ılımlı ve barışçıl taraflarını önde tutmaktadır. İnsanların bunları benimsemesi hayatını mutlu ve huzurlu kılmasına fırsat oluşturmaktadır. Din insanları anomiden, travmalardan, korkudan ve yalnızlıktan korumaktadır. Bunun yanında dini kurumların oluşturduğu sivil toplum örgütleri de devlet üzerinde denetim mekanizması kurarak baskıcı yönetimlere karşı etkili bir muhalefet oluşturmaktadır (Koni ve Torun, 2013: 191).

Muhafazakâr düşünce insanı esasen “mütedeyyin bir hayvan” şeklinde nitelendirmektedir. Bu sebeple din toplumsal alanı kuşatmakta, din sayesinde toplumsal alana ilahi bir yer ayrılmaktadır. Bundan dolayı kutsaldan arınmış bir toplumun olamayacağını söyleyen muhafazakâr düşünceye göre din inanç, cemaat ve toplum biçimine bürünmektedir. Muhafazakârların çoğu hiçbir toplumun ya da toplumsal grubun (cemaatin) dinden tecrit edilmiş şekilde yaşayamayacağı görüşünde birleşmektedir (Işık, 2023: 35).

Muhafazakârlık dinle ilgili görüşlerini cemaat boyutunda da açıklamıştır. Muhafazakârlığa göre cemaat ve cemaatçi eğilimler toplumsal yaşamda dinin işlevine katkı sağlayan önemli yapılar olarak görülmektedirler. Cemaat dinin mevcudiyetine destek veren, dayanışma ve bağlılık duygusuna ortam sağlayan sosyal bir gerçekliktir. Cemaat dayanışmasının zaafa uğraması dini değerlerin etkinliğinde daralmaya yol açmaktadır. Dolayısıyla dini değerlerin zaafa uğramasıyla toplumsal dayanışma ve bağlılık duygusunun zaafa uğraması arasında paralel bir ilişki bulunmaktadır. Örneğin Durkheim, dini değerlerin zaafa uğradığı Protestan bölgelerde intihar oranlarının yüksek olduğu sonucuna varmıştır. Bu bağlamda dini değerlerin sarsılmasıyla samimi kültürel değerler de sarsılmaktadır. Bireyler anomi ve yabancılaşma duygusuna maruz kalmaktadır. Bu durum da bireylerin intihara yönelmelerine yol açmaktadır. Muhafazakârlar cemaati yalnız maddi bir değer olarak görmemektedirler. Aynı zamanda onun var ettiği cemaatçi kültürüne de önem atfetmektedirler. Bu noktada komşuluk, arkadaşlık ve dindarlık ilişkileri üzerine özenle eğilmektedirler. Özetle cemaat muhafazakârların nazarında toplumsal yaşama devinim kazandıran etkili bir güç olarak nitelendirilmektedir (Çaha, 2024: 23).

Muhafazakârlıkta geleneksel kurumlar içerisinde en önemli görülen kurum din kurumudur. Muhafazakârlar dini sadece substantif (özel) yönü olan, kurtuluş ve manevi deneyim unsuru olarak nitelendirilen bir kurum olarak görmemektedirler. Zira muhafazakârlara göre din aynı zamanda toplumsal birlik ve bütünlüğe yönelik katkılar sağlamaktadır. Bununla birlikte

muhafazakârlık “dincilik” anlamından da uzak bir kavramdır. Çünkü “dincilik” toplumu dini kurallara dayanarak baskıyla dizayn etmeyi amaçlamaktadır. Dincilikle muhafazakârlığın özdeş görülmesi bütünüyle toplumsal reform planının nostaljik yönüdür. Özetle muhafazakârlık dincilikten öte dindarlıkla uyuşabilen, fakat dindarlıkla da özdeş olmayan bir ideolojidir (Erdoğan, 2004: 6).

Ayrıca muhafazakâr bir bireyin dinin sosyolojik boyutunu idrak edebilmesi için dindar olması ya da bir dine inanması da gerekmemektedir. Örneğin Burke dindar olmasına rağmen Hume değildi. Yeni muhafazakâr düşüncenin öncülerinden Kristol dindar olmakla birlikte Oakeshott ve Strauss dindar değillerdi. (Safi, 54: 2005). Öyle ki, her iki durumda da muhafazakârlar dini denge unsuru olarak görmektedirler. Bir başka yönden muhafazakâr düşüncede herhangi bir dinin baskın olmaması, toplum tarafından belirlenen dinin geçerli olması, devletin din tercihinde belirleyici olmaması durumu söz konusudur. Muhafazakârlık dini ideoloji haline getirmemekte, toplumu dindarlaştırma yöntemi gütmemektedir. Dini sosyolojik bir kurum ve geleneğin bir parçası olarak görmektedir (Işık, 2023: 36).

6. SONUÇ

Muhafazakârlık, yukarıda da ele aldığımız üzere farklı perspektiflerde incelenebilecek dayanak noktalarına sahip bir kavram olarak karşımıza çıkmaktadır. Muhafazakâr düşünce deneyimi içerisinde bulunan, fakat birbirinden ayrılan farklı anlayışları ve uygulamaları düşündüğümüzde muhafazakârlığın değişken yapısıyla karşılaşmamız kaçınılmaz olmaktadır. Muhafazakârlık birtakım benzer düşünce akıllarına sahip olmakla birlikte yukarıda değindiğimiz üzere “Kıta Avrupası Muhafazakârlığı”, “İngiliz Muhafazakârlığı” ve “Amerikan Muhafazakârlığı” gibi birbirinden ayrılan çeşitli düşünce geleneklerine sahiptir. Muhafazakârlığa dair değerlendirmeler genel anlamda yukarıdaki düşünce gelenekleri dikkate alınarak gerçekleştirilmektedir. Muhafazakârlık bu çeşitlilik içerisinde birtakım toplumsal kurumları referans kaynağı olarak görmüş, bizlere bu kaynaklara dayanarak birtakım anlatılar sunmuştur. Bu referanslar aile, gelenek, otorite, düzen, mülkiyet ve din gibi temel referans kaynaklarıdır. Bu referanslar içerisinde din toplumun omurgasını oluşturan en önemli kurumlardan biridir.

Muhafazakâr düşünceye göre, geleneksel kurumlar arasında din kurumu özel bir öneme sahiptir. Ancak muhafazakârlar dini yalnızca bireysel kurtuluş ve manevi deneyimlerle sınırlı, özsel (substantif) bir yapı olarak değerlendirmezler. Onlar dini, aynı zamanda toplumun bir arada kalmasına, sosyal düzenin korunmasına ve ortak değerlerin sürdürülmesine katkı sağlayan temel bir unsur olarak görmektedirler. Bununla birlikte, muhafazakârlık kavramı “dincilik” ile karıştırılmamalıdır. Dincilik, toplumu katı dini kurallara göre şekillendirmeyi ve

bu doğrultuda baskıcı bir düzen kurmayı hedefler. Oysa muhafazakârlık, böyle bir dayatmacı yaklaşımı benimsemez. Dincilikle muhafazakârlığın eş tutulması, genellikle geçmişe duyulan özlemle şekillenen bir toplumsal reform arzusunun yansımasıdır. Dolayısıyla muhafazakârlık, dindarlıkla örtüşebilen, fakat onunla birebir aynı olmayan bir ideolojidir; dini değerlere saygı duyar ama onları siyasal bir araç haline getirmez.

Muhafazakâr düşünceye göre din, bireylerin içtenlikle bağlı olduğu derin bir gerçekliktir. Bu anlayış çerçevesinde, din ve ibadet özgürlüğü yasal güvencelerle korunmalı, ancak bu özgürlük siyasal alana taşınarak istismar edilmemelidir. Çünkü muhafazakârlık, siyasetle dinin alanlarının ayrı tutulması gerektiğine inanır. Zira “siyaset” ile “vaaz kürsüsü” tabiatları gereği birbirine zıt alanlardır. Muhafazakârlar genellikle dinin toplumsal işlevine vurgu yapar ve bu nedenle dinin dengeli, ılımlı ve barışçıl yönlerini ön planda tutarlar. Bu yönlerin bireyler tarafından benimsenmesi, onların daha huzurlu ve anlamlı bir yaşam sürmelerine katkı sağlar. Ayrıca din, bireyleri toplumsal çözülme, yalnızlık, korku ve travma gibi olumsuzluklardan koruyan bir sığınak işlevi görür. Öte yandan, dini temelli sivil toplum kuruluşları da demokratik toplumlarda önemli bir denetim işlevi üstlenir. Bu yapılar, gerektiğinde devletin otoriterleşmesine karşı etkili bir denge ve denetim mekanizması oluşturarak toplumsal muhalefetin sesi olabilir.

Sonuç olarak muhafazakârlık dini bireysel bir arınma, manevi bir deneyim ve motivasyon kaynağı olarak görmekle birlikte, aynı zamanda toplumsal bağları güçlendiren bir olgu olarak da görmektedir. Dolayısıyla devlet, ekonomi ve mülkiyet toplumun fiziki yönünü, din ise canını ve ruhi yönünü oluşturup şekillendirmektedir. Muhafazakârlara göre dinden yoksun bir toplum canından ve ruhundan da yoksunlaşmak üzere olan bir canlıyı andırmaktadır. Bu anlamda din muhafazakârlığa göre birleştirici ve bütünleştirici bir unsurdur. Zira dinin söz konusu işlevini takdir etmek için muhafazakâr bir bireyin dindar olması da gerekmemektedir.

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COMPETENCES THAT NEED TO BE FORMED IN PEDAGOGICALLY ORIENTED SPECIALTIES AT THE MASTER'S LEVEL

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ABSTRACT

It is known that the Bologna Declaration, which the Republic of Azerbaijan officially adopted and joined in 2005, and the commitments stated therein are a program of long-term activity. This process has been taking shape in the European higher education system for decades, the parameters of the process have emerged in the national higher education systems and have mutually penetrated neighboring states.

The multi-level higher education system, which is among the parameters of the commitments of the Bologna process, combines many advantages. Master's degree education, which is the second stage of multi-level education, is primarily perceived as an integral part of continuous professional education. With the help of master's education, certain tasks related to the expansion of students' knowledge, skills and abilities are solved. At this level of education, the acquisition of scientific knowledge in a specific direction and the process of specialization are carried out, and most importantly, the formation of research competence in graduates is carried out.

At the master's level, attention should be paid to the level of educational and methodological support for master's students in various training and research processes, as well as the organization of such support, as qualitative indicators of the preparation of future teachers. One of the important issues is the analysis of the content of educational and methodological materials, that is, teaching aids, used in the process of preparing future teachers at the master's level. In addition to the formation of scientific knowledge in master's students, the scientific information, proposed tasks and stated questions contained in textbooks, which are the main means of creating research competence and obtaining education, are of a research nature.

The concept of "competence" is the result of the new economy and a new approach to human resources, which arises from the need to adapt a person to frequently changing conditions. A competent person possesses the knowledge, skills and habits necessary for working in a particular specialty, is able to demonstrate independence and flexibility in the analysis of professional problems, and at the same time maintain cooperation in the professional field. Competence is based primarily on the knowledge required through the development of a

person's own culture of thinking, analytical reflection, support for the development of independence and responsibility when making decisions, and performance criteria in standards.

INTRODUCTION.

In the dictionary of the European Training Foundation, the term competence is described in the same sense as competence. Competence (lat. Competentia, compete – I reach, I achieve, I approach; compens, compentis – suitable, capable, the ability to do something well or efficiently; compliance with the requirements for employment; the ability to perform specific labor functions.

Let's pay attention to the meaning of the word competence in different languages. From Latin “Competere” (competence), it is pronounced as “competence” in French, “kompetenz” in German, “competencia” in Spanish, and “competenza” in Italian, and is translated as competence, that is, competence.

Thus, it becomes clear that competence is nothing more than suitability for a certain type of activity and the ability to perform tasks due to our knowledge and skills.

RESEARCH AND FINDINGS.

Based on our analysis and, most importantly, on the basis of studying the content of professional competencies included in the Educational Program of the specialty, it becomes clear that the following competencies must be formed in students studying in pedagogically oriented specialties at the master's level:

1. communicative-speech competence
2. forecasting competence
3. professional-ethical competence
4. global competence
5. professional competencies aimed at the effective organization of scientific and research activities
6. organizational-administrative competence
7. information communication skills

Let's pay attention to the content of each of these competencies.

An important category of the pedagogical culture of future teachers studying at the master's level is communicative and speech skills. The communicative and speech activity of future teachers is an activity aimed at achieving a certain goal, based on pedagogical ethics, respect and the intrinsic value of actions, having a distributive character between the subjects of interaction. One of the features of master's students is their professional culture, and its

necessary components are communicative and speech competence. Communicative and speech competences occupy a special place in the development of their professionalism.

The social order in the field of pedagogical education dictates the expansion of intercultural, interethnic relations and all types of social relations. Today, society places high demands on the communicative and speech qualities of pedagogical personnel. This allows them to be competitive in social, economic, political conditions - both in education, in the labor market, and in society. In the mentioned conditions, along with the ability to work in the information space, the qualities of self-education, acquisition of the necessary knowledge, self-presentation skills, mobility and the ability to solve non-standard communicative problems belong entirely to future teachers studying at the master's level. 4 criteria for the formation of communicative and speech competence in future teachers were identified:

- 1) speech culture (accuracy, clarity and logical structure of speech);
- 2) expressiveness (the ability to express one's thoughts);
- 3) professional communication (the ability to establish an effective dialogue, prepare presentations and reports);
- 4) conflict-free communication (the ability to prevent and constructively resolve conflicts).

Currently, many foreign researchers, leading figures of pedagogical science consider the predictive competence of a specialist in the education system to be one of the professional components of a teacher.

The global perspective of the results of pedagogical activity makes it necessary to analyze the possibilities of the formation of predictive competence. For this reason, the formation of predictive competence in the preparation of future teachers at the master's level can be considered one of the main tasks.

To study the essence and characteristics of predictive competence, let's consider the concepts of forecast, forecasting, and predictive ability.

Recently, one of the main directions in documents on higher education in our republic has been to give importance to the competencies of future specialists and to recognize competencies acquired outside the formal education and training environment. The concept of "competence" is considered as a systematized personal qualities that are a kind of indicator of the ability to universally apply existing knowledge and skills (Gizi, A. L. Z. (2016).

In the works of E.D. Dneprov, competence is considered as the readiness to use existing educational skills, knowledge and methods of activity to master theoretical and practical tasks. The main parameters of professional competence, which is a unity of theoretical and practical preparation for the implementation of pedagogical activity, the performance of professional

functions, are determined by the functional structure of pedagogical activity and include a number of theoretical and practical skills. By predictive skills, researchers mean the following:

- performing actions aimed at obtaining a forecast;
- performing mental actions that allow the teacher to acquire advanced pedagogical experience in order to increase the efficiency of the educational process;
- having a complex of mental and practical actions aimed at solving prognostic problems based on the conscious application of psychological, pedagogical and methodological knowledge in practice to be;

Forecasting is an independent universal multifunctional pedagogical activity aimed at the application of possible trends and development prospects of objects and subjects of pedagogical activity (gizi Allahverdiyeva, L. Z. (2023).

The professional and ethical competence of a teacher acts as an indicator and at the same time its result of professional and personal readiness for work in an educational institution. Because the fulfillment of any pedagogical task has a moral meaning. The ethical competence of a future teacher constitutes the main regulations of his actions, which are determined in his habits, customs, principles of life and professional activity, mental state, actions, deeds and qualities; professional and pedagogical norms ensure the conscious choice of ethical behavior of the teacher in accordance with the rules of ethical behavior.

The professional and ethical competence of a future teacher studying at the master's level is an individual-psychological preparation that is formed during the professional training process and includes the formation of a system of special professional competencies that successfully fulfill the functional duties of the graduate and allow for the assessment of the level of education. As a result of this education, responsibility for the results of one's activities in terms of ethics and moral values, including in situations of moral choice, increases (Allahverdiyeva, L. (2024).

The functions of the professional and ethical competence of a future teacher at the master's level can be determined as follows:

- analytical: the ability to analyze the professional characteristics of the future teacher from the point of view of the norms of the ethical context;
- predictive: prediction of professional ethical actions in situations of moral choice;
- communicative: regulation of the speech culture of the future teacher in accordance with the requirements of the code of ethics;
- regulatory: implementation of the professional activity of the future teacher within the framework of the existing normative and legal framework;

- regulatory as a specialist: adaptation of professional pedagogical activity and one's own behavior in situations of interaction with the learner and others in accordance with the requirements and norms of the code of ethics;
- ethnocultural: tolerant attitude towards people with different values, attitudes, goals, religious beliefs.

Global competencies are one of the important competencies that form the basis of successful existence in modern society is a component of functional literacy. The main skills of global competence include the ability to evaluate information;

the ability to identify ideas, approaches, perspectives, and analyze them; the ability to formulate arguments; explain complex situations and problems; and the ability to evaluate actions and their consequences (Allahverdiyeva, L. (2024).

Global competence is defined as a multidimensional ability, which includes the following:

- learning global and intercultural problems;
- understanding and evaluating different points of view and worldviews;
- successfully interacting with others with respect;
- taking measures for collective well-being and sustainable development.

According to researchers, the structure of global competence is divided into four aspects: knowledge, skills, values, and attitudes. The acquisition of relevant knowledge, skills, attitudes, and values occurs throughout life, and there is no time when a person becomes fully competent in this area.

Let's consider the main concepts that are necessary for understanding by both teachers and graduate students in the process of developing global competencies. Among these concepts The concept of sustainable development, cultural models, and intercultural dialogue are particularly distinguished.

CONCLUSION.

WE THINK that in the modern era, when science and technology are observed to be rapidly and innovatively developing, there is an urgent need for the formation of professional competencies in graduate teachers. As a result of meeting this need, creative and intellectual young people, young scientists who are useful to society, with highly developed scientific and research skills, will be formed.

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KAPSAYICI YETERLİLİK VE KÜLTÜR: MODERN ÖĞRETMENLERİN TEMEL NİTELİĞİ

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ÖZET

Bu makale, giderek daha çeşitli sınıflarda çalışan eğitimciler için kapsayıcı yeterlilik ve kültürel farkındalığın temel nitelikler olarak önemini ele almaktadır. Modern öğretmenlik uygulamalarının yalnızca bilgi aktarmaktan ibaret olmadığını, aynı zamanda tüm öğrenciler için eşit ve destekleyici öğrenme ortamları oluşturma becerisini de gerektirdiğini savunmaktadır. Uluslararası eğitim çerçeveleri, politika belgeleri ve akademik araştırmalardan yararlanarak çalışmada pedagojik uyum ve kültürel duyarlılığın etkili öğretimin temel bileşenleri olduğu vurgulanmaktadır.

Kapsayıcı yeterlilik, farklı öğrenme ihtiyaçlarının tanınması, öğretimin farklılaştırılması ve adalet ile aidiyete yönelik bir bağlılık gibi çok boyutlu bir yapı olarak sunulmaktadır. Makale öğrencilerin bireysel deneyimlerini dikkate almayı, çeşitli öğretim yöntemleri kullanmayı, güvenli ve güvenilir sınıf ortamları geliştirmeyi ve kalıpyargıları eleştirel bir şekilde sorgulamayı kapsayan temel stratejileri ortaya koymaktadır.

Kültürel farkındalık ise öğrencilerin sınıfa getirdiği çeşitli geçmişleri anlamak ve değer vermek açısından kritik bir unsur olarak tanımlanmakta, hem öğretmen-öğrenci etkileşimlerini hem de öğretim materyallerinin uygunluğunu artırmaktadır. Finlandiya, Kanada, Amerika Birleşik Devletleri ve Azerbaycan eğitim sistemlerinin karşılaştırmalı bir analizi, öğretmen eğitimi, politika uygulamaları ve kaynak tahsisi ile ilgili hem umut verici uygulamaları hem de devam eden zorlukları ortaya koymaktadır. Çalışmada, kapsayıcı eğitimin hedeflerine tam anlamıyla ulaşabilmesi için sürekli mesleki gelişim, yansıtıcı uygulamalar ve sistemsal destek gerektiği vurgulanmaktadır.

Bulgular, öğrenci katılımını, akademik başarıyı ve sosyal-duygusal gelişimi desteklemek isteyen eğitimciler için kapsayıcı yeterlilik ve kültürel farkındalığın vazgeçilmez özellikler olduğunu göstermektedir. Sonuç olarak çalışma, tüm öğrencilerin çeşitli eğitim ortamlarında başarılı olabilmesi için bireysel öğretmen uygulamaları ile kurumsal desteğin bir arada yürütülmesini savunmaktadır.

Anahtar Kelimeler: Kapsayıcı yeterlilik, kültürel farkındalık, farklılaştırılmış öğretim, kapsayıcı eğitim, küresel eğitim sistemleri

INCLUSIVE COMPETENCE AND CULTURE: A CORE QUALITY FOR MODERN TEACHERS

ABSTRACT

This paper explores inclusive competence and cultural awareness as essential attributes for educators working in increasingly diverse classrooms. It argues that modern teaching requires not only the transmission of knowledge but also the ability to create equitable and supportive learning environments for all students, regardless of background, identity, or ability. Drawing upon international educational frameworks, policy documents, and scholarly research, the study highlights the importance of pedagogical adaptability and cultural sensitivity as foundational components of effective teaching practice.

Inclusive competence is presented as a multidimensional construct encompassing differentiated instruction, recognition of diverse learning needs, and a commitment to equity and belonging. The paper outlines key strategies for developing inclusive competence, including engaging with students' individual experiences, employing varied instructional methods, fostering safe and trusting classroom communities, and critically challenging stereotypes. Cultural awareness is further identified as a key element in understanding and valuing the diverse backgrounds students bring to the classroom, enhancing both teacher-student interactions and curriculum relevance.

A comparative analysis of education systems in Finland, Canada, the United States, and Azerbaijan illustrates different approaches to inclusion, highlighting both promising practices and ongoing challenges related to teacher training, policy implementation, and resource allocation. The study emphasizes the need for continuous professional development, reflective practice, and systemic support to fully realize the goals of inclusive education.

The findings underscore that inclusive competence and cultural awareness are indispensable qualities for educators committed to fostering student engagement, academic achievement, and social-emotional growth. Ultimately, the study advocates for a comprehensive approach to inclusion that combines individual teacher practices with institutional commitment, ensuring all learners thrive in diverse educational settings.

Key words: Inclusive competence, cultural awareness, differentiated instruction, inclusive education, global education systems

INTRODUCTION

Education systems around the world are becoming increasingly diverse. Teachers are no longer tasked solely with delivering subject content but are expected to create inclusive, equitable

learning environments that support all students, regardless of background, ability, or identity. Inclusive competence—the skills and mindset to address this diversity—is now recognized as a foundational requirement for effective teaching [Gay, G., 2010, p. 44]. This paper examines the components of inclusive competence and cultural awareness, drawing on international examples, research findings, and policy frameworks.

Inclusive competence is all about having the skills and mindset to teach a diverse group of students in a way that works for everyone. It's about knowing how to adapt your teaching to meet different needs, understanding the unique perspectives kids bring, and making sure no one feels left out. This isn't something you master overnight—it's a journey of learning, reflecting, and growing.

Here's what it looks like in action:

1. **Seeing the whole student:** Every kid comes from somewhere—a culture, a family, a set of experiences. A great teacher gets curious about those differences and uses that understanding to connect with their students [Nieto, S., & Bode, P., 2018, p. 71].
2. **Mixing up your teaching:** Some kids learn best by reading, others by doing, and some need extra support. Inclusive teachers tweak their lessons to make sure every student can shine [Tomlinson, C. A., 2014, p. 14].
3. **Listening with heart:** It's about truly hearing your students, building trust, and creating a space where they feel safe being themselves [Florian, L., & Black-Hawkins, K., 2011, p. 819].
4. **Calling out unfairness:** Good teachers don't shy away from tough topics. They challenge stereotypes and make sure their classroom is a place where everyone gets a fair shot [Ladson-Billings, G., 1995, p. 483].

While inclusive competence is about your skills as a teacher, inclusive culture is about the vibe of your classroom. It's the feeling that every student belongs, no matter who they are. As a teacher, you set the tone by demonstrating what inclusion looks like and encouraging children to respect and learn from one another [Banks, J. A., & Banks, C. A. M., 2019, p. 36].

Here's what an inclusive classroom feels like:

1. **Fair doesn't mean the same:** Some students need extra help to succeed, and that's okay. It's about giving each kid what they need, not just treating everyone equally [Ontario Ministry of Education, 2009, p. 5].

2. **Teamwork makes the dream work:** Kids learn best when they work together, share ideas, and celebrate each other's differences [OECD, 2012, p. 27].
3. **A safe space to be you:** Whether a student is shy, outspoken, or figuring out who they are, they should feel comfortable being themselves in your classroom [Nieto, S., & Bode, P., 2018, p. 79].
4. **Stories that reflect everyone:** The books you read, the history you teach, and the examples you use should show the diversity of the world, so every student sees themselves in the learning [Sleeter, C. E., 2011, p. 18].

Inclusive competence refers to the ability of educators to teach in ways that support the diverse needs of all students. It involves differentiated instruction, recognition of systemic barriers, and efforts to foster equitable participation [Tomlinson, C. A., 2014, p. 20]. Teachers with high inclusive competence adapt lessons for varied learning styles, accommodate language and ability differences, and create a classroom culture that promotes respect and belonging [Nieto, S., & Bode, P., 2018, p. 65].

Culture influences how students learn, behave, and communicate. Culturally responsive teaching acknowledges and incorporates students' cultural backgrounds into instructional methods and content [Banks, J. A., & Banks, C. A. M., 2019, p. 24]. Awareness of culture affects teacher-student interactions, classroom dynamics, and curriculum relevance. Teachers must also reflect on their cultural assumptions and biases to foster genuine inclusivity [Gay, G., 2010, p. 65].

Comparative perspectives:

1. **Finland:** Finland's education system emphasizes equality and student well-being. Teachers are trained extensively in inclusive practices and enjoy a high degree of professional autonomy. Multi-tiered systems of support and individualized education plans (IEPs) are common tools for addressing diverse learning needs [Sahlberg, P., 2015, p. 143].
2. **Canada:** Canadian schools prioritize multiculturalism and inclusive education, especially in provinces like Ontario and British Columbia. Policy documents mandate anti-bias training, inclusive curriculum design, and community engagement [Ontario Ministry of Education, 2009, p. 12]. Inclusive education in Canada also addresses Indigenous perspectives and rights [Banks, J. A., & Banks, C. A. M., 2019, p. 54].
3. **United States:** The U.S. has made significant legal and policy commitments to inclusion through the Individuals with Disabilities Education Act (IDEA) and Title IX. However,

practices vary by state and district. Universal Design for Learning (UDL) and Response to Intervention (RTI) are commonly promoted frameworks [Al-Azawei, A., Serenelli, F., & Lundqvist, K., 2016, p. 101].

4. Azerbaijan and Post-Soviet Contexts: Countries like Azerbaijan are actively reforming their education systems to align with international standards on inclusion. Policies increasingly support the integration of students with special needs into general education settings, although challenges remain in teacher training and resource allocation [Aliyev, R., & Aliyeva, L., 2017, p. 55; UNESCO, 2020, p. 9].

Creating inclusive classrooms involves both structural and personal change. Teachers must:

1. Participate in ongoing DEI (diversity, equity, and inclusion) training [UNESCO, 2020, p. 17]
2. Apply differentiated instructional methods [Tomlinson, C. A., 2014, p. 16]
3. Use culturally responsive pedagogy [Gay, G., 2010, p. 45; Banks, J. A., & Banks, C. A. M., 2019, p. 40]
4. Reflect on and challenge personal biases [Nieto, S., & Bode, P., 2018, p. 88]
5. Incorporate technology equitably to support diverse learners [Al-Azawei, A., Serenelli, F., & Lundqvist, K., 2016, p. 107]

These practices must be supported by institutional policies, adequate funding, and leadership commitment [OECD, 2012, p. 29].

Inclusive classrooms are associated with better academic performance, improved student engagement, and stronger social-emotional development [OECD, 2012, p. 31]. However, implementation challenges include insufficient teacher preparation, resistance to change, and systemic inequities [UNESCO, 2020, p. 20].

CONCLUSION

Inclusive competence and cultural awareness are indispensable in today's educational landscape. Teachers must be equipped to understand and respond to the diverse needs of students, fostering environments where all learners thrive. Comparing educational systems highlights the importance of systemic support and ongoing professional development. Inclusion, when authentically practiced, benefits every learner and reflects the true purpose of education: equity, empowerment, and opportunity for all.

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Özət. Hazırda təbiət elmlərində (qeyri-xətti analiz, xaos nəzəriyyəsi, fraktal həndəsə, kəskinləşən rejimlər nəzəriyyəsi) doğan sinergetikanın getdikcə daha çox fənlərarası tədqiqat sahəsinə çevrildiyini iddia etmək olar. Sinergetikanın ideyaları həm yaradıcılıq fenomenini dərk etməkdə, həm də yaradıcı təfəkkürün sirlərini açmaqda səmərəlidir. Eyni zamanda, hər hansı bir sistemin inkişafı, tədqiqatçıların fikrincə, dünyanın iki əks təkamülü kimi bu əksliklərin əksidir: entropik və negentropik. Sinergetikanın mövqelərinə görə, təkamül proseslərinin - tarixi, ontogenetik, idrakın əsasını daim xaosu nizama çevirən, qeyri-sabitlik və uyğunlaşma prosesləri vəziyyətləri ilə işləyən özünütəşkil etmə mexanizmi olduğu güman edilir. Alimlər sinergetikanın mərkəzi probleminin nizam və xaos arasındakı əlaqə problemi olduğunu iddia edirlər.

Açar sözləri: yaradıcı, düşüncə, sinergetika, baxış, fenomen.

A SYNERGETIC VIEW OF CREATIVE THINKING

Abstract. It can be argued that synergetics, which originated in the natural sciences (nonlinear analysis, chaos theory, fractal geometry, theory of sharpening regimes), is increasingly becoming an interdisciplinary field of research. The ideas of synergetics are effective both in understanding the phenomenon of creativity and in revealing the secrets of creative thinking. At the same time, the development of any system, according to researchers, is a reflection of these opposites, like two opposite evolutions of the world: entropic and negentropic. According to the positions of synergetics, it is assumed that the basis of evolutionary processes - historical, ontogenetic, cognition is a self-organizing mechanism that constantly transforms chaos into order, working with states of instability and adaptive processes. Scientists argue that the central problem of synergetics is the problem of the relationship between order and chaos.

Keywords: creative, thinking, synergetics, view, phenomenon.

Qiriş. Hazırda təbiət elmlərində (qeyri-xətti analiz, xaos nəzəriyyəsi, fraktal həndəsə, kəskinləşən rejimlər nəzəriyyəsi) doğan sinergetikanın getdikcə daha çox fənlərarası tədqiqat sahəsinə çevrildiyini iddia etmək olar. Sinergetikanın ideyaları həm yaradıcılıq fenomenini dərk

etməkdə, həm də yaradıcı təfəkkürün sirlərini açmaqda səmərəlidir [5]. "Sinergetika" termininin mənasını izah edək. "Synergy" (yunanca) - "birgə fəaliyyət". Sinergetika bir neçə müxtəlif amilin birgə təsiri nəticəsində yaranan belə hadisələri öyrənir, halbuki hər bir amil ayrı-ayrılıqda bu fenomenə səbəb olmur [6]. Ən mənalı halda, sistemin formasının, strukturunun və funksiyasının kortəbii mürəkkəbləşməsi kimi sistemlərin öz-özünə təşkili fenomeni - sıçrayışla - bu hadisələr dairəsinə düşür. Onun parametrlərində yavaş və hamar bir dəyişiklik ilə (Prigogine, 1990, 1991; Nikolis, 1990; Haken, 1990). Yuxarıdakı müəlliflər sinergetikanın mərkəzi probleminin nizam və xaos arasındakı əlaqə problemi olduğunu iddia edirlər.

İşləmə. Eyni zamanda, hər hansı bir sistemin inkişafı, tədqiqatçıların fikrincə, dünyanın iki əks təkamülü kimi bu əksliklərin əksidir: entropik və negentropik. Sinergetikanın mövqelərinə görə, təkamül proseslərinin - tarixi, ontogenetik, idrakın əsasını daim xaosu nizama çevirən, qeyri-sabitlik və uyğunlaşma prosesləri vəziyyətləri ilə işləyən özünü-təşkil etmə mexanizmi olduğu güman edilir. Sinergetika mürəkkəb sistemlərin öz-özünə təşkili nəzəriyyəsi kimi müasir düşüncə tipini təcəssüm etdirir. Bu nəzəriyyənin intensiv inkişafı Q.Haken, İ.Priqojine, S.P.Kurdyumov kimi alimlərin adları ilə bağlıdır. Sinergetika mürəkkəb sistemlərin təkamülünün və öz-özünə təşkilinin ümumi qanunlarını öyrənir. Onun çərçivəsində mürəkkəb sistemlərin davranışının təkamüllü qeyri-xətti modelləri qurulur [7], [8], [9], [10].

Bizə elə gəlir ki, sinergetik modelləri insan təfəkkürünün yaradıcı fəaliyyətini dərk etmək üçün də tətbiq etmək olar. Sinergetikanın inkişafı dünyanı öyrənməyə yanaşmalarda köklü dəyişikliklərə səbəb olur. Bu, varlıqdan çevrilməyə, sabitlikdən idarə olunan inkişafa, nizam obrazlarından yeni nizamlı inkişaf edən strukturlar yaradan xaosa, mənfi əks əlaqə (homeostaz) vasitəsilə öz tarazlığını qoruyan sistemlərdən qeyri-xətti müsbət əks əlaqə sayəsində sürətli təkamül proseslərinə, təkamüldən birgə təkamülə, müxtəlif kompleks sistemlərin qarşılıqlı razılaşdırılmış təkamülünə konseptual deməkdir. Beləliklə, yeni sinergetik düşüncə tərzini qeyri-xətti, təkamül və vahiddir.

Ən mənalı halda, sistemin formasının, strukturunun və funksiyasının kortəbii mürəkkəbləşməsi kimi sistemlərin öz-özünə təşkili fenomeni - bir sıçrayışla - belə bir hadisələr dairəsinə düşür. Onun parametrlərində yavaş və hamar bir dəyişiklik ilə (Prigogine, 1990, 1991; Nikolis, 1990; Haken, 1990). Göstərilən müəlliflər iddia edirlər ki, sinergetikanın əsas problemi nizam və xaos arasındakı əlaqə problemidir. Eyni zamanda, hər hansı bir sistemin inkişafı, tədqiqatçıların fikrincə, dünyanın iki əks təkamülü kimi bu əksliklərin əksidir: entropik və negentropik. Sinergetikanın mövqelərinə görə, təkamül proseslərinin - tarixi, ontogenetik, idrakın əsasını daim xaosu nizama çevirən, qeyri-sabitlik və uyğunlaşma prosesləri vəziyyətləri ilə işləyən

özünü təşkil etmə mexanizmi olduğu güman edilir. Sinergetika mürəkkəb sistemlərin öz-özünə təşkili nəzəriyyəsi kimi müasir düşüncə növünü təcəssüm etdirir.

Hazırda fərdi yaradıcılığın öyrənilməsinə metodoloji yanaşmalar yaradıcı impulsun müəyyən edilməsi meyarına görə fərqlənir. Prioritetlərin üstünlük təşkil etməsindən asılı olaraq müxtəlif yanaşmaları aşağıdakı kimi xarakterizə etmək olar:

1. Məhsuldar, intellektual yanaşma. Yaradıcılıq subyektin fəaliyyətinin daha ümumi xassəsinin, onun situasiya zərurətindən kənara çıxmağa hazır olmasının və vəziyyətin qeyri-müəyyənliyinə uyğunlaşma metodunu dəyişdirmək qabiliyyətinin xüsusi halı kimi qəbul edilir (G. Eysenck, D. Wexler, N. S. Leites, L. Termen, J. Piaget, R. Sternholberg.).

2. Şəxsi yanaşma. Yaradıcılıq fərdin özünü ifadə etmə prosesidir, buna görə də yaradıcılıq şəxsi xüsusiyyətlərin törəməsidir. Fərddə intellektual inkişaf səviyyəsindən asılı olmayaraq yaradıcı davranış yaradan müəyyən yaradıcılıqogen əlamətlər vardır (F.Barron, A.B.Ermolaeva-Tomina, V.N.Kozlenko, A.G.Maslou, K.Rogers, E.Fromm, M.Vollah, N.Koqan).

3. Yaradıcılığın ikili xarakterli spesifik koqnitiv-şəxsi üslub olduğunu güman edən sintetik yanaşma: həm şəxsi, həm də idrak. İlkin olaraq sırf koqnitiv formalaşma kimi inkişaf edən yaradıcılığın formalaşmış idrak istəkləri və niyyətləri vasitəsilə motivasiya sferasında sabitləşdiyinə inanılır. Motivasiya amillərinin təsiri altında yaradıcılığın idrak səviyyəsinin inkişafı və tətbiqi üzərində nəzarəti təmin edən yaradıcı xüsusiyyətlər formalaşır (D.B.Boqoyavlenskaya, V.N.Drujinin, S.Kaplan, A.M.Matyuşkin, Ya.P.Ponomarev, J.Renzulli, A.Tannenbaum, J.Keldhuzen, J.Keldler).

4. Yaradıcı fəaliyyətin mədəni uyğunluğuna yanaşma (A.N.Leontyev, V.P.Zinçenko, A.V.Bruşlinski və s.). Onun problemləri, metodları, standartları, normaları mədəniyyətdə təqdim olunur və onun əsas məzmununu təşkil edir. Fərq ondadır ki, yaradıcı və “adi” (məhsuldar və reproduktiv) fəaliyyət standartları mədəniyyətin müxtəlif təbəqələrindədir. Standartlaşdırılmış fəaliyyət mədəniyyət təbəqəsində yerləşir ki, orada dominant amil artıq reallaşdırılan imkanlar, artıq həll edilmiş problemlərdir. Özlüyündə yeni normanın yaranması mexanizmi kimi çıxış edən qeyri-standart fəaliyyət bəşər mədəniyyətinin gizli, reallaşdırılmamış imkanları, tarixən yetkinləşmiş, mənimsənilməmiş formaları ilə təmsil olunan tamam başqa mədəni təbəqəyə aiddir. Düşünən subyektin yaradıcılığı məhz artıq məlum, mənimsənilmiş normalar əsasında praktikada mədəniyyətin bu mənimsənilməmiş qatlarına yüksəlmək bacarığından ibarətdir.

5. A.A.Koblyakov-nın irəli sürdüyü sinergetik yanaşma. [3], şəxsi yaradıcılığın ziddiyyətli təbiətinin mahiyyətini anlamağa imkan verir. Bu yanaşmaya görə, universal yaradıcılıq qabiliyyəti xüsusi bir növ ziddiyyətə əsaslanır, onun aradan qaldırılması mövcud alternativlərdən birinin formal seçimi kimi həyata keçirilə bilməz.

Yaradıcı şəkildə həll edilən ziddiyyətlər disjunksiya məntiqindən (ya - və ya) birləşmə məntiqinə keçid tələb edir: qəbul edilmiş qərar mövcud alternativlərin heç birinə endirilə bilməyən yeni keyfiyyəti təmsil edir, lakin onları bütövlükdə ehtiva edir: əvvəllər verilmiş alternativlərin hər biri, sanki, yeni keyfiyyətin müəyyən proyeksiyasına çevrilir. Yaradıcı insanın adı bir insandan fərqli olaraq öz təbiətinin əks xüsusiyyətlərini özündə üzə çıxarmaqdan çəkinməməsi faktını K.G. Jung. Həmçinin, ilk baxışdan yaradıcı şəxsiyyətlərin bir-birini istisna edən, oynaqlıq və nizam-intizam kimi xüsusiyyətləri, həm introvertlərin, həm də ekstrovertlərin xüsusiyyətlərinin təzahürü, reallıq və fantaziya hissi, təvazökarlıq və qürur, böyük fiziki enerji və sülh, istirahət vəziyyəti kimi qeyd olunur.

Beləliklə, sinergetik yanaşma bizə yaradıcı şəxsiyyətin strukturunda özünü təşkilatın, özünü tamamlamanın müəyyən mexanizmini görməyə imkan verir. Elmi yenilik və aktualıq pedaqoji nəzəriyyədə sinergetik ideyaların tətbiqi ilə bağlı məsələlər kompleksini fərqləndirir.

Elmi yenilik və aktualıq pedaqoji nəzəriyyədə sinergetik ideyaların tətbiqi ilə bağlı məsələlər məcmusunu fərqləndirir. Pedaqoji nəzəriyyənin müasirləşdirilməsi, onun sistemli tədqiqatların sinergetik inkişafı mərhələsi ilə səciyyələnən post-qeyri-klassik elmin əsas tələblərinə uyğunlaşdırılması zərurətinin dərk edilməsi elmi ictimaiyyətə XX əsrin 80-ci illərinin sonlarında gəldi. 1989-cu ildə Vyanada keçirilən beynəlxalq simpoziumda çıxış edən kanadalı professor R.Ramsay iddia edirdi ki, ötən əsrin mexaniki baxış və konsepsiyalar şəbəkəsinə qarışmış pedaqoji elmin nəzəri və metodoloji əsaslarının vəziyyəti dərin narahatlıq doğurur [5]. Onun fikrincə, elmin bütün digər sahələrinə atılan təbiət elmlərinin son nailiyyətlərinin ciddi çağırışına cavab axtarmaq lazımdır.

Yenidən düşünməyə ehtiyac var. Cəmiyyətdə pedaqogika və bütün sosial-pedaqoji fəaliyyət üçün yeni anlayış vermək və yeni əsasları inkişaf etdirmək. R.Ramsay və onun həmkarları hesab edirlər ki, sosial və pedaqoji fəaliyyətin global modeli müxtəlif xarakterli sistemlərdə struktur formalaşmasının ümumi mexanizmi ideyasına əsaslanırsa bilər. Eyni zamanda, model milli dövlətlərdən, hakim ideologiyalardan və mədəniyyətlərdən müstəqil olur. Xaotik qeyri-sabitlik yolu ilə nizamın formalaşmasına dair nəzəri mövqe fərqlər və insan davranışının kollektivist aspektləri arasında mürəkkəb qarşılıqlı əlaqəni daha dəqiq təsvir etməyə imkan verir.

Beləliklə, təklif olunan pedaqoji elm və təhsilin islahatı konsepsiyası sinergetik ideologiya ilə hərtərəfli şəkildə hopmuşdur. Məsələn, xarici pedaqoji məktəbləri təhlil edəndə görmək olar ki, onların bəzilərində sinergetik üsullardan kifayət qədər istifadə olunur. E.N. Knyazeva və S.P.Kurdyumov [1], [2]. geştalt formalaşmasını təhlil edərək qeyd edək ki, bu pedaqoji sistemdən istifadə edərkən bəziləri bütövlükdə müəyyən edilən və eyni zamanda bir-birini dəstəkləyən və müəyyən edən vahid idrak strukturları (geştaltlar) formalaşır. Gestalt formalaşması açıq dialoqun qeyri-xətti vəziyyətidir. Bu, tələbələrin öz güc və qabiliyyətlərinin oyanması, onların inkişafda öz yollarından birinə başlaması vəziyyətidir. Beləliklə, təhsil şəxsiyyət strukturunda psixikanın formalaşmasında ən mühüm amillərdən biridir. Aydın olur ki, sinergetik yanaşma həm də yaradıcı təfəkkürün özünü təşkil etməyə yönəlmiş düşüncə kimi xüsusiyyətlərini dərk etmək üçün tətbiq oluna bilər.

Nəticə. Yaradıcı şəxsiyyətin özünü təşkili, özünü tamamlaması mexanizminə aşağıdakılar daxildir :[4], [5].

1.Yaradan bütövə diqqət yetirin. Təbii ki, hələlik bütövün konkret obrazı yoxdur, yalnız bütövə diqqət yetirin. Münasibət (əsas ideya və ya obraz) axtarışın “rəhbər ipi” rolunu oynayır. Bu yaradıcı fəaliyyətin cəlbədicisidir.

2. Müxtəlifliyin ilkin artımı və idrak dəyərlərinin yenidən qiymətləndirilməsi əsasında lazımsız hər şeyin seçilməsi və kəsilməsi baş verir. Yaradıcı təfəkkür mexanizmi variantların təsadüfi sadalanması deyil, bütövü təşkil etmək üçün əsas şeyin seçimidir. Özünü təşkil etmə məhz bu əsas əlaqə ətrafında baş verir. İntellektual və şifahi yaradıcılıq əvvəlcə xaosun koqnitiv analoqu kimi qəbul edilənlərin çoxunun amansızcasına kəsilməsi ilə əlaqələndirilir.

3. Yaradıcı təfəkkürün özünü təşkili mexanizmi biliklər şəbəkəsindəki boşluqların doldurulması, idrak strukturunun özünü tamamlaması, vahid obrazın öz-özünə yığılması mexanizmi kimi təqdim oluna bilər. Üstəlik, bu, Gestalt psixoloqlarının təklif etdiyi kimi, sadəcə olaraq, “dərkədiyi yenidənqurma”, vahid strukturun qəfil təşkili deyil. Sinergetik modelə görə, yaradıcı təfəkkür bu hissələrin öz-özünə mürəkkəbləşməsi nəticəsində bütövün hissələrdən öz-özünə çıxmasıdır. Fikir və obrazların axını öz potensialına görə daha mürəkkəbləşir. Özünü kortəbii şəkildə qurur.

4. Elmi kəşfi problem sahəsinin yenidən təşkili kimi şərh etmək olar. Biliyin kristallaşması və yeni struktura çıxış baş verir. Üstəlik, elmdə uğurla inkişaf edən yaradıcılıq prosesi adətən biliyin bütöv bir sıra kristallaşmasına gətirib çıxarır ki, bu da bu prosesi əsasən geri dönməz edir. Kəşflər yaradana təsir edir, onu şəxsiyyətə çevirir. Elmi problemin həlli yolunun çox tez və gözlənilmədən tapılması bəşirət insanın yaradıcılıq fəaliyyətində ən heyvətəmiz hadisələrdən biridir. Bu fenomeni sırf məntiqi vasitələrlə izah etmək çətindir. Koqnitiv fəaliyyətin böyük

konsentrasiyası qəfil və gözlənilməz fikir parıltıları üçün ilkin şərt, zəruri, lakin qeyri-kafi şərt kimi xidmət edir. Insight həqiqətən biliklərin innovativ kristallaşması, eləcə də gələcəyə sıçrayış deməkdir. İdrakın kulminasiya nöqtəsi işıqlandırma və ya aha təcrübəsidir. Ən müəmmalı görünür: bu anda sonsuzluğa toxunur. İntuisiya işini stimullaşdırmaq və fikir parıltısına şərait yaratmaq üçün yaradıcı subyekt öz enerjisini cəmləşdirməlidir. Daxili enerji mənbələri (açarları) gündəlik həyatın dağılma, diqqəti yayındırma, dağıdıcı axınlardan daha güclü olduğu zaman o, özündə kəskinləşən belə bir rejim təşkil etməlidir.

5. Yaradıcı iş müəyyən ritmlərə tabedir. Yeni bir şeyə sıçrayış və bilikdə sürətli artım, yaradıcı fəaliyyətin partlaması adətən gecikmə, "vaxtın qeyd edilməsi", proseslərdə əhəmiyyətli bir yavaşlama ilə müşayiət olunur. Elmi mühitin xüsusi vəziyyəti kimi qeyri-sabitlik elmi mühitin kiçik dəyişikliklərə, elmi problemlərin həllində irəliləyişlərə yüksək həssaslığı deməkdir. Sinergetikadan məlumdur ki, qeyri-sabitlik vəziyyətində olan mühit qeyri-xətti müsbət əks əlaqə sayəsində kiçik pozuntuları, dalğalanmaları dəfələrlə gücləndirə və onları yeni makroskopik nizamlı vəziyyətlər şəklində inkişaf etdirə bilər. Qeyri-sabitlik vəziyyətlərində reallığın müxtəlif səviyyələri arasında nüfuzedici əlaqə mövcuddur. Beləliklə, sinergetik yanaşma yaradıcı təfəkkürün bir sıra xarakterik xüsusiyyətlərini müəyyən etməyə imkan verir. Özünü təşkil edən sistemlər və yaradıcı düşüncə prosesləri ortaq bir şeyə malikdir. Onların hamısı yaradıcı yenilənməyə və təkmilləşməyə yönəlib. Sinergetika müdrik olmağı öyrətmir, təbiətin və təfəkkürün təkamül müdrikliyini ortaya qoyur. Bu, yumşaq nəzarət, məsləhət və tövsiyələr vasitəsilə, zəif, rezonanslı təsirlər vasitəsilə nəzarətin hikmətidir.

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YOĞUNLUK FONKSİYONEL TEORİSİ İLE $Y_{1-x}Sr_xTiO_3$ ($x=0.01, 0.10, 0.50, 0.99$) BİLEŞİKLERİNİN YAPISAL, ELASTİK VE ELEKTRONİK ÖZELLİKLERİ

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ÖZET

Perovskit kristal yapısı, benzersiz özellikleri ve potansiyel uygulamaları nedeniyle önemli bir araştırma konusudur. Özellikle $YTiO_3$, güçlü elektron korelasyon etkileri ve yörünge düzenlemesi gösteren ferromanyetik bir Mott yalıtkanıdır ve bu nedenle elektronik uygulamalar için iyi bir adaydır. Bu çalışmada, mekanik özellikleri iyileştirirken elektronik özellikleri korumak amacıyla, $Pm\bar{3}m$ uzay grubunda $Y_{1-x}Sr_xTiO_3$ ($x=0.01, 0.10, 0.50, 0.99$) perovskitlerin yapısal, elastik ve elektronik özellikleri yoğunluk fonksiyonel teorisi (DFT) kullanılarak araştırılmıştır. Başlangıç geometrisi optimizasyonları, $6\times 6\times 6$ Monkhorst-Pack k-nokta ağı ile GGA-PBE fonksiyoneli kullanılarak gerçekleştirilmiştir. DFT hesaplamalarında CASTEP kodu ve ultra yumuşak sudo potansiyeller kullanılmıştır. Tam rahat yapısal işlemler ile sonlu gerinim teorisi kullanılarak malzemelerin mekanik kararlılığını doğrulayan elastik sabitler belirlenmiştir. Elektronik özellikler, bant yapısı ve kısmi yoğunluk durumu (PDOS) hesaplamalarıyla analiz edilmiştir. Sr katkılmasına bağlı bant yapılarında farklılıklar gözlenmesine rağmen bant aralığı oluşmamıştır, bu da bileşiklerin Mott yalıtkan doğasının devamlılığını göstermektedir. Çalışma, elektronik durumlarda p ve d orbitallerinin baskın olduğunu ortaya koymuştur. Bulgular, Sr katkılmasının elastik özellikler üzerinde önemli etkileri olduğunu ve bu malzemeleri sağlam mekanik özelliklerin gerektiği çeşitli uygulamalar için potansiyel olarak değerli hale getirdiğini göstermektedir.

Anahtar kelimeler: Perovskit, $YTiO_3$, $SrTiO_3$, yoğunluk fonksiyonel teorisi, elastik özellikler, elektronik yapı, mekanik özellikler, bant yapısı

STRUCTURAL, ELASTIC, AND ELECTRONIC PROPERTIES OF $Y_{1-x}Sr_xTiO_3$ ($x=0.01, 0.10, 0.50, 0.99$) BY MEANS OF DENSITY FUNCTIONAL THEORY

ABSTRACT

The perovskite crystal structure has garnered significant attention due to its unique properties and potential applications. Particularly, $YTiO_3$ is a ferromagnetic Mott insulator with strong electron correlation effects and orbital ordering, so it is a good candidate for electronic applications. In this research, we investigate the structural, elastic, and electronic properties of $Y_{1-x}Sr_xTiO_3$ ($x=0.01, 0.10, 0.50, 0.99$) perovskites within the $Pm\bar{3}m$ space group using density functional theory (DFT) to improve mechanical properties while preserving electronic

properties. Initial geometry optimizations were performed using the GGA-PBE functional with a $6 \times 6 \times 6$ Monkhorst-Pack k-point mesh. The study utilized the CASTEP code with ultrasoft pseudopotentials for DFT calculations. Complete structural relaxations were achieved, and the elastic constants which confirm the mechanical stability of the materials were determined using the finite strain theory. The electronic properties were analyzed through band structure and partial density of states (PDOS) calculations. Despite variations in band structures due to Sr doping, no bandgap was observed, indicating the metallic nature of the compounds. The study highlights that p and d orbitals are predominant in electronic states. The findings suggest that Sr doping significantly influences the elastic properties, making these materials potentially valuable for various applications requiring robust mechanical properties.

Keywords: Perovskite, YTiO_3 , SrTiO_3 , density functional theory, elastic properties, electronic structure, mechanical properties, band structure

Introduction

The perovskite crystal structure has garnered significant attention due to its unique properties and potential applications. One of the key compounds within this family is Yttrium titanate (YTiO_3) which has been a subject of interest, with studies focusing on the use of molecular dynamics simulations to explore the crystal symmetry and oxygen-ion transport in perovskite materials, shedding light on their behavior at different temperatures (Robens et al., 2021). YTiO_3 is a ferromagnetic Mott insulator with strong electron correlation effects and orbital ordering (Craco et al., 2006; Yue et al., 2020). High-quality epitaxial YTiO_3 thin films have been synthesized using pulsed laser deposition and molecular beam epitaxy (Cao et al., 2015; Yue et al., 2020). The electronic structure of YTiO_3 is characterized by a Mott-Hubbard band gap of ~ 1.5 eV and a lower Hubbard band at 1.1 eV below the Fermi level (Yue et al., 2020). Both structural distortions and multi-orbital electron interactions contribute to orbital polarization in YTiO_3 (Craco et al., 2006). Doping with La or Ca significantly affects the electronic and optical properties of YTiO_3 , including spectral weight transfer and changes in the band structure and optical conductivity (Craco et al., 2006; Sai et al., 2010). Furthermore, YTiO_3 has been studied for its potential applications in energy storage, electronic devices, and sensors (Zhang et al., 2022). One study investigated the metal-insulator transition at $\text{YTiO}_3/\text{LaTiO}_3$ interfaces grown by the soft chemical method (Tolentino Cabral et al., 2023). The researchers aimed to understand the behavior of the interface between YTiO_3 and LaTiO_3 , shedding light on potential applications in electronics and optoelectronics. Additionally, a computational study explored the use of $\text{YTiO}_{3 \pm \delta}$ as cathode materials in solid oxide fuel cells

(SOFCs) (Martins et al., 2023). This study delved into the native defects and oxygen diffusion within YTiO_3 , providing valuable insights for the development of advanced SOFC technologies. In another study, Yttrium-doped SrTiO_3 (SYT) demonstrated high electrical conductivity, structural stability, and chemical compatibility with YSZ and LSGM, making it a promising anode material for solid oxide fuel cells, achieving a maximum power density of 58 mW/cm^2 at 900°C (Hui & Petric, 2002). Furthermore, investigations on functional properties of $\text{Al}_{0.8}\text{Eu}_y\text{La}_{0.2-y}\text{TiO}_3$ ($y = 0.01 - 0.04$) nanoparticles synthesized by the hydrothermal method have also been conducted (S et al., 2022). The research focused on the potential applications of these nanoparticles and their unique properties for specific electronic or optical devices. The effect of high-temperature annealing on the phase transformations of the perovskite YTiO_{3-x} system was also explored, providing important insights into the structural characteristics of YTiO_3 -based materials (Mustakhieva et al., 2019). Measurement of elastic modulus in YTiO_3 suggests the appearance of the magnetostriction effect (Suzuki, 2003).

Additionally, the magnetic properties of YTiO_3 have been studied extensively in the literature, revealing several intriguing phenomena. Gossling et al. (Gossling et al., 2006) investigated optical excitations in Mott-Hubbard insulators YTiO_3 and SmTiO_3 , observing absorption bands and peak anomalies attributed to charge-neutral quasibound states. Akimitsu et al. (Akimitsu et al., 2001) used the polarized neutron diffraction technique to directly observe the orbital ordering in ferromagnetic YTiO_3 . Additionally, a study by Zhou et al. (Zhou et al., 2014) explored the magnetic properties and electronic structures of YTiO_3 -based superlattices, revealing unexpected magnetic orders and electronic behavior at the interfaces. In a different approach, a joint refinement model for the spin-resolved one-electron reduced density matrix of YTiO_3 was proposed by Gueddida et al. (Gueddida et al., 2018), which provided insights into the magnetic properties of YTiO_3 using magnetic structure factors and magnetic Compton profiles data. Chae et al. (Chae et al., 2006) investigated epitaxial growth and the magnetic properties of orthorhombic YTiO_3 thin films, revealing ferromagnetic transitions and the influence of substrate-induced atomic arrangements. Moreover, the transition from orbital liquid to the Jahn-Teller insulator in orthorhombic perovskites RTiO_3 , including YTiO_3 , was examined by Cheng et al. (Cheng et al., 2008), demonstrating a spin/orbital transition at a magnetic transition temperature. Furthermore, a first-principles study by Weng et al. (Weng et al., 2023) investigated electron doping of $\text{SmNiO}_3 / \text{YTiO}_3$ via interfacial charge transfer and its effects on the electronic and magnetic properties, highlighting the complex interplay between different materials. An interesting work by An et al. (An et al., 2015) explored the

possibility of ferrimagnetism and ferroelectricity in half-substituted rare-earth titanates, including $\text{Y}_{0.5}\text{La}_{0.5}\text{TiO}_3$.

In this study, we investigate the effect of doping Sr into YTiO_3 with different ratios (0.01, 0.10, 0.50, 0.99). Our investigation covers elastic and electronic properties. The outline of this article is as follows. In the next section, the main methods are explained. The investigation results are given in the Results and Discussion section. Lastly, the outcomes of this research are given in the conclusion.

Materials and methods

$\text{Y}_{1-x}\text{Sr}_x\text{TiO}_3$ in $\text{Pm}\bar{3}\text{m}$ space group is doped by Sr by various ratios ($x=0.01, 0.10, 0.50, 0.99$). In

Fig. 1, the initial structure of YTiO_3 is given with the lattice constant $a=3.88\text{\AA}$. The geometry computation is completed with GGA-PBE, and cutoff energy is 630 eV which is defined based on used pseudopotentials and finite basis set correction (Francis & Payne, 1990). The Monkhorst–Pack scheme was utilized to perform special k-points sampling integration across the Brillouin zone with the $6\times 6\times 6$ mesh (Monkhorst & Pack, 1976).

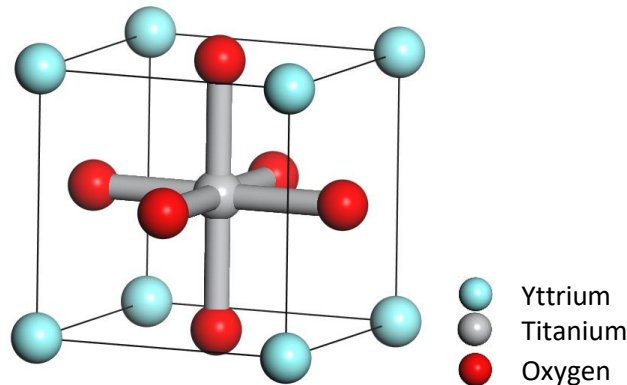


Fig. 1. YTiO_3 crystal structure

Our DFT calculations are performed using the projector-augmented wave approach as implemented in the CASTEP (Clark et al., 2005; Hohenberg & Kohn, 1964). We described the exchange and correlation potential using the GGA-PW91 functional, and the electron-core interactions with the ultrasoft pseudopotential (Perdew & Zunger, 1981). The energy convergence tolerance was set at $5.0 \times 10^{-6} \text{ eV/atom}$, the maximum force was set at $0.01 \text{ eV/\AA}$, the maximum stress was set at 0.02 GPa , and the maximum displacement was set at $5.0 \times 10^{-4} \text{ \AA}$. The Perdew-Burke-Ernzerhof generalized gradient approximation was used to solve the Kohn-Sham equations (Kohn & Sham, 1965). The crystal structures underwent

complete relaxation using the Broyden-Fletcher-Goldfarb-Shanno (BFGS) minimization method (Pfrommer et al., 1997).

The elastic properties are determined by the CASTEP through the application of the finite strain theory (Murnaghan, 1952). This theory allows for the calculation of elastic constants, which are the coefficients that relate the applied strain to the resulting stress, $\sigma_i = c_{ij}\varepsilon_j$. The polycrystalline bulk modulus B and shearmodulus G are then evaluated using the Voigt-Reuss-Hill approximation based on the obtained c_{ij} values (Hill, 1952).

Results and Discussion

In this study, we investigated the structural, elastic, and electronic properties of $Y_{1-x}Sr_xTiO_3$ ($x=0, 0.01, 0.1, 0.5, 0.99$) perovskites using density functional theory (DFT). The materials exhibit a cubic structure ($Pm\bar{3}m$) with optimized lattice constants. Elastic properties, including bulk modulus, shear modulus, and Young's modulus, confirm mechanical stability in accordance with the Born-Huang criteria. Electronic properties, examined through band structure and partial density of states (PDOS), reveal significant alterations in band structure due to Sr doping; however, no bandgap is observed, and the metallic nature of the materials is retained, with notable contributions from p and d orbitals.

Structural Properties

The structural properties and geometries of $Y_{1-x}Sr_xTiO_3$ ($x=0, 0.01, 0.1, 0.5, \text{ and } 0.99$) perovskites were examined using density functional theory (DFT) (See

Fig. 1). The materials were found to have cubic structures with the space group $Pm\bar{3}m$ (no. 221). The states of complete relaxation in the structures are achieved through the optimization of its geometry, taking into account the lattice constants and internal atomic positions. This process involves adjusting the arrangement of atoms within the structure to minimize any residual stress or strain. By optimizing these parameters, the structure can achieve a more stable and energetically favorable configuration. Wyckoff positions of Y, Ti, and O are respectively (0, 0, 0), (1/2, 1/2, 1/2), and (1/2, 1/2, 0). The optimized lattice constants, obtained from the unit cell optimization for the ground state stable atomic configuration, are presented in Table 1. To ascertain the stability of perovskite materials, we employ a computational approach to calculate and present the elastic constants in the subsequent sections, providing comprehensive details.

Table 1. Computed crystal parameters

Compounds	Lattice Parameter (Å)	Density (amu/Å ³)
YTiO ₃ [This Work]	3.888	3.144
YTiO ₃ (Jain et al., 2013)	3.89	3.132
Y _{0.99} Sr _{0.01} TiO ₃	3.889	4.633
Y _{0.5} Sr _{0.5} TiO ₃	3.920	4.522
Y _{0.1} Sr _{0.9} TiO ₃	3.932	4.483
Y _{0.01} Sr _{0.99} TiO ₃	3.924	4.509

Elastic Properties

The study of the elastic properties of materials is essential prior to their practical use, as many device features depend on the elastic properties of the materials used in their manufacturing. Therefore, materials with superior elastic properties are highly valuable for incorporation into various devices. The elastic constant serves as a mathematical link between the mechanical and dynamical characteristics of materials, playing a crucial role in determining their properties and how they respond to external forces. Based on the principles of cubic symmetry, the elastic tensor consists of three distinct elastic components, namely c_{11} , c_{12} , and c_{44} . The bulk modulus (BM) calculates the stress needed to change a material's volume, whereas the shear modulus (SM) describes how resistant a material is to shear stress-induced deformation. The forces per unit cross sectional area needed for an elongation or shortening dimensional change are measured by the Young Modulus (YM).

The obtained values for these elastic constants are presented in **Table 2** and are evaluated against the Born-Huang generalized stability criteria (Mouhat & Coudert, 2014) as defined in equation (1) for the Pm $\bar{3}$ m structure. Therefore, it can be concluded that compounds exhibit mechanical stability.

$$c_{44} > 0, c_{11} > |c_{12}|, c_{11} + 2c_{12} > 0 \quad (1)$$

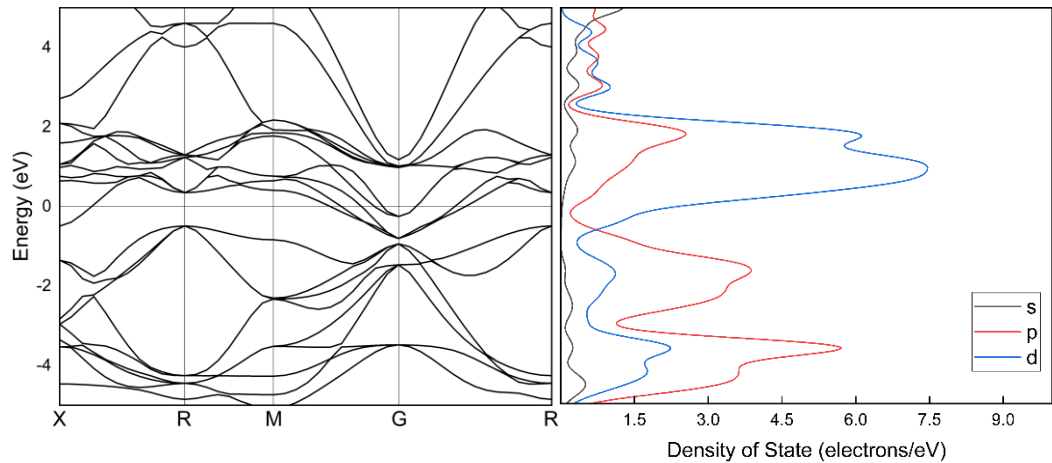
Table 2 displays the findings of our study on the elastic properties under no pressure conditions. Based on the computation results, elastic stability is confirmed.

Table 2. Elastic constants of Y_{1-x}Sr_xTiO₃ (x=0.01, 0.10, 0.50, 0.99)

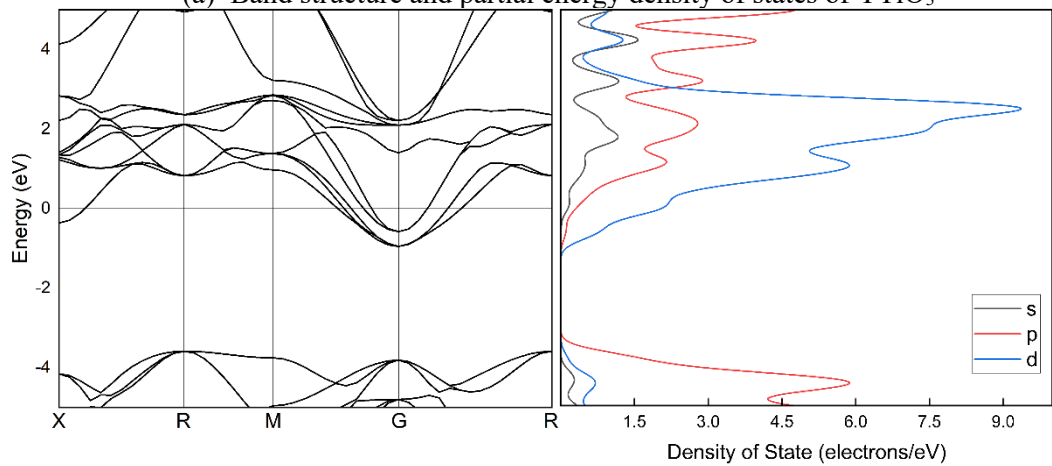
Compounds	C ₁₁ (GPa)	C ₁₂ (GPa)	C ₄₄ (GPa)	BM (GPa)	SM (GPa)	YM (GPa)
YTiO ₃	288.12775	15.46215	131.04480	183.40578	156.27653	113.67433
Y _{0.99} Sr _{0.01} TiO ₃	290.92433	132.91674	16.17490	185.58594	41.30646	115.36065
Y _{0.5} Sr _{0.5} TiO ₃	304.87325	73.32170	77.23745	150.50555	92.65278	230.63188
Y _{0.1} Sr _{0.9} TiO ₃	326.90365	104.50730	90.79475	178.63942	98.95612	250.59631
Y _{0.01} Sr _{0.99} TiO ₃	311.60835	98.84900	110.50245	169.76878	108.85334	269.05522

Electronic Properties

Fig. 2 illustrates the band arrangement and PDOS of $Y_{1-x}Sr_xTiO_3$ ($x=0, 0.01, 0.1, 0.5$, and 0.99), where the lattice parameters have been optimized along the high symmetry directions within the first Brillouin zone. The electronic band structure helps to identify the valence band and the area empty of electrons. The possible energies of electrons are explained by the conduction band. The conduction and valence bands are distinguished by the E_F . The valence bands are seen behind the E_F , while the conduction band is located above it. The findings indicate that, despite a considerable alteration in band structures due to Sr doping, there is no bandgap. The valence and conduction band spacing is expanding in doped crystals, but the metal nature of the crystals is preserved. In the band structure, p and d orbitals are particularly stronger than s orbitals.



(a) Band structure and partial energy density of states of $YTiO_3$



(b) Band structure and partial energy density of states of $Y_{0.99}Sr_{0.01}TiO_3$

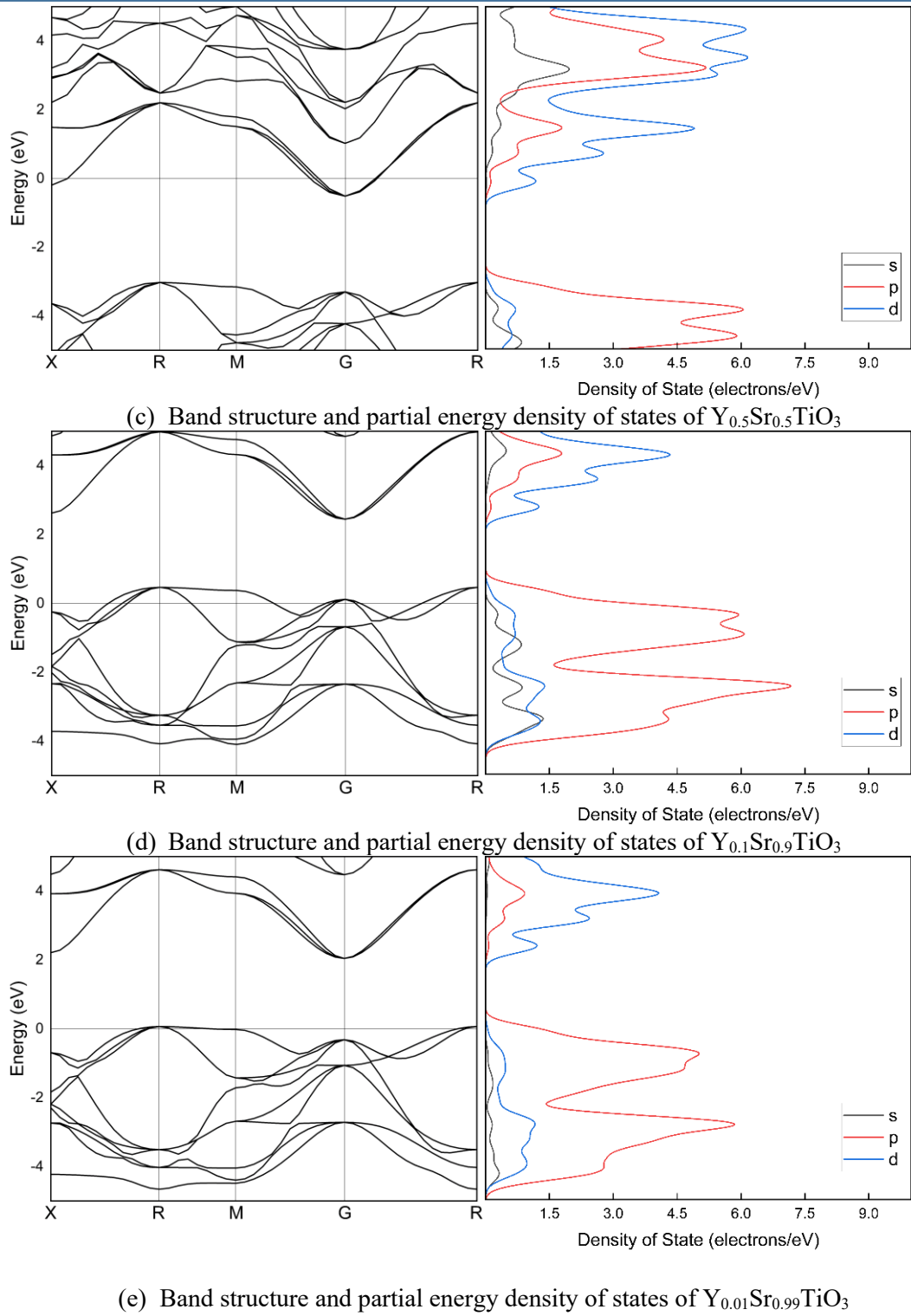


Fig. 2. The electronic structures of $\text{Y}_{1-x}\text{Sr}_x\text{TiO}_3$. The band structures are shown at the equilibrium lattice parameters, highlighting the high symmetry wave-vectors, k . The partial energy densities of states are presented, and the Fermi level is set as 0 eV.

Conclusion

In conclusion, the structural, elastic, and electronic properties of $\text{Y}_{1-x}\text{Sr}_x\text{TiO}_3$ ($x=0.01, 0.10, 0.50, 0.99$) perovskites within the $\text{Pm}\bar{3}\text{m}$ space group were thoroughly investigated using density functional theory (DFT). The initial geometry optimizations, performed with the GGA-PBE functional, revealed stable configurations with varying Sr doping levels. Detailed elastic property calculations confirmed the mechanical stability of these compounds, with significant variations in elastic constants attributed to Sr doping. The electronic structure analysis, including band structure and partial density of states (PDOS), indicated that despite changes in the band structures, the materials retained their metallic nature, dominated by p and d orbitals. These findings underscore the potential of Sr-doped YTiO_3 perovskites for applications that demand superior mechanical properties and highlight the influence of Sr doping on the materials' structural and electronic characteristics.

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DETECTION OF THERMAL BEHAVIORS OF LI – ION BATTERIES USED IN ELECTRIC VEHICLES WITH FBG BASED QUASI DISTRIBUTED SENSORS

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ABSTRACT

The rapid development of electric vehicle technologies has made it important to ensure the reliability of systems using these technologies. In this context, the performance of Li – Ion battery systems, which are widely used in electric vehicle battery systems, and the ability to predict the thermal behavior of battery internal structures are of vital importance. Therefore, in parallel with the developing technology, temperature detection and measurement systems have also developed at the same scale. Fiber Bragg Grating (FBG) sensors are sensors that can make much more precise measurements compared to the alternatives that have emerged for this purpose and use optical fiber as a sensor. FBG sensors can provide high temperature sensitivity at the level of $\pm 1.0 \times 10^{-2} \text{ }^{\circ}\text{C}$ by showing a shift of approximately 10 pm/ $^{\circ}\text{C}$ in the Bragg wavelength depending on the temperature change, while the sensitivity of thermocouples is generally in the range of $\pm 0.5 \text{ }^{\circ}\text{C}$ to $\pm 2.0 \text{ }^{\circ}\text{C}$. Therefore, these sensors are considered as quasi distributed sensor structures where optical fiber is used as the sensor and have an important role in the detection and measurement of Li – Ion battery temperatures used in electric vehicles.

In this study, Bragg wavelength shifts depending on the temperature change of FBG sensor at three different initial temperatures (0 $^{\circ}\text{C}$, 10 $^{\circ}\text{C}$ and 25 $^{\circ}\text{C}$) have been analyzed. Bragg wavelength shift has been found to be $\sim 0.714 \text{ nm}$ for the temperature change between 25 $^{\circ}\text{C}$ and 34.709 $^{\circ}\text{C}$. Bragg wavelength shift has been obtained as $\sim 1.0319 \text{ nm}$ for the temperature values between 10 $^{\circ}\text{C}$ and 24.039 $^{\circ}\text{C}$ and $\sim 1.368 \text{ nm}$ for the temperature change between 0 $^{\circ}\text{C}$ and 18.611 $^{\circ}\text{C}$. As a result, the temperature sensitivity of the Li – Ion battery for the given temperature changes has been computed as approximately 73.5 pm/ $^{\circ}\text{C}$ in these measurements.

These findings and the obtained numerical results show that FBG sensors can be used both in thermo – optical sensing systems and in temperature sensing systems where the thermal behavior of Li – Ion batteries is measured.

Keywords: FBG based sensor, Li – Ion battery, electric vehicle, Bragg wavelength shift, temperature measurement, temperature sensitivity, thermal behavior

ELEKTRİKLİ ARAÇLARDA KULLANILAN LI – ION BATARYALARIN ISIL DAVRANIŞLARININ FBG ESASLI YARI DAĞINIK SENSÖRLERLE TESPİTİ

ÖZET

Elektrikli araç teknolojilerindeki hızlı gelişim, bu teknolojileri kullanan sistemlerin güvenilirliğinin sağlanmasını önemli hale getirmiştir. Bu bağlamda, elektrikli araçların batarya sistemlerinde yaygın olarak kullanılan Li – Ion batarya sistemlerinin performansı ve batarya iç yapılarının ısı davranışının önceden tespit edilebilmesi hayati öneme sahip bir süreçtir. Bu nedenle, gelişen teknolojiye paralel olarak sıcaklık algılama ve ölçüm sistemleri de aynı ölçekte gelişim göstermiştir. Fiber Bragg Izgara (FBG) sensörler, bu amaçla ortaya çıkan alternatiflerine kıyasla çok daha hassas ölçümler yapabilen ve optik fiberin algılayıcı olarak kullanıldığı sensörlerdir. FBG sensörler, sıcaklık değişimine bağlı olarak Bragg dalga boyasında yaklaşık 10 pm/°C'lik bir kayma göstererek $\pm 1.0 \times 10^{-2}$ °C seviyesinde yüksek sıcaklık hassasiyeti sağlayabilirken, termokuplların hassasiyeti genellikle, ± 0.5 °C – ± 2.0 °C aralığındadır. Bu nedenle bu sensörler, optik fiberin algılayıcı olarak kullanıldığı yarı dağınık sensör yapıları olarak değerlendirilmekte olup elektrikli araçlarda kullanılan Li – Ion batarya sıcaklıklarının algılanması ve ölçümünde önemli bir role sahiptir.

Bu çalışmada, üç farklı başlangıç sıcaklığında (0 °C, 10 °C ve 25 °C) FBG sensörün sıcaklık değişimine bağlı olarak Bragg dalga boyu kaymaları analiz edilmiştir. Sıcaklığın 25 °C ile 34,709 °C aralığında değişimine karşılık Bragg dalgaboyu kayması $\sim 0,714$ nm olarak bulunmuştur. Bragg dalgaboyu kayması, sıcaklığın 10 °C ile 24,039 °C arasındaki değerleri için $\sim 1,0319$ nm ve sıcaklığın 0 °C ile 18,611 °C arasındaki değerleri için $\sim 1,368$ nm olarak elde edilmiştir. Sonuç olarak, Li-Ion bataryanın verilen sıcaklık değişimleri için sıcaklık hassasiyeti bu ölçümlerde yaklaşık olarak 73,5 pm/°C olarak hesaplanmıştır. Bu bulgular ve elde edilen nümerik sonuçlar, FBG sensörlerin hem termo – optik algılama sistemlerinde hem de Li – Ion bataryaların ısı davranışlarının ölçüldüğü sıcaklık algılama sistemlerinde kullanılabilir olduğunu göstermektedir.

Anahtar Kelimeler: FBG esaslı sensör, Li – Ion batarya, elektrikli araç, Bragg dalgaboyu kayması, sıcaklık ölçümü, sıcaklık duyarlılığı, ısı davranış

1. INTRODUCTION

As electric vehicles become more common, the performance, safety level and durability of Li-Ion batteries have become critical. Thanks to their high energy density and long cycle life, Li-Ion batteries have become the most preferred battery type today (Goodenough & Park, 2013; Scrosati & Garche, 2010). However, failure to control operating temperatures can lead to loss of performance, cell damage, and the risk of thermal runaway (Hill & Rogowski, 2020). Therefore, accurate monitoring of battery temperatures is of great importance. FBG (Fiber Bragg Grating) sensors stand out compared to traditional sensors due to their small size and high temperature and strain sensitivity (Kersey et al., 1997). The high-resolution temperature and strain data obtained from these sensors allow battery management systems (BMS) to operate effectively (Hine, Bae & Oh, 2017). FBG sensors are placed in specific areas on battery packs to measure and analyze this data in real time. These systems consist of battery cells, FBG interrogator, power supply, computer and data acquisition units. In FBG-based detection systems, thermal anomalies such as sudden temperature increases and local heating can be precisely detected with the data obtained from the sensors, and the risk of thermal runaway can be determined at an early stage. This provides a significant advantage in terms of battery safety. Figure 1 shows a Li-Ion battery pack with an FBG sensor.

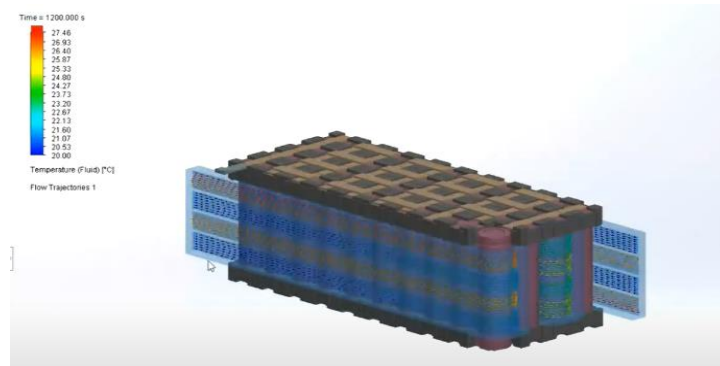


Figure 1. FBG sensor integrated into Li-Ion battery pack

Li-Ion batteries are widely used in electric vehicles and portable systems due to their advantages such as high energy density and long cycle life. However, these batteries are very sensitive to temperature changes. Increases in cell temperature can create serious risks such as capacity loss, shortening of life and thermal runaway (Pesaran, 2002). Therefore, thermal management systems developed for batteries have gained great importance. In the study by Liu et al. (2014), it has been observed that FBG sensors placed on the battery surface made faster and more accurate temperature measurements than conventional sensors. Similarly, Hine, Bae,

and Oh (2017) detected temperature gradients in different regions by monitoring the temperature along the battery pack with FBG sensors and thus suggested a more balanced cooling strategy. In the study of Zhang and his team (2020), FBG sensors have been integrated into the battery system and automatic cooling control based on temperature data has been performed. This application revealed that FBG sensors can be used not only in monitoring but also in decision support mechanisms.

In this study, Bragg wavelength shifts values depending on temperature variations have been obtained for initial temperatures (0°C, 10°C and 25°C) and corresponding simulations have been performed in Matlab. In this context, findings acquired in the study have been shown that FBG sensors can be used in temperature sensing systems where thermal behaviors of Li-Ion batteries are detected and measured.

2.THEORY

Li – Ion batteries are rechargeable energy storage systems extensively employed in electric vehicles and due to their high energy density, long cycle life and lightweight structure (Nitta et al., 2015). They are especially preferred in electric vehicles because they are more efficient and require less maintenance compared to traditional battery types. Thanks to their high energy density, fast charge-discharge ability and low self-discharge rates, Li – Ion batteries are the ideal solution for electric vehicle manufacturers in terms of performance criteria such as range, speed and safety (Tarascon & Armand, 2001).

Figure 2 shows the structure of a Li-Ion battery (Mishra, Dubey & Pandey, 2022).

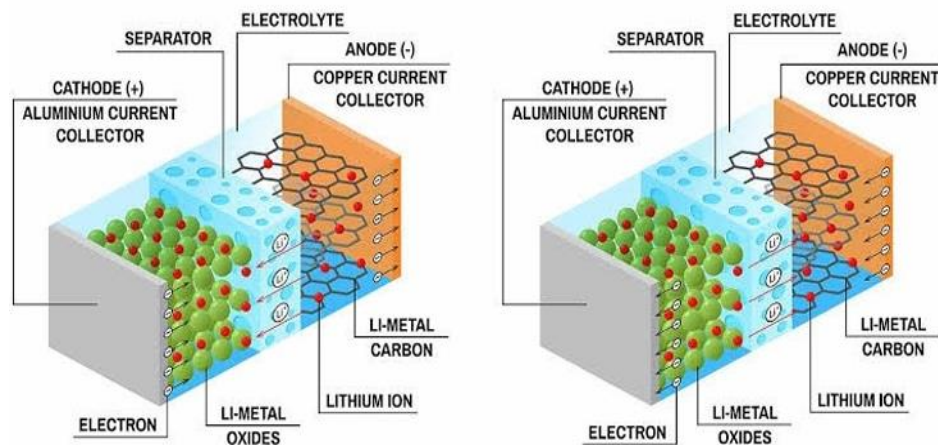


Figure 2. Li Ion battery structure and working principle

Li – Ion batteries operate by the movement of lithium ions between the anode and cathode through the electrolyte during charging and discharging. The ion movement that occurs in this

process provides electric flow in the external circuit. Graphite is usually used as the anode and lithium metal oxides as the cathode; the electrolyte consists of organic solvents containing lithium salts. During charging, lithium ions pass from the cathode to the anode through the electrolyte, allowing energy to be stored in the battery. During discharge, these ions return from the anode to the cathode, creating an electron flow in the external circuit, and this current provides energy to the devices.

2.1. FBG Sensor

FBG sensors are optical fiber-based, passive, electromagnetic interference-proof and high-sensitivity sensor systems. They are generally used to monitor physical parameters such as temperature, strain, pressure and acceleration. In electric vehicles, their use for temperature and strain measurements, especially in Li-Ion battery systems, has increased significantly in recent years. FBG sensor representation is given in Figure 3 (EON Photonics).

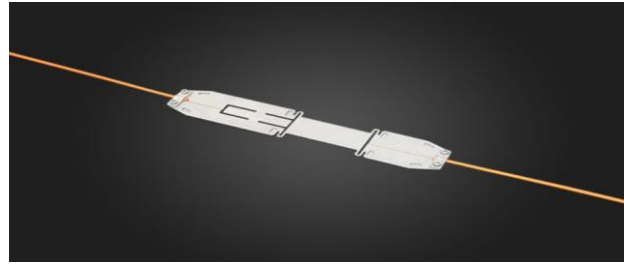


Figure 3. FBG sensor illustration

FBG sensors consist of periodic refractive index changes placed in the core of an optical fiber. This structure causes the reflection of light of a certain wavelength (Bragg wavelength) while allowing other wavelengths to pass. This back reflected wavelength is caused by the variations in physical quantities such as temperature and strain formations occurred in the battery packs. Therefore, FBG sensing device, i.e. sensors can directly detect changes in environmental conditions in the medium.

The Bragg wavelength is expressed as given in (1) (Peng et al., 2019).

$$\lambda_B = 2n\Lambda \quad (1)$$

In formula (1), λ_B corresponds to the reflected Bragg wavelength, n corresponds to the refractive index of the optical fiber core, and Λ corresponds to the grating spacing. Depending on the temperature or strain, a shift in the Bragg wavelength ($\Delta\lambda_B$) occurs. This change is given in (2) (Peng et al., 2019).

$$\frac{\Delta\lambda_B}{\lambda_B} = (1 - \rho_a)\varepsilon + (a + \xi)\Delta T \quad (2)$$

In Equation (2), ε and ΔT correspond to the strain generation and temperature change, respectively.

2.2. Temperature and Strain Sensitivity of FBG Sensors

The sensitivity of FBG sensor is a performance parameter that expresses the magnitude of the variation of the output optic signal in response to a unit change in the temperature and strain formation detected by the FBG. The high sensitivity of the sensor means that the FBG can sense even small variations in the system. In these sensors, the output signal is caused by the shift in the Bragg wavelength ($\Delta\lambda_B$) as a result of the physical formations affecting the sensor performance. The sensitivity of the FBG sensor is defined as the rate of change in $\Delta\lambda_B$ in response to a unit variation in the detected physical parameter (ΔP).

$$SP = \frac{\Delta\lambda_B}{\Delta P} \quad (3)$$

In (3), SP represents the sensitivity to the relevant physical parameter. The sensitivity unit is pm/ $\mu\varepsilon$ or pm/ $^{\circ}\text{C}$ for strain and temperature, respectively. The strain and the temperature sensitivities are given in (4.a) and (4.b), respectively.

$$S\varepsilon = (1 - p_e)\lambda_B \quad (4.a)$$

$$ST = (\alpha_\Lambda + \alpha_n)\lambda_B \quad (4.b)$$

In the equations, p_e is the effective elasto-optic coefficient of the fiber, α_Λ is the thermal expansion coefficient of the fiber and α_n is the thermo-optic coefficient of the fiber.

Figure 4 shows the relationship between discharge capacity and the sensitivity changes for different temperatures. Figure 4 shows the change in instantaneous temperature sensitivity of the FBG sensor according to the discharge capacity of the battery under three different initial temperature (25 $^{\circ}\text{C}$, 10 $^{\circ}\text{C}$ and 0 $^{\circ}\text{C}$). The instantaneous sensitivity is calculated by the ratio of the wavelength change ($\Delta\lambda$) to the temperature change (ΔT). In the simulations in Figure 6, it is seen that the sensitivity is not constant under all three temperature conditions, but fluctuates around a certain average. While the sensitivity varies in the range of 0.009 – 0.012 nm/ $^{\circ}\text{C}$ at 25 $^{\circ}\text{C}$, and it changes in the range of 0.0105 – 0.0115 nm/ $^{\circ}\text{C}$ approximately at both 10 $^{\circ}\text{C}$ and 0 $^{\circ}\text{C}$. This situation shows that the sensor is affected by the thermal changes inside the battery. In general, the fact that the sensitivity values remain in a narrow range and give similar results

proves that the FBG sensor is reliable and consistent. Obtaining similar sensitivity profiles under different temperature conditions shows that the sensor can exhibit predictable performance over a wide temperature range. This shows that a dynamic sensitivity model instead of a static one will give more accurate results.

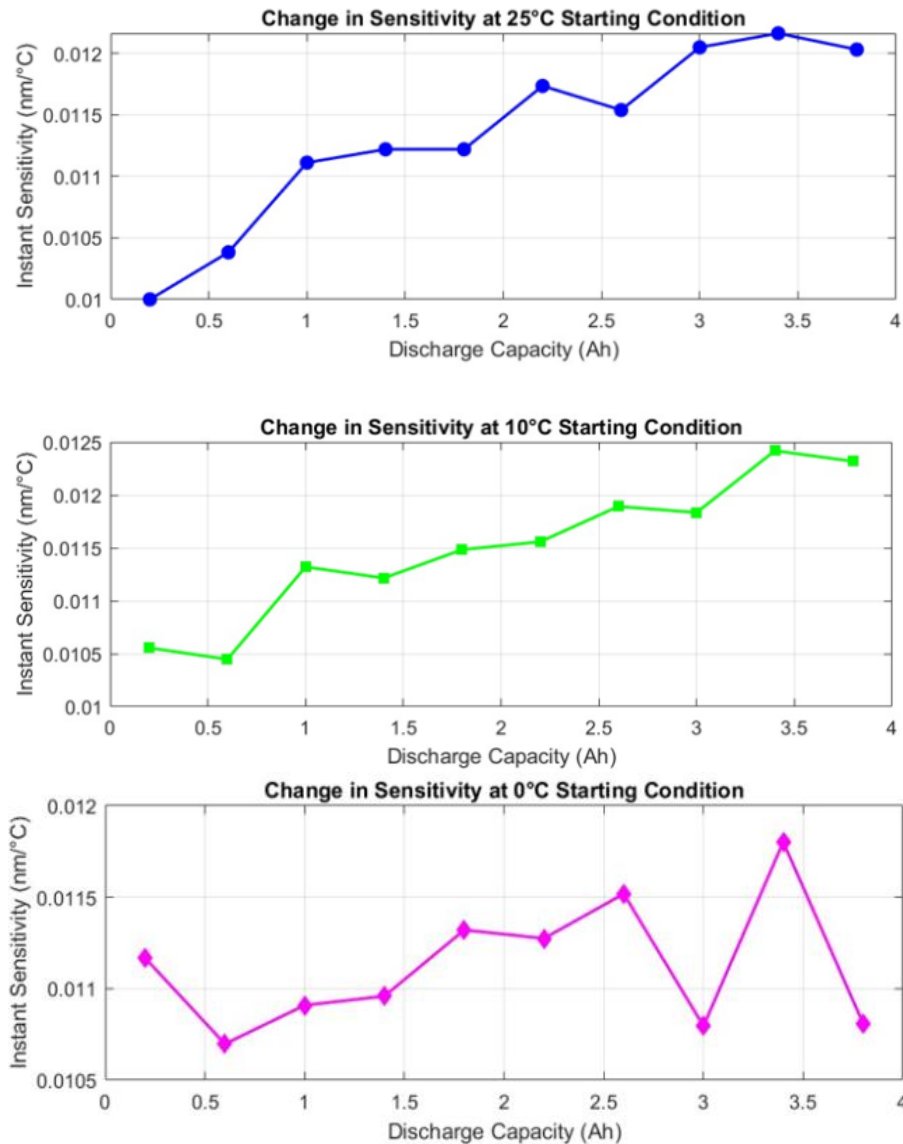


Figure 4. Sensitivity changes observed in the batteries for different initial conditions

3. RESULTS AND DISCUSSION

In this study, technical specifications and performance data of the NCR18650GA model Li-Ion battery cell have been used. In line with this data, simulations of the temperature and strain parameters of the battery have been performed in the Matlab environment and the analyses related to these parameters have also been accomplished.

Figure 5 shows the changes in battery voltage for different temperature values (0 °C, 10 °C and 25 °C).

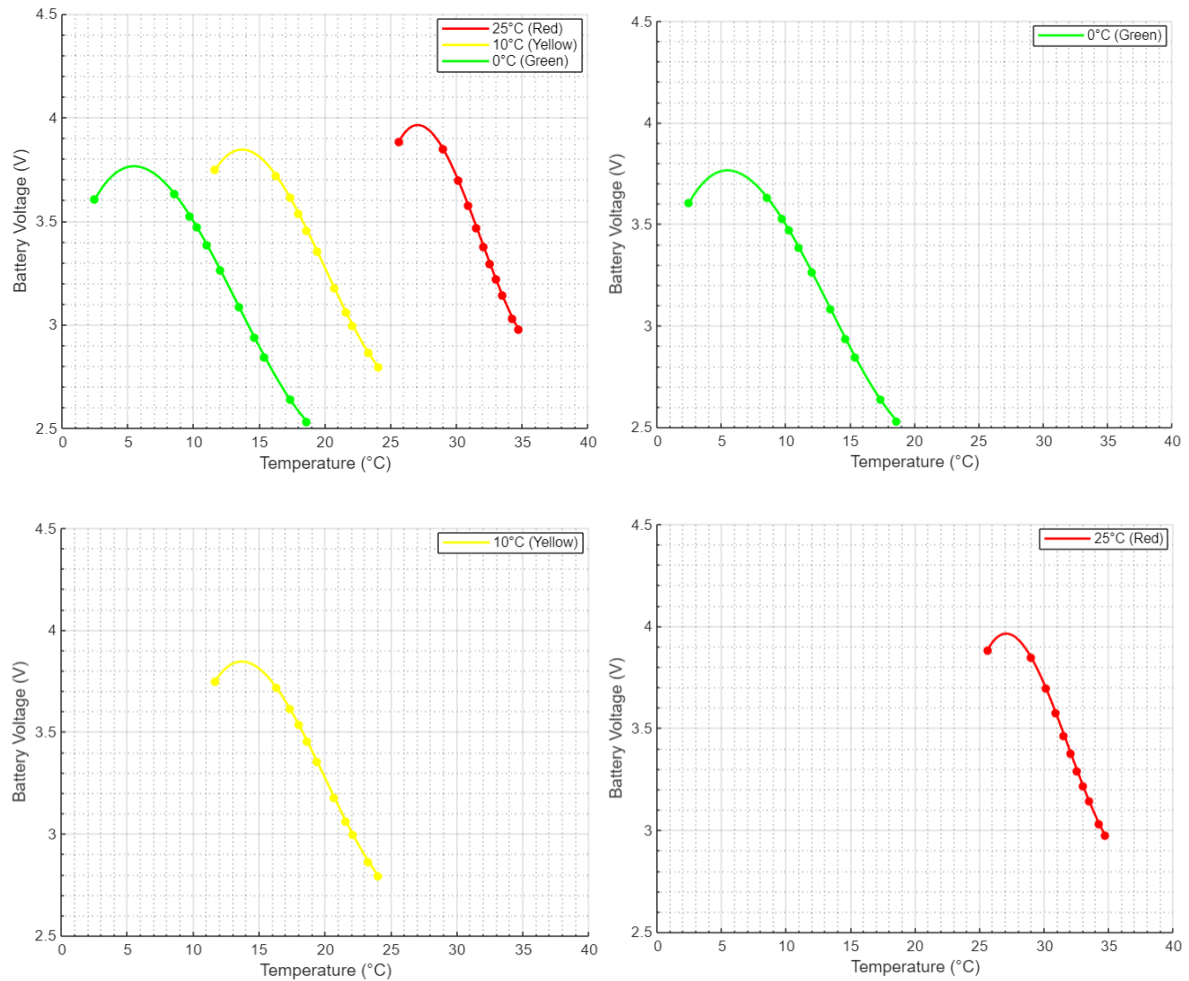


Figure 5. Battery voltage values at 0 °C, 10 °C and 25 °C temperatures

As seen in Figure 5, the battery voltage at three different temperature values shows a rapid drop at a certain point as the temperature increases. This drop point shifts to a higher level as the temperature level increases, meaning that the battery can maintain a constant voltage for a longer period of time. The green line represents 0 °C, indicating that the battery voltage drops quite early at the lowest temperature.

This indicates that the battery capacity will decrease more rapidly in cold environmental conditions. The yellow line represents the situation at 10 °C, and the red line represents the situation at 25 °C. The most optimum performance is observed at 25 °C. Table 1 shows the battery voltage values depending on the temperature.

Table 1 shows the voltage values of Li – Ion batteries at different temperatures. As can be seen, the battery can maintain higher voltage levels as the temperature increases, while the voltage levels decrease more rapidly as the temperature decreases.

Table 1. Li – Ion battery voltage values at different temperatures

BatteryVoltage (25 °C)	Temperature (25 °C)	BatteryVoltage (10 °C)	Temperature (10 °C)	BatteryVoltage (0 °C)	Temperature (0 °C)
3.886	25.590	3.744	11.632	3.599	2.456
3.825	28.950	3.741	16.284	3.660	8.530
3.709	30.113	3.647	17.318	3.579	9.693
3.602	30.889	3.541	17.978	3.466	10.210
3.479	31.535	3.408	18.611	3.334	10.985
3.370	32.052	3.295	19.386	3.202	12.019
3.266	32.548	3.172	20.679	3.066	13.441
3.205	32.987	3.101	21.583	2.972	14.604
3.147	33.473	3.027	22.100	2.875	15.380
3.040	34.253	2.875	23.287	2.665	17.318
2.976	34.709	2.764	24.039	2.500	18.611

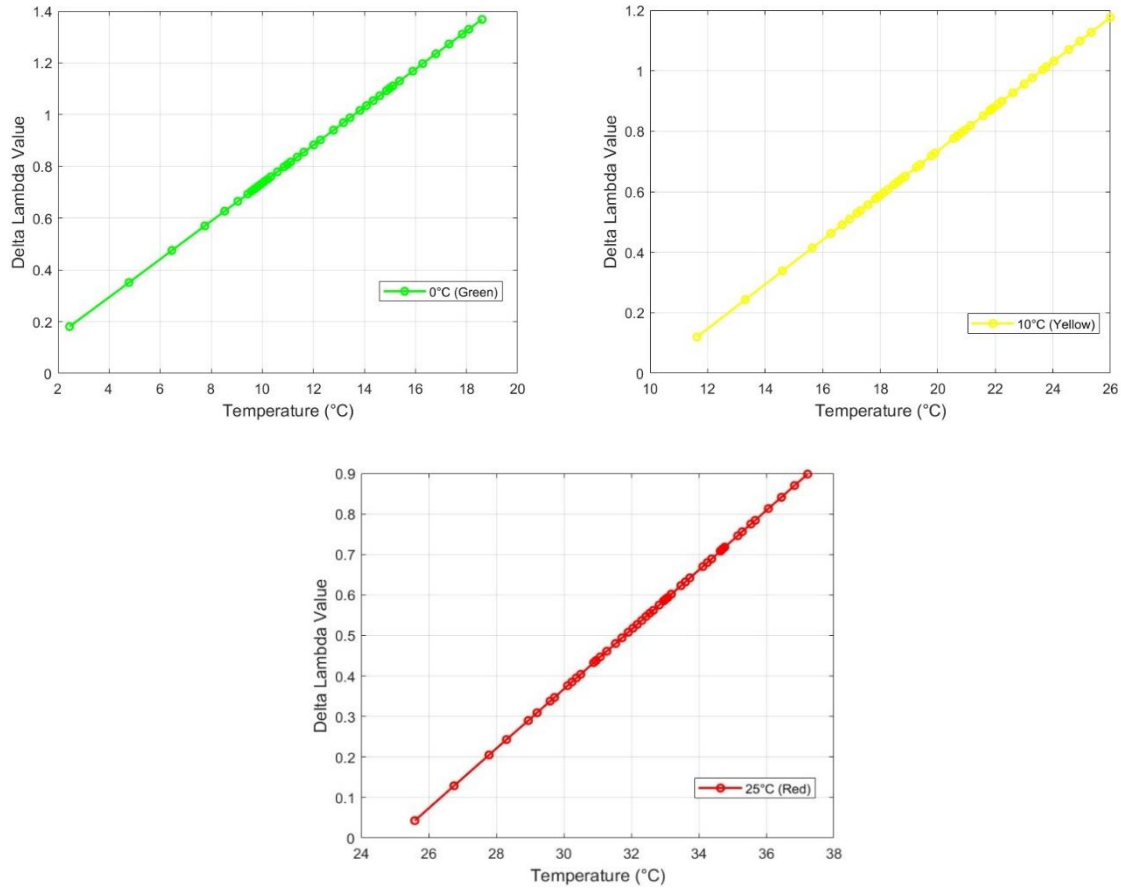


Figure 6. Relationship between Bragg wavelength shift and temperature

As required by the basic operating principle of FBG sensors, external factors such as temperature or strain cause the Bragg wavelength reflected by the sensor to change. Therefore, analyzing the Bragg wavelength shifts corresponding to temperature data is of great importance in understanding the performance of the sensors in the battery system. Figure 6 shows the Bragg wavelength shifts for different temperatures.

CONCLUSION

In this study, the thermal behavior of Li – Ion battery systems, which are widely used in electric vehicles, has been investigated using Fiber Bragg Grating (FBG) based quasi distributed sensors. Thanks to the structure of FBG sensors that are sensitive to temperature changes, the thermal changes occurring in the battery packs have been detected with high precision by shifts in the Bragg wavelength. In this context, Bragg wavelength shifts depending on the temperature change of FBG sensor at three different initial temperatures (0 °C, 10 °C and 25 °C) have been analyzed. Bragg wavelength shift has been computed as 0.714 nm for the temperature variation in the range of 25 – 34.709 °C. Furthermore, Bragg wavelength shift has been found to be ~

1.0319 nm for the temperatures changing from 10 °C to 24.039 °C and ~ 1.368 nm for the temperature variation between 0 °C and 18.611 °C.

As a result, the temperature sensitivity of the Li – Ion battery for the given temperature changes has been computed as ~ 73.5 pm/°C in these measurements. These findings and the obtained numerical results in the study show that FBG sensors can be used both in thermo – optical and temperature sensing systems where the thermal behavior of Li – Ion batteries is detected and measured, properly.

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СОВРЕМЕННЫЕ ТЕНДЕНЦИИ В ИСПОЛЬЗОВАНИИ АЗЕРБАЙДЖАНСКИХ ОРНАМЕНТОВ В СТРУКТУРЕ ТРИКОТАЖНЫХ ПОЛОТЕН И СПЕЦИФИКА ИХ ВЫРАБОТКИ

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Аннотация

Использование традиционных азербайджанских орнаментов в структуре трикотажных полотен стало своего рода тенденцией. На художественные и конструктивные возможности этого направления производства большое влияние оказывает развитие технологий вязального оборудования и новых видов пряжи для трикотажа. Национальные орнаментальные композиции, занимают центральное место в азербайджанской художественной традиции и выступают не только как декоративные элементы, но и как носители глубокой символики, связанной с мифологией, религией и образом жизни народа.

Характерным мотивом азербайджанского орнамента являются геометрические фигуры, растительные и зооморфные образы, а также знаменитый элемент «Бута», символизирующий огонь. Роль цвета и его символическое значение в орнаментальной палитре занимает особое место. Примерами традиционного использования являются орнаменты в различных видах народного прикладного искусства, включая ковроткачество, керамику и ткачество, а также их адаптация и применение в современном трикотажном производстве.

Национальные декоративные мотивы получают новое развитие в текстильной промышленности, расширяя эстетические и технологические возможности трикотажных изделиях и способствуя сохранению культурного наследия Азербайджана в условиях современной моды и дизайна.

Ключевые слова: трикотаж, орнамент, азербайджанский декор, текстильный дизайн, жаккард.

MODERN TRENDS IN THE USE OF AZERBAIJANI ORNAMENTS IN THE STRUCTURE OF KNITTED FABRICS AND THE SPECIFICS OF THEIR PRODUCTION

Abstract

The use of traditional Azerbaijani ornaments in the structure of knitted fabrics has become a notable trend. The artistic and structural potential of this area of production is significantly influenced by advances in knitting equipment technologies and the development of new types of yarn for knitwear. National ornamental compositions occupy a central place in Azerbaijan's artistic tradition, serving not only as decorative elements but also as carriers of deep symbolism related to mythology, religion, and the lifestyle of the people.

Characteristic motifs of Azerbaijani ornamentation include geometric shapes, plant and zoomorphic imagery, as well as the renowned "Buta" element, symbolizing fire. The role of color and its symbolic meaning holds a special place in the ornamental palette. Traditional applications of these ornaments can be seen in various types of folk arts and crafts, including carpet weaving, ceramics, and textile weaving, as well as their adaptation and integration into modern knitwear production.

National decorative motifs are gaining new life in the textile industry, enhancing the aesthetic and technological capabilities of knitted products and contributing to the preservation of Azerbaijan's cultural heritage in the context of contemporary fashion and design.

Keywords: knitwear, ornament, Azerbaijani decor, textile design, jacquard.

INTRODUCTION

Over the past few decades, knitted materials have gained wide popularity both in mass clothing production and in bespoke fashion design. Technological advancements, including improvements in knitting equipment and the emergence of new types of yarn, have significantly expanded the artistic and structural capabilities of knitted fabrics [1, 8, 12]. Changes in knitting production technologies in the 20th and 21st centuries have also influenced its decorative potential. Today, much attention is given to the use of national ornamental compositions in knitted products of various purposes [3].

In Azerbaijani artistic tradition, national ornamentation occupies a central place. It is present in various forms of folk applied arts, such as carpet weaving, ceramics, textile weaving, and jewelry-making. These compositions serve not only a decorative purpose but also act as carriers of symbolic information related to mythology, religious beliefs, and traditional ways of life [4].

In the context of modern textile industry, Azerbaijani ornaments are experiencing a revival. They are successfully utilized in all sectors of the industry: weaving, knitting, nonwoven textile production, and more. This opens up new opportunities for fashion design and technology.

The vast array of national ornaments is distinguished by both the diversity of motifs and the harmony of composition, as well as profound symbolism. A characteristic feature of these ornaments is their deep connection with nature, the lifestyle of the people, and their folklore characters. These patterns have accompanied the Azerbaijani people for centuries throughout their cultural development. Each generation preserved and passed down these designs, imbuing them with great expressive power [2, 4].

Popular among them are repeating geometric shapes: triangles, squares, stars, crosses, circles, ovals, and others, as well as ornaments combining these elements. Through geometric ornaments, craftsmen and weavers expressed their closeness to nature, conveyed its various manifestations, and depicted the seasons, the four classical elements—fire, air, water, and earth—and other symbolic motifs [4].

The most widespread national ornament after geometric motifs is the use of plant-based elements. These include representations of leaves, flowers, grapevines, seeds, and more. Zoomorphic ornaments feature depictions of mythical birds, sheep, and various legendary creatures.

"Buta" is one of the principal decorative elements in Azerbaijani ornamentation (see Fig. 1). It is used in all forms of art, including knitted textile production. This almond-shaped motif is considered one of the oldest in Azerbaijani applied arts and symbolizes fire, which holds a significant place in the culture of the region [2, 4].



Fig. 1. The “Buta” ornament and a ceramic plate featuring its design.

There are also numerous ornaments symbolizing flora. Such motifs are influenced by the natural features of specific regions. For example, a plant long known in Azerbaijan as *Khari Bulbul* is

considered the national flower, and its ornamental depiction is widely used in many forms of folk applied arts. In recent years, the image of this flower has gained even greater popularity, symbolizing the victory and unity of the nation. This beautiful flower is commonly found in Shusha and the surrounding areas, especially in the Karabakh region. It is also known by its botanical name, *Ophrys caucasica* (see Fig. 2).



Fig. 2. Image of the “Khary-bulbul” flower and a ceramic vase.

Zoomorphic ornaments are also very common—they adorn carpets of the Karabakh school. Heroic horses, such as the Karabakh horse, known for its speed and endurance, are also regarded as national symbols of Azerbaijan. This endemic animal is one of the oldest horse breeds in the world [4].

In Azerbaijani ornamentation, **color** holds special significance. Rich, contrasting shades dominate the palette: red, blue, green, black, and white. Each of these colors carries a specific emotional and symbolic meaning: red symbolizes strength and life, blue—wisdom and faith, green—nature and fertility [2, 4].



Fig. 3. Silver belt featuring an image of the Karabakh stallion.

National ornaments exhibit common traditions, yet they also vary across different regions. For example, in the western regions of Azerbaijan, zoomorphic and martial symbols are predominant in both woven and non-woven textiles and products. In contrast, the southern and eastern regions tend to favor plant-based motifs, particularly those reflecting local flora. This

diversity highlights not only the natural characteristics of each region but also their unique cultural and historical identities.



Fig. 4. Carpet and clay plate featuring the image of the Karabakh stallion.

Regional characteristics of ornamentation in Azerbaijan represent an important element of the country's cultural heritage, particularly in art forms such as carpet weaving, architectural decoration, embroidery, and decorative applied arts. Each region possesses its own unique artistic style, reflected in composition, color schemes, motifs, and symbolism [4, 6].

The **Karabakh style** of ornamentation (Shusha, Jabrayil, Fuzuli, Aghdam) features rich, intricate compositions frequently incorporating floral and plant motifs such as roses, buds, and branches. Warm tones dominate this style—red, burgundy, dark blue, and green. A distinguishing feature is the high density of the pattern, with minimal empty space. Notable examples include Karabakh carpets like *Khanlig*, *Chelabi*, *Malibayli*, and *Shusha* [6].

The **Ganja style** of ornamentation (Ganja, Gazakh, Shamkir) is characterized by geometric forms and clear symmetry. Medallions, polygonal elements, and cross-shaped motifs are frequently used. The color palette tends to be more contrasting, featuring shades of blue, yellow, black, and white. Examples include carpets such as *Ganja*, *Gazakh*, and *Fakhrali*, which are notable for their strict architectural structure and medallion compositions [2, 6].

The **Talysh style** (Lankaran, Astara, and Lerik districts) draws inspiration from nature—trees, leaves, waves, and animals. Symmetry is moderate, and the ornament often "grows" across the entire surface. The colors are soft and muted: dark green, ochre, and beige. A notable example is the *Lankaran* carpet, which features images of "geese" and mythological symbols [6].

The **Sheki style** (Sheki, Zagatala, Balaken) is distinguished by delicate, intricate details reminiscent of stained glass—reflecting the influence of the region's architecture. It features

rosettes, polygonal stars, and elements similar to *shebeke* (traditional Azerbaijani stained glass).

The color palette includes yellow-orange, emerald, and sapphire hues [4, 6].

The **Baku style** (Absheron, Baku) is more restrained. Its ornamentation aligns with urban decorative culture, marked by simplicity and clarity. Geometric shapes dominate over floral motifs, and the carpets often feature banded compositions [6].

Today, Azerbaijani ornaments are no longer confined to traditional decorative and applied arts. They have become an active part of modern design, fashion, and architecture. National motifs have emerged as a vital component of the country's visual identity. These ornaments are now found in clothing, accessories, interior design, urban environments, and even digital visuals.

Contemporary designers and brands are increasingly turning to cultural heritage as a source of inspiration. This approach allows for the creation of products that merge ethnic expressiveness with current aesthetic trends.

The use of ornaments in mass production also promotes national culture among younger generations and beyond the country's borders. There is a growing and sustained interest in national ornamentation, handcrafted items, and artisanal aesthetics. Knitted products featuring national ornaments are highly decorative and give garments distinctiveness and uniqueness.

Modern textile production offers a wide range of opportunities for the creative interpretation of national motifs. One especially promising direction is the application of Azerbaijani ornaments in knitted fabrics, where the unique properties of the material open up new artistic and technological possibilities.

Knitted fabric differs from other types of textiles primarily in its structure: unlike woven fabrics formed by interlacing threads, knitwear is created through the sequential formation and interlocking of loops. This structure gives the fabric softness, flexibility, and a high degree of elasticity. Thanks to its loop-based structure, knitwear also has good thermal insulation properties, is comfortable to wear, and easily conforms to the shape of the body. These qualities offer both significant advantages for product development and certain technological challenges when it comes to applying ornamentation. One of the primary technological requirements is to ensure and maintain the **accuracy and integrity** of the pattern. The design must retain its shape and dimensions even when the surface is stretched or deformed [4, 6].

The production of knitted fabric with ornamentation is a specialized process in which the pattern (ornament) is incorporated directly during the knitting phase. This can be achieved through various techniques, such as **jacquard knitting**, **intarsia**, **plating**, and others [1, 7, 12].

Using a **jacquard knitting machine** is one of the main methods for creating patterned knitwear, where the design is formed directly during knitting by using threads of different colors and

properties. In this method, the reverse side of the fabric features **floats**—strands of yarn that run across the back as they are carried from one point to another to continue the design [7].

In the **intarsia method**, each color is knitted separately, and the segments are joined together to form the desired pattern. In this case, no floats appear on the reverse side. However, the limited number of colors and the density of the knit require the **simplification** of shapes or the selection of the most recognizable elements of the ornament. Therefore, intarsia is typically used for **large-scale designs** [1].

Ornamentation can also be applied to knitted fabric using **printing techniques**, in which the fabric is first produced and then the design is applied after appropriate treatment. This method is no longer considered part of the process of creating knitwear with inlaid ornamentation. In this case, the **quality of the ink** plays a critical role, especially on elastic materials, as it determines the **durability** of the design against stretching and washing [8].

To produce knitwear with specific ornamentation, **flatbed** or **circular knitting machines** are required—often equipped with **computerized control systems**. Modern knitting machines allow for the programming and production of complex patterns directly into the fabric [12]. A key task in this process is the **development of the pattern chart** and the **testing of sample swatches** to ensure the accuracy of pattern reproduction. Yarn characteristics such as **shrinkage**, **colorfastness**, **thread thickness**, and especially the **stretchability** of the fabric play a significant role, as they affect how the ornament deforms during wear. This challenge is addressed by adjusting the **proportions of the motif** based on the fabric's elasticity [1, 12].

Knitting the pattern directly from **pre-dyed yarns** ensures the **durability** of the design. Unlike printing, the ornament is **knitted into the structure** of the fabric, making it resistant to washing and abrasion. The fabric structure can be further enriched by using yarns of different origins (e.g., wool, cotton, silk, synthetics) and properties (e.g., linear density, twist, fuzziness, etc.) [1].

Computerized knitting machines allow the creation of **complex and highly detailed designs**. These high-tech machines combine traditional **jacquard techniques** with modern **software and electronic control**, enabling automation and a high degree of accuracy in pattern execution [1, 6]. They not only allow complex patterns to be programmed but also make it easy to **switch between designs**. Pattern files can be uploaded via **USB**, **local networks**, or **specialized design software**. These machines support knitting **custom motifs**, **logos**, and even **photo-like images**. Professional software commonly used includes **DesignaKnit**, **Stoll M1+**, **Shima Seiki SDS-ONE APEX**, among others [2, 6].

Examples of applications include **fashion garments** with personalized designs, **sportswear**, **upholstery fabrics**, and **technical knitwear**, such as textiles for **medical purposes**.

Among the most popular models of computerized knitting machines are:

- **Stoll** flat knitting machines (Germany), known for their versatility;
- **Shima Seiki** SDS-ONE APEX systems (Japan), including **3D knitting** technologies;
- **Mayer & Cie** circular knitting machines (Germany);
- **Santoni** circular machines (Italy), especially known for **seamless knitting technologies** [2].

The **visual perception** of knitted garments is shaped not only by their ornamental decoration but also significantly influenced by their **textural characteristics**. The expressiveness of knitwear is determined by the **combined interaction** of pattern, texture, and compositional structure. Elements such as the **size of the ornament**, the **proportion between the decorative motif and the background**, and the **placement and orientation** of the design—all of these factors can alter the visual perception of a garment's form [1, 2].

This is especially evident in knitted fabrics where **textural effects** are combined with **decorative motifs** inspired by national ornamental traditions. In this context, **Azerbaijani ornaments** are of particular interest: their **complex symbolism**, **geometric clarity**, and **stylistic distinctiveness** provide a strong foundation for expressive and innovative design solutions [4].

Thus, the **centuries-old tradition** of folk decorative arts—including **ornamental knitting** in traditional Azerbaijani clothing—can serve as a **relevant source of inspiration** in the development of innovative knitted fabrics that blend **national visual codes** with **contemporary design approaches**. Modern designers apply a variety of strategies for incorporating ornamentation into knitwear. Ornamentation can be used as a **decorative accent**, for example on the **collar, sleeves, cuffs**, or **yoke**, adding ethnic expressiveness without overwhelming the overall visual impact. In garments like **sweaters, cardigans, and dresses**, the ornament may be **repeated across the entire surface** or strategically placed in **central areas** (such as the chest or back) to highlight the **core concept** of the collection [3, 5].

Azerbaijani designers actively incorporate national ornaments into their collections. These pieces combine **traditional motifs** with **modern design**, emphasizing the richness of the region's cultural heritage. Successful collections demonstrate a **harmonious balance** between traditional ornamentation and innovative design solutions. For example, in **Gulnara Khalilova's** collection "*Khari Bulbul*," floral motifs inspired by **Karabakh's symbolic flower** are integrated into modern silhouettes using **jacquard knitting** and **embroidery** techniques

[10]. The brand **Anara Zakirli**, in its “*Zarafshan*” collection, adapts **carpet patterns** to contemporary forms and techniques such as **digital printing** and **appliqué**. This approach preserves **traditional symbolism** while presenting it in a **modern design context** [11].

Let's consider the creation of the “**Buta**” ornament using a **jacquard knitting machine**. This process requires **precise programming** and strict adherence to a specific sequence of operations. The first step is to develop a **graphic representation** of the ornament (for example, using software such as **Adobe Illustrator**, **DesignaKnit**, **ArahPaint**, etc.). The design is then converted into a **bitmap image**, where each pixel corresponds to a specific **color** or **type of stitch**. The pattern is broken down into **rows and columns**, corresponding to the **needles** on the machine. Each color is encoded depending on the type of jacquard machine being used (single-bed, double-bed, float, tucked, etc.). A **control punch card** is created or a **digital program** is uploaded into the machine's **electronic system** [12].

The next step involves **threading the yarns** in the required colors, **adjusting yarn tension**, setting **stitch density**, and selecting the appropriate **yarn feeders**. The jacquard system determines which needles are engaged to form loops in each color. The needles rise, catch the yarn, form new loops, and release the old ones. This process is repeated row by row, gradually producing a fabric featuring the **Buta** ornament. For a complex, multicolored pattern, an **electronic jacquard machine** with multiple yarn feeders is necessary to ensure **automatic color changes** and **high precision** in pattern execution.

Conclusion

An analysis of the potential for incorporating **Azerbaijani national ornaments** into knitted textiles reveals that the combination of **rich artistic heritage** and **modern technology** offers broad prospects for the advancement of textile design. The centuries-old legacy of decorative applied arts—particularly ornamental motifs such as “**Buta**”—remains highly relevant and continues to inspire contemporary designers.

Modern computerized knitting machines and specialized design software make it possible to **accurately reproduce intricate ornamental compositions**, including **ethnic patterns**, directly during the knitting process. This ensures not only **high durability** of the design but also strong **decorative expression**. The use of **jacquard techniques**, **intarsia**, **printing**, and other methods enables the **adaptation of traditional elements** to the current demands of fashion and production.

Azerbaijani designers such as **Gulnara Khalilova** and **Anara Zakirli** successfully demonstrate how ornamentation can become a **central element of visual identity**. Incorporating national

motifs into knitted garments enhances their **aesthetic value**, contributes to the **preservation of cultural heritage**, and broadens the **creative scope** of textile design.

In this way, the **integration of Azerbaijani ornaments** into knitted fashion not only **enriches contemporary design**, but also creates a **unique expressive language** that unites **tradition and innovation**.

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STYLOMETRIC INSIGHTS: BERT VS. N-GRAMS IN AUTHORSHIP ATTRIBUTION

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ABSTRACT

Authorship attribution is a task in computational linguistics that aims to identify the writer of a text by analyzing stylistic and linguistic patterns. This study investigates the effectiveness of various feature extraction methods on a Turkish dataset comprising 1200 documents written by 30 different authors. Three types of features are explored: character-based n-grams, word-based n-grams, and contextual embeddings from BERT (Bidirectional Encoder Representations from Transformers). While traditional n-gram models capture local patterns using token or character sequences, BERT provides dense, context-aware representations that reflect deeper semantic and syntactic structures. Several supervised learning algorithms are applied using these features to classify documents by author. The objective is to compare the performance of these models and determine which combinations of feature sets and classifiers yield the most accurate and robust results for authorship attribution. Findings from the experiments provide insights into the strengths and limitations of each approach. The results contribute to the development of more effective computational models for applications such as plagiarism detection, forensic linguistics, and social media analysis.

INTRODUCTION

Author classification is a subfield of computational linguistics that deals with the identification or verification of a text. The process takes place automatically and uses features in the text. A central component is that each person has a characteristically unconscious writing style. By taking advantage of this, it is possible to assign the authorship of a text to someone by using machine learning models. This is used in various areas including educational institutions to carry out plagiarism checks. Furthermore, it supports copyright enforcement in the publishing and media industry, the prevention of disinformation campaigns on social media, and forensic linguistics for analyzing suspicious and anonymous communications.

Different feature extraction methods influence the outcome of the classification results. Feature extraction can be carried out using word-based n-grams or character-based n-grams. In addition, the obtained features can be combined in the model. Word-based and character-based N-grams are used to capture local patterns in texts. Word-based N-grams analyze sequences of words, while character-based N-grams consider sequences of characters. Another way to extract features is with pre-trained models like BERT. BERT (Bidirectional Encoder Representations from Transformers) is a large-scale and flexible language representation model which performs pretraining on text to train deep bidirectional representation. It captures both lexical meaning and contextual dependencies by mapping words into fixed-dimensional vector spaces. BERT does not generate frequency-based, independent representations like traditional models such as TF-IDF or n-grams. Instead, it produces contextual, dense, and semantically rich vector representations of entire texts or documents. In the context of authorship attribution, these vectors serve as high-level representations of writing style, capturing subtle linguistic and stylistic features that are useful for distinguishing between different authors.

In this study, various feature extraction techniques—including character-based n-grams, word-based n-grams, and BERT embeddings—are applied to a Turkish authorship dataset consisting of 1200 documents written by 30 distinct authors. Using these different representation methods, several supervised learning models (Random Forest (RF), Support Vector Machines (SVM) and XGBoost algorithms) are utilized to assign each document to its corresponding writer. Afterwards the performance of each model for each feature set will be evaluated. The goal is to determine which combinations of feature and model offer the most accurate, robust and fair performance for the authorship attribution task.

The rest of the paper is organized as follows: Section 2 provides a summary of the relevant literature. Section 3 outlines the methodology and describes the data set used in the study. Section 4 presents the experimental results along with a discussion of key findings. Finally, Section 5 points out concluding remarks and suggestions for future research.

1.LITERATURE REVIEW

The volume of documents available on the internet continues to increase at an accelerated pace, prompting significant interest in developing efficient methods for organizing and categorizing this vast amount of information. This research aims to identify and classify the authorship of texts by employing various character-based n-gram, word-based n-grams and BERT representations.

Documents can be represented as sequences of character n-grams, which are contiguous substrings of length n . Such representations are language-independent and do not require

extensive preprocessing, making them widely applicable. Character n-grams are particularly valuable for authorship attribution tasks, as they effectively capture stylistic features at multiple linguistic levels, including lexical choices, syntactic categories, punctuation patterns, and capitalization styles. Moreover, they exhibit robustness against common issues such as grammatical inaccuracies and unconventional uses of abbreviations or punctuation (Stamatatos [1], Grieve [2]).

The literature provides numerous examples demonstrating the efficacy of character n-gram representations in authorship classification. Kjell [3] successfully utilized character n-grams to differentiate between the Federalist Papers' authors. Similarly, Furnkranz [4] and Peng [5] proposed models where each author is characterized by vectors composed of the most frequent n-grams extracted from their texts. Forsyth and Holmes [6] further highlighted that bigrams and other character n-grams outperform lexical-based features in various text classification scenarios. Consistent with these findings, Stamatatos [7] reported promising results leveraging character n-gram information for author identification.

Documents may also be represented as sequences of word-level n-grams, which are designed to leverage contextual and phrasal information present in the text. While this approach aims to enhance classification by capturing patterns of word co-occurrence, empirical findings suggest that it often does not outperform models based on individual word features (Sanderson and Guenther [8]; Coyotl-Morales et al. [9]; Guran et al. [10]). Gamon [11] observes that word n-gram-based representations tend to emphasize topic-related or content-specific elements, rather than stylistic markers, thereby limiting their effectiveness in tasks where authorial style is the primary discriminative factor.

Gardazi et al. [12] explores the intricate architecture of BERT, its applications across various NLP tasks, and the ongoing enhancements made to its design through different adaptations. Through bidirectional training, BERT retains rich semantic information and surpasses previous models in tasks such as document classification, idiom recognition, and question answering. Fine-tuning allows for outstanding results in specialized applications, e.g., in cybersecurity or with low-resource languages. Overall, contextual embedding significantly improves performance in numerous NLP applications. Fabien et al. [13] propose BertAA, a fine-tuned version of a pre-trained BERT language model enhanced with an additional dense layer and softmax activation for authorship classification. Their method achieves competitive results on several benchmark datasets, including Enron Email, Blog Authorship, and IMDb (including IMDb62), outperforming existing state-of-the-art techniques by up to 5.3% in relative terms. Gabrovšek et al. [14] explore the application of the BERT language model to the task of

authorship attribution in Slovenian, focusing specifically on short texts, and provide empirical evidence supporting the model's effectiveness in capturing authorial style within limited textual data. Silva et al. [15], introduce a GAN-BERT-based approach for authorship attribution in novels from the late 19th century.

In our study, we evaluate the performance of different feature extraction methods on a Turkish dataset of 1,200 documents by 30 authors, using character n-grams, word n-grams, and BERT-based contextual embeddings.

2.METHODS AND DATASETS

2.1.Dataset

The dataset consists of 1200 different Turkish texts samples belonging to a total of 30 different authors. Each author has a label to have a reference to the author who wrote the text. To simplify the classification process, numerical labels have been used (e.g., 0, 1, 2, etc.). This ensures that the labels are compatible with the machine learning models. The processed dataset was split using a stratified sampling strategy. Afterwards the data was split to 80% and 20% of subsets, where 80% are used for training and the remaining 20% are used for testing. It ensures that the distribution of authors across the subsets is fair and that the results can be evaluated accordingly.

2.2.Feature Extraction Methods

In this research, TF-IDF, n-grams and BERT were used for feature extraction. TF-IDF (Term Frequency – Inverse Document Frequency) is a classic method for converting texts into vectors. It evaluates the frequency of a word in the document and the rarity in the entire corpus. Terms that frequently occur in a document but rarely appear in the corpus receive higher weight to emphasize their importance in that specific text.

N-grams are a sequence of n tokens from a text which can be based on words and characters. While word-based n-grams capture stylistic patterns, character-based n-grams recognize recurring character patterns, suffixes, or stylistic features within and across words.

BERT has emerged as one of the most effective models in natural language processing, offering substantial advancements over traditional static word embedding methods such as Word2Vec and GloVe. Unlike these earlier approaches, BERT produces dynamic, context-aware word representations that reflect the specific semantic nuances of each word within its sentence-level environment. Dbmdz/bert-base-turkish-cased is the BERT model used for the author classification in this research. It is a model that is trained on a Turkish training corpus. Each text was tokenized and processed by this model to generate contextualized embeddings for every token. These were used to obtain a single dense vector representation for each document by mean-pooling the embeddings across each sentence.

For this study, the following feature sets were extracted:

- Individual words (word based 1-grams)
- Word based 2-grams
- Word based 3-grams
- Combined Word based 3-grams and 2-grams
- Character based 2-grams
- Character based 3-grams
- Combined character based 3-grams and 2-grams
- BERT

2.3.Models

The models used for the classification were RF, SVM and XGBoost. RF is an ensemble classification algorithm which uses trees as base classifiers and was introduced by Breiman in 2001 [16]. It uses a bagging approach, where decision trees are trained on random subsets of data. The classification is carried out through majority voting within the ensemble, which improves stability and accuracy. The Gini-Index is used for node-splitting, which measures impurity in the node. Because each tree is based on random subsets of data, only a random selection of features is also considered (V.F. Rodriguez-Galiano, [17]).

SVM was developed in the 1990s by Vapnik [18]. It is a classification method that can perform both linear and nonlinear separation. The idea is to map the input data into a higher-dimensional space and construct a hyperplane there that separates the classes with the maximum distance. The maximum distance is the central component of optimization. If the data is not separable, a soft margin optimization is performed using slack variables to account for outliers and noise. This enables SVM to achieve precise classification with high discriminatory power, especially for high-dimensional data (Chandra et al., [19]).

XGBoost is a powerful learning algorithm based on gradient boosting. This is an iterative learning method in which base learners are trained sequentially to correct error models. XGBoost optimizes this process using additional regularization, thus avoiding overfitting. This achieves high accuracy and robust generalizability. The model structure is based on an additive combination of decision trees, with each new tree reducing the gradient error of the previous one. Optimization is performed using an objective function containing the loss term and a regularization term, which ultimately helps avoid overfitting (Qiu et al., [20]).

The models used were configured uniformly to allow for fair comparison: RF and XGBoost were each configured with 100 trees, with XGBoost using the "mlogloss" loss function. SVM used a linear architecture.

2.4.Evaluation Metrics

Confusion matrix metrics were used to evaluate the classification models. The same training and test data sets with %80-%20 splitting ratio were applied to all models, and the results were evaluated. The models can produce four possible outcomes: True-Positive (TP), False-Positive (FP), True-Negative (TN), and False- Negative (FN). TP is the proportion of tests correctly declared as positive, TN is the proportion of tests correctly declared as negative, FP is the proportion of tests incorrectly declared as positive, and FN is the proportion of tests incorrectly declared as negative. Using these values, the following metrics were calculated:

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \quad (1)$$

$$\text{Precision} = \frac{TP}{TP+FP} \quad (2)$$

$$\text{Recall} = \frac{TP}{TP+FN} \quad (3)$$

$$\text{F-Score} = 2 * \frac{\text{Positive Precision} * \text{Positive Recall}}{\text{Positive Precision} + \text{Positive Recall}} \quad (4)$$

3.EVALUATION RESULTS

This section analyses the performance of each feature applied to each model and compares the results. It highlights the strengths of different models and provides insights into which combinations of features and algorithms are most effective for the author classification of the Turkish documents. Each figure will focus on a specific metric or comparison.

Figure 1 illustrates the accuracy values achieved by each model for each feature extraction method. The best accuracy was achieved by SVM using character 3-grams (0.88) and character 2+3-grams (0.87), followed by XGBoost with character 2+3-grams (0.83) and character 3-grams (0.81). RF performed best with character n-gram features, particularly character 3-grams (0.77) and character 2+3-grams (0.75). These results indicate that character-based n-grams—especially 3-grams and the combination of 2- and 3-grams—are highly informative for author classification.

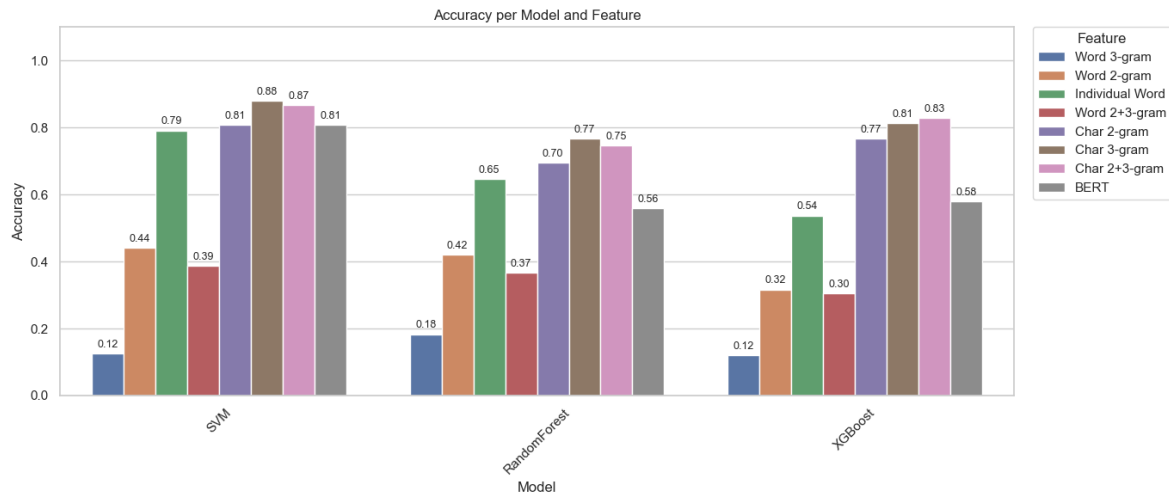


Figure 3. Accucary Scores for Each Model–Feature Combination

Figure 2 shows the recall values obtained by each model across the different feature extraction methods. As can be seen, SVM with word 3-grams achieves the maximum value of 1.0, followed by XGBoost with 0.86 using character 2+3-grams.

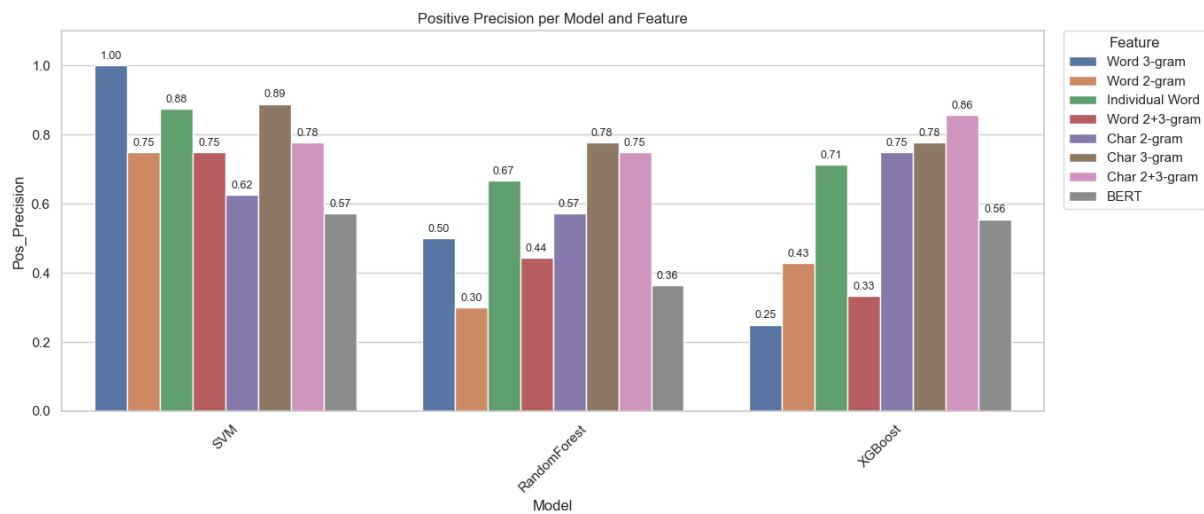


Figure 2. Precision Scores for Each Model–Feature Combination

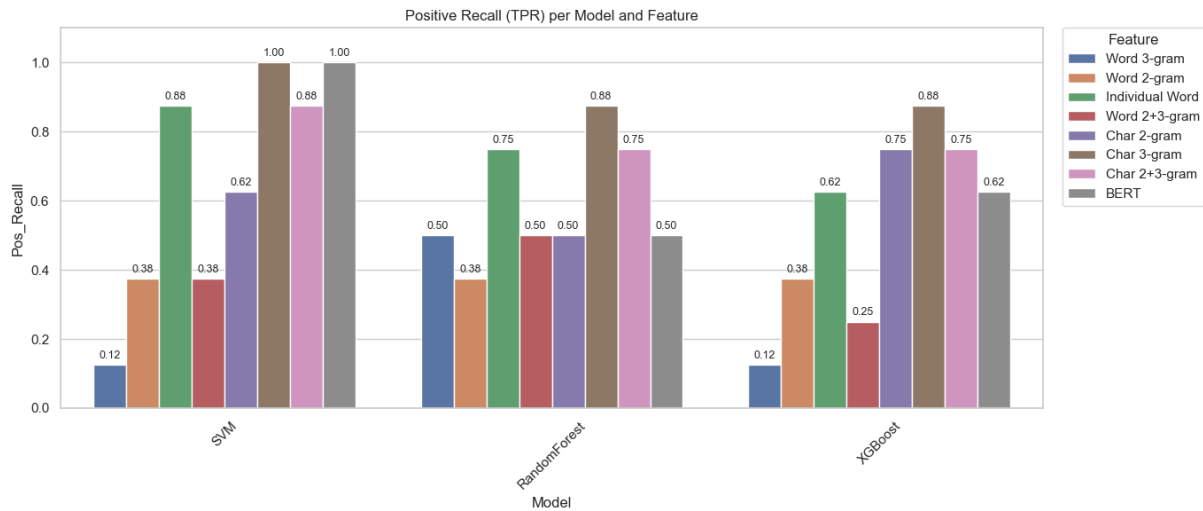


Figure 3. Recall Scores for Each Model–Feature Combination

Figure 3 shows that SVM achieves a perfect score of 1.0 with both BERT and character 3-grams. RF also performs well, obtaining scores of 0.75 with individual words and character 2+3-grams, and 0.88 with character 3-grams. The performance of the remaining feature types hovers around 0.5.

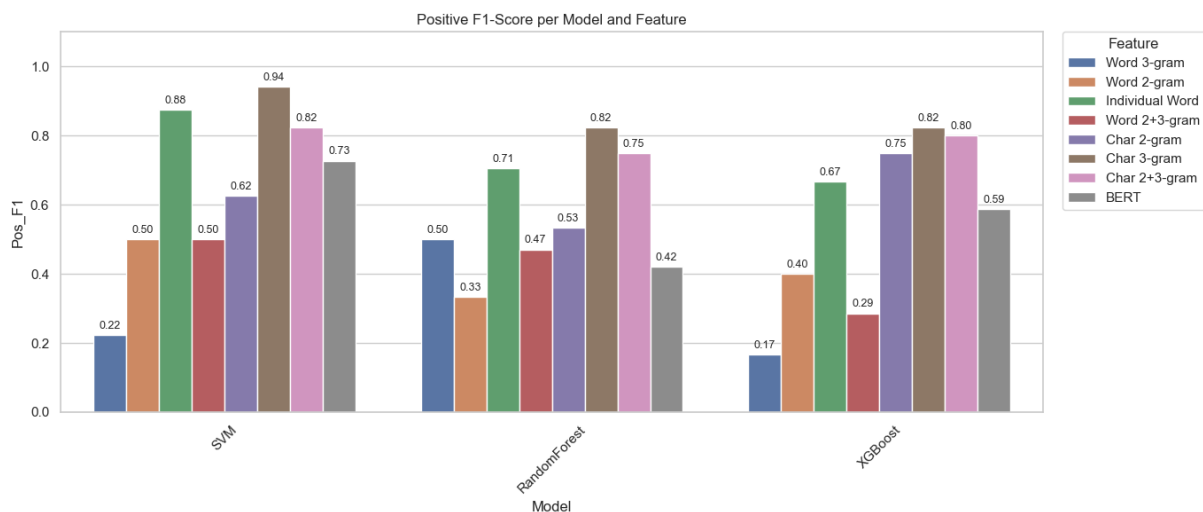


Figure 4. F-Scores for Each Model–Feature Combination

Figure 4 presents the highest F-score achieved by SVM using character 3-grams (0.94), highlighting its strong capability in identifying true positive instances. This is followed by the Individual Words feature with a score of 0.88. The third highest score for SVM is obtained with

character 2+3-grams (0.82), which is equal to the best scores achieved by both XGBoost and RF when using character 3-grams.

The results indicate that SVM consistently outperforms other models across all evaluation metrics when paired with effective feature extraction methods. In particular, character-based n-grams—especially character 3-grams and the combined character 2+3-grams—prove to be highly effective for author classification, yielding the highest accuracy and F1 scores. SVM achieves near-perfect or perfect performance in multiple settings, including a perfect recall score of 1.0 with word 3-grams and a perfect F1 score with both BERT and character 3-grams. While XGBoost also shows strong results, especially with character 2+3-grams, its performance remains slightly below that of SVM. RF performs reasonably well with character-based features, reaching its peak with character 3-grams, but usually yields lower results compared to the other two models. Overall, the findings underscore the importance of feature selection, with character-level features—particularly character 3-grams—playing a crucial role in achieving high classification performance across models.

CONCLUSION

This study addresses the task of author classification on a corpus of Turkish texts. Several feature extraction methods and supervised machine learning models were employed. The feature extraction methods include character- and word-based n-grams, as well as BERT embeddings. The classification algorithms used were SVM, RF, and XGBoost. Performance evaluation was conducted using accuracy, error rate, precision, recall, and F-score metrics. The goal was to determine which combination of model and features provided the most robust, accurate, and fair performance for the author classification task.

The findings demonstrate that SVM consistently deliver superior performance relative to other evaluated models across all metrics when combined with appropriate feature extraction techniques. Notably, character-level n-grams—particularly character 3-grams and the combination of character 2- and 3-grams—emerge as the most informative features for author identification, producing the highest accuracy and F1 scores. SVM attains good results in several scenarios, including a flawless recall of 1.0 with word-level 3-grams and an effective F-measure when utilizing both BERT embeddings and character 3-grams. Although XGBoost exhibits competitive outcomes, especially with character 2+3-grams, its overall effectiveness remains marginally inferior to that of SVM. Random Forest (RF) achieves moderate success, performing best with character 3-grams; however, its results generally fall short compared to those of SVM and XGBoost.

Collectively, these results highlight the critical role of feature engineering, underscoring that character-based representations—most notably character 3-grams—are essential for optimizing classification accuracy across different modeling approaches. For future work, we will explore hybrid models and feature extension strategies to further improve performance.

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THE APPLICATION OF MODERN TECHNOLOGIES IN OIL AND GAS FIELDS IN AZERBAIJAN AND THEIR KEY ROLE

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ABSTRACT

This article examines the application of modern technologies in the development of oil and gas fields in Azerbaijan and their importance for the industry. The main topic of discussion is the role of innovative technologies applied in the oil and gas sector to increase competitiveness, increase production efficiency and ensure environmental safety. The article analyzes the application examples of technologies such as 3D seismic surveys, horizontal drilling, smart wells, artificial intelligence and automated control systems in Azerbaijan and their economic and operational advantages. As a result, it is determined that these technologies ensure more efficient and sustainable exploitation of oil and gas resources, reduce operating costs and minimize environmental impacts. The article also covers the problems encountered in this area and future development prospects.

Keywords: Oil industry, modern methods, technology, Shah Deniz field, energy security, environmental monitoring, Caspian Sea

Introduction. Azerbaijan has been one of the countries playing an important role in the oil and gas industry for many years. Especially after independence, the application of modern technologies in this field has significantly increased the efficiency and sustainability of production processes. This article examines the application of modern technologies in the Azerbaijani oil and gas industry and their main role.

INTRODUCTION

The oil and gas industry is one of the main leading sectors in the economy of Azerbaijan. However, the application of modern technologies is necessary for the sustainable development of this sector and maintaining its competitiveness in international energy markets. Compared to traditional production methods, technological innovations enable the efficient exploitation of deeper, more complex and difficult fields. Since the issues of energy security and environmental sustainability have come to the fore in the world today, it is important for Azerbaijan to take strategic steps in this direction [1, 2].

Currently, the application of advanced technologies has begun in a number of large oil and gas fields operating in Azerbaijan. However, the level of application of technologies, the extent to which local resources and human resources are suitable for these changes, as well as the

economic and environmental consequences of these processes, should be studied. Thus, this article systematically examines the current situation regarding the application of modern technologies, its importance, application areas and future development directions.

Several years ago, the State Oil Company of Azerbaijan (SOCAR) established the Caspian Innovation Center (CIC) to manage digital transformation processes.

The CIC conducted a detailed analysis of all software used at SOCAR, identified gaps and identified areas that needed optimization. In 2018, CIC began implementing digital projects in the exploration and production sector. The drilling sector relies entirely on the SAP ERP platform, as there are numerous risks and uncertainties in this area. All processes here, including planning, drilling and well commissioning, are automated. The SAP UFAM platform was applied for the first time in the world to systematize and automate all processes of oil and gas production. SOCAR's Azneft Production Association uses leading technologies, including machine learning. The company's systems predict expected production from the well, possible risks and events.

Automatic calculation of the project cost, automation of safety and environmental work are also widely used on the SAP platform in 2021 [3]. Automation work is being carried out in the recycling and sales sectors, including at the “Azerikimya” Production Association. After the creation of a unified base, the company will have systems that meet “Industry 4” standards. SOCAR has already developed a plan that includes the analysis of company data, the Internet of Things, video analysis and the application of other new generation technologies.

On April 9, 2021, the Visualization Center was opened at the “SOCAR Tower”, designed to manage production operations from a single digital center, hold special meetings in specialized areas, discuss large-scale and critical projects, make operational decisions, as well as perform crisis and emergency management functions.

For more than 10 years, SOCAR has been successfully creating a corporate digital management platform along with the automation of business processes. This process currently covers all the main areas of activity of the company. In the company's Oil and Gas Corporate Database, up to 50 percent of the 44,000 wells drilled in Azerbaijan over the past 175 years, currently in operation and decommissioned, have already been digitized. Using this database, specialists can build a model of the fields using interpretation software [3, 5].

By monitoring the drilling process in real time, it is possible to obtain the depth of any well, the load on the bit, pressure, volume of injected fluid and other drilling parameters. Digital systems are also applied in other areas such as oil and gas production, processing and gas transportation. Managing operations using digital models and the ability to control various

devices in real time and from a single point enhance the company's operational efficiency. Video surveillance equipment installed on offshore platforms and other production areas allows for constant visual monitoring of the situation, ensuring more effective management of possible emergencies. For this, smart sensors are widely used. Smart sensors are devices that not only collect data, but also have the functions of pre-processing, diagnostics and automatic decision-making. They play an important role in the automation and optimization of production processes in the oil and gas industry. Unlike traditional sensors, smart sensors analyze data, evaluate the results before sending them to a central system, and often respond on the spot. Smart sensors have the following functions [6]:

- **Real-time monitoring:** That is, it continuously monitors pressure, temperature, vibration, flow and other indicators, and immediately detects any deviations.
- **Initial data analysis and diagnostics:** It analyzes data locally and determines the cause of failures.
- **Automated response function:** It can automatically deactivate equipment or change its mode in case of stress or danger.
- **Data transmission to cloud systems:** The information center is integrated with servers and artificial intelligence algorithms.

The application areas of smart sensors in the oil and gas industry are as follows [3]:

Well management. Smart sensors installed in wells constantly monitor the production status and analyze the flow rate, well pressure and operating status. This increases well performance and prevents failures.

Pipeline safety: Leakage, vibration or pressure changes are automatically recorded through smart sensors and an immediate warning system is activated.

Energy consumption management. Sensors in compressor and pump stations optimize energy use, reducing both costs and minimizing the carbon footprint.

In Azerbaijan, the application of smart sensors is mainly carried out within the framework of international energy companies and their partnerships. For example: in the “Azeri-Chirag-Guneshli” field, operated in partnership with BP and SOCAR, smart sensors provide detailed analysis of well behavior and this data is integrated into the real-time management system [2, 6]. Here, smart sensors installed mainly by BP serve for continuous monitoring of well performance and optimization of production. Also, smart sensors in gas fields within the framework of the “Shah Deniz” project ensure precise regulation of gas flow and increase safety (Figure 1).

SMART SENSOR FOR GAS FLOW DETECTION



Figure 1. Smart gas flow sensors are essential for accurate flow measurement and control, productivity and energy efficiency. Smart flow sensors are devices that are based on the latest technologies and have both measurement and data processing capabilities for this purpose (fig 2).

GAS FLOW METERS SENSOR



Figure 2.

SENSOR INSTALLATION AND USE. The correct installation and use of smart gas flow sensors is vital for their measurement accuracy, long-term reliability and effective use in industrial processes. These sensors are used to monitor and control the velocity, volume and in some cases the composition of the gas with high precision. When installing these sensors, the type of sensor must first be determined. Before installation, parameters such as the type of gas to be used (e.g. natural gas, methane, propane, etc.), flow rate, pressure and temperature must be taken into account. The operating principle of the sensor (thermal, ultrasonic, pressure difference, Coriolis, etc.) must also be selected according to the process. Then, the location of the sensor is determined and the sensors are installed in the gas pipelines either internally or externally. It is important to position the sensor in accordance with the flow direction. This has a significant impact on the accuracy of the measurement. After the sensor is installed, it is connected to the pipe by flanges or welding. Cable connections are made for power supply and data transmission. The use of the sensor is carried out based on the signal outputs. The most commonly used signal outputs are: 4–20 mA, Modbus RTU, HART, Profibus signals. After

installation, the sensor must undergo initial calibration. This can be performed either in advance by the manufacturer in laboratory conditions or in the field with special calibration devices. In the test mode, it is observed how the sensor reacts to real gas flow [4].

When a critical flow level is exceeded, the sensors can send signals for automatic opening and closing of valves, gas redirection and activation of safety systems. Regular inspection and cleaning should be carried out to prevent dust, dirt or condensate from accumulating on the surface of the sensors. Calibration is recommended once or twice a year for accuracy. For this, the firmware of the sensor systems should be updated periodically.

Safety regulations must be followed when using these sensors. Therefore, the area where the sensor is installed must comply with explosion protection standards (ATEX, IECEx, etc.) since it works with flammable gases. Installation and maintenance must be carried out only by qualified engineers or technical personnel. Compliance with local and international standards and regulations (e.g. ISO 5167, API, ASME MFC) must be ensured [5].

CONCLUSION

We have obtained the following results when applying smart sensors in the oil and gas sector: The application of smart sensors reduces human labor, which leads to faster resolution of operations.

1. Extends the service life of equipment;
2. Reduces production costs and energy losses;
3. Prevents accidents and environmental damage.
4. In the future, smart sensor technologies are expected to be more closely integrated with 5G, artificial intelligence and IoT systems. This will both make technical processes more transparent and automated, and will also give impetus to the expansion of the concept of “digital oil and gas industry” in Azerbaijan.

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RAPID PROTOTYPING OF RADAR ABSORBING MATERIALS WITH FUSED DEPOSITION MODELLING

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ABSTRACT

Radar Absorbing Materials (RAMs) are materials that are engineered to reduce the reflection of electromagnetic waves. These materials are used in stealth technology by reducing radar signals reflected from the metallic surfaces of aircraft, in antenna design by absorbing stray signals to enhance signal directionality, and electromagnetic interference (EMI) shielding. This study focuses on magnetic RAMs, where absorption is achieved using iron particles suspended in an Acrylonitrile Butadiene Styrene (ABS) polymer matrix. Fused Deposition Modeling (FDM), a common 3D printing method, offers a convenient way to manufacture these RAMs in various shapes and with different additive ratios, making it easier to test many different designs.

For this study, ABS-iron powder (25 μm) composite filaments were fabricated and analyzed. The process began with preparing a concentrated masterbatch (70 wt% iron powder in ABS) by mixing ABS and iron powder with acetone to create a slurry, which was then dried and shredded. This masterbatch was then mixed with plain ABS pellets to achieve final iron powder concentrations of 30 wt% and 50 wt% in the feed for extrusion. These mixtures were extruded into 1.75 mm filaments using a custom-built, low-cost single screw extruder. Various RAM plates and tensile samples were then 3D printed. Reflection loss was measured from 8-12 GHz using a Vector Network Analyzer. Tensile strength was measured in both horizontal (material) and vertical (layer adhesion) orientations. Results showed absorption is influenced by iron content and geometry, while the vertical strength (layer adhesion) is significantly reduced at 50 wt% iron. Still, the FDM method proved convenient for quickly testing different RAM designs.

Keywords: Radar absorbing materials; 3D printing; filament fabrication

OPTIMIZATION OF POWER GENERATION AND STORAGE SYSTEMS FOR RURAL HEALTH CENTERS USING HOMER

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ABSTRACT

Rural health centers in developing countries face significant challenges in accessing reliable and sustainable energy, compromising healthcare delivery. This study presents an optimization of power generation and storage systems for rural health centers using HOMER software. The study aims to design and optimize a hybrid renewable energy system that combines solar photovoltaic, wind, and energy storage to meet the energy demands of rural health centers. Using HOMER software, the study simulates and optimizes different energy system configurations, considering factors such as energy demand, resource availability, and economic viability. The results show that optimized hybrid renewable energy systems can provide reliable, cost-effective, and sustainable energy solutions for rural health centers, reducing reliance on diesel generators and greenhouse gas emissions. The study's findings have implications for policymakers, healthcare administrators, and energy practitioners seeking to improve energy access and healthcare delivery in rural areas. The optimized energy systems can enhance the quality of healthcare services, reduce energy costs, and promote sustainable development in rural communities.

Keywords: Hybrid Renewable Energy Systems, Rural Health Centers, HOMER Software, Energy Optimization

RESEARCH OF PERIODIC MONITORING OF THE TECHNICAL DIAGNOSTICS SUBSYSTEM OF OBJECT CONTROLLERS OF MICROPROCESSOR CENTRALIZATION

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ABSTRACT

Introduction and problem statement. One of the most important characteristics of functional safety (FS) of a microprocessor centralization (MPC) system is the ability to timely detect and prevent dangerous failure of microprocessor object controllers (MPC) when they acquire a pre-failure state associated with a dangerous failure of individual information and control channels. This property of MPC is provided by a subsystem of continuous or periodic technical diagnostics. In the latter case, the diagnostic period should be less than the period of technical control, which is performed through functional tests, due to the impossibility of covering all possible manifestations of the MPC system functioning [1 – 4].

In turn, the reliability of the subsystem of technical diagnostics of the IPC should be periodically investigated by reproducing their pre-failure states (for the above case - dangerous failures of individual channels). Considering that the software and hardware of the IPC are implemented according to safe schemes and algorithms, performing non-destructive testing in this study using only real IPCs is not possible, and destructive testing is unacceptable from the point of view of technical and economic feasibility [5, 6].

Literature review and identification of unresolved parts of the problem. The need for timely detection of the pre-failure state of the MPC and approximate ways to solve the specified problem are noted in the works [4, 7]. The author's research cycle aimed at developing test methods that are taken as the basis of the specified procedure is published in the works [3, 4, 8 – 10]. An unresolved component of the problem of detecting the pre-failure state of the MPC is the reliability of the functioning of the technical diagnostics subsystem [4].

Purpose of the article. The purpose of the study is to develop a procedure for periodic control of the guaranteed detection by the technical diagnostics subsystem of the pre-failure state of the MPC by means of physical simulation modeling, based on the combined test methods (MCT) of the MPC system.

Algorithms for performing the procedure. The main measure for solving the specified problem is to use the capabilities of a specialized simulation model (SIM), capable of simulating a wide range of IPC states, including dangerous failures of their components, as well as a specialized combined model (SCM) as a result of the synthesis of simulation and physical modeling. The procedure developed for controlling the diagnostic subsystem is based on the use of the separated channel method (SCM), which consists in reproducing part of the IPC information and control channels by real devices, and the other part by SIM software modules [8]. The structural diagram of the SCM-configured IPC system is shown in Fig. 1.

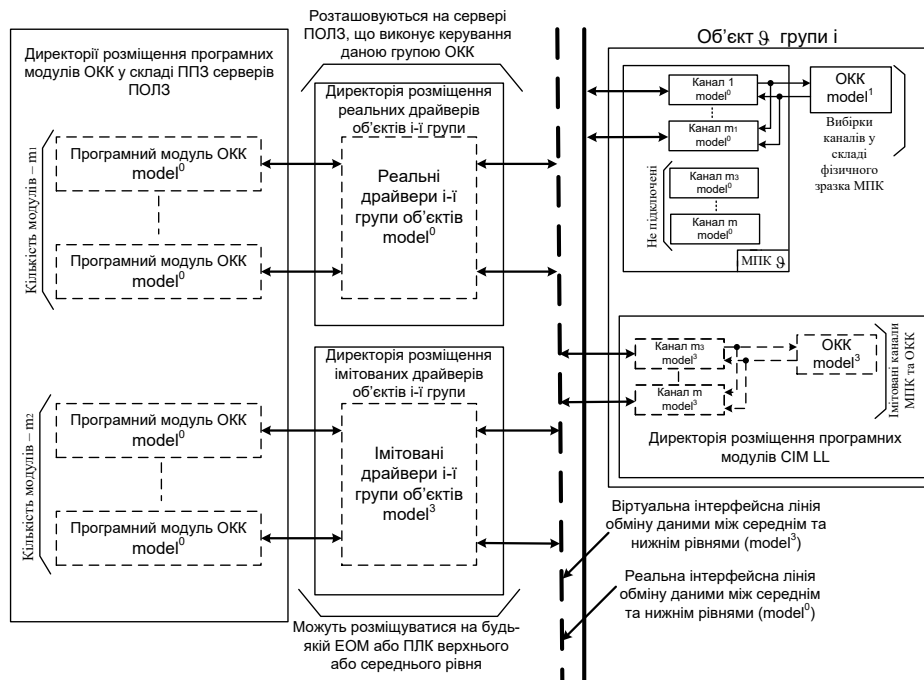


Fig. 1. Structural diagram of a specialized combined model of the MPC, configured to work using the separate channels method

The structural diagram in Fig. 1 is constructed taking into account the following features of the formation and formalized description of the MVC [8 – 10]:

- allocation of control and monitoring objects (CMO) of the MPC system into groups according to functional characteristics, united by a common interface driver for interaction between the logical dependency processing subsystem (PLZ) of the MPC and the MPC, which represent, respectively, the middle (ML) and lower (LL) levels of the MPC;
- use of real and virtual interface lines for data exchange between the PLZ and the MPC, respectively, for interaction with real and simulated information and control channels;
- use of conditional ordinal classification of models (model0 – real device; model1 – physical model; model3 – simulation model).

[illegible]

169

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graph TD
    Start([Початок]) --> N[/Кількість груп об'єктів  
n = ''/]
    N --> I1{i = 1; n}
    I1 -- i > n --> End([Кінець])
    I1 -- i <= n --> M[/К-сть каналів групи i  
m = ''/]
    M -- j > m --> I1
    M -- j <= m --> Setup[Налаштування  
стенду МПЦ для  
каналу j=μ групи i]
    Setup --> K1{k = 1; r}
    K1 -- k > r --> End
    K1 -- k <= r --> Select[/Вибір МПК №k для  
діагностування/]
    Select --> S[/К-сть небезп. відмов  
МПК №k згідно ГМВ  
s = ''/]
    S -- l > s --> K1
    S -- l <= s --> Sim[Імітація небезп.  
відмови №l для  
МПК №k каналу j  
групи i]
    Sim --> Fix{Фіксація відмови}
    Fix -- так --> K1
    Fix -- ні --> M
    Fix --> End
    subgraph Box [Індикація справної роботи  
підсистеми технічного  
діагностування]
        End
    end

```

The SIM control window of the MPC-S system is implemented by the “SymulatorControl” subprogram, which forms a window with a set of control elements on the computer monitor in which it operates, which can be used using the “mouse” manipulator and keyboard in order to simulate the required state of the selected MPC or the OKC connected to it (Fig. 4) [4].

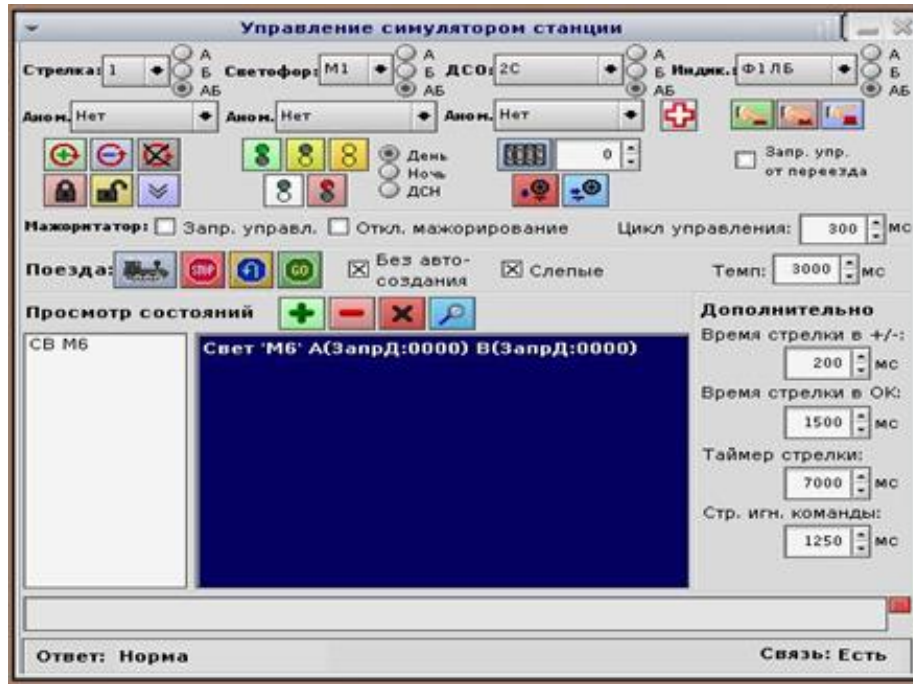


Fig. 4. Appearance of the control window of the MPC-S simulation model

The SIM control window is designed in such a way as to minimize its size (to reduce the screen area occupied by it). Therefore, the selection of MPK and OKK to set their states is provided using drop-down lists, from which one specific object is selected for a given operation. For OKKs of the same type of a certain group, one corresponding list is presented. For each group of objects, the window provides a set of buttons for setting the selected OKK or MPK to the desired state. This operation within the framework of the developed procedure is performed on separate channels of control and monitoring of the object, according to which the discrepancy of data on the channels about its state is simulated. The “Test-CAN” program window, as well as when confirming the adequacy of the SIM, is used for independent monitoring of actual data generated by the SCM (as a combination of the SIM and the channel of the real MPK) and transmitted to the POLZ via the interface CAN line. On the example of displaying the state of the turnout controllers (MKST), the “Test-CAN” window is shown in Fig. 7.

In positions (1), (2), (3), (4), (5), (6) the number of the controlled turn signal (in the general case also of the traffic light, rail sensor and input-output module) and the identifiers of its channels A and B (1st and 2nd) are entered. In positions (7), (8), (9), (10) the turn signal status codes (in hexadecimal format) perceived by the driver (real or simulated) are displayed, as well as the status indicator. Positions (11) and (12) contain the command code sent to the driver from the corresponding channel of the POLZ server. Service positions (13) – (16) are intended for setting the “Test-CAN” program to the corresponding operating mode.

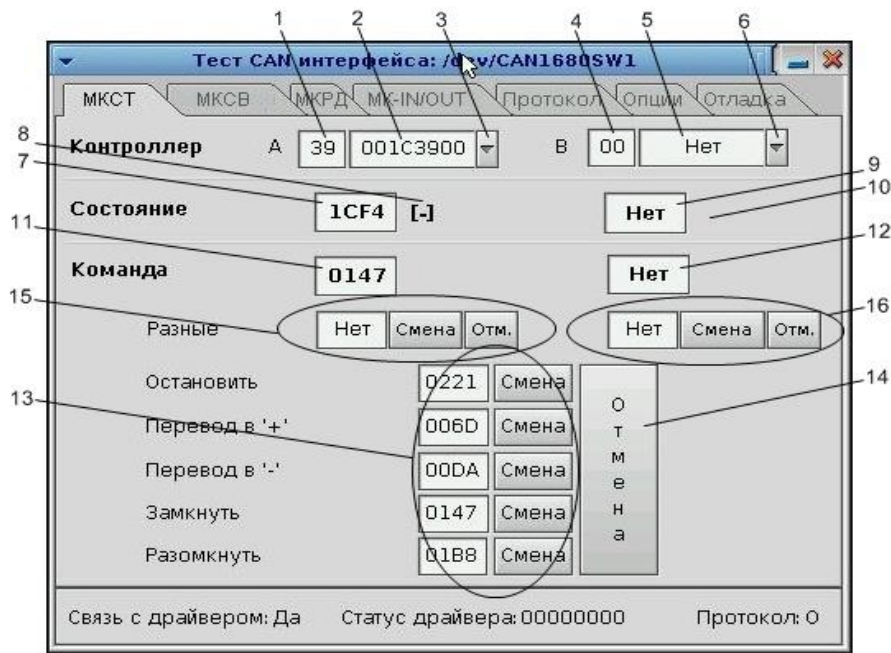


Fig. 5. User window of the “Test-CAN” program

When simulating, for example, a dangerous failure of channel B, which will be displayed in position (4), the specified state must be displayed by the technical diagnostics subsystem on the monitors of the DSP and SHN ARM workstations. Based on this correspondence, a conclusion is made about the proper operation of the subsystem (block “Indication of the proper operation of the technical diagnostics subsystem” in the block diagrams of Fig. 3 and 4).

Status of the procedure implementation in railway transport. The actual implementation of the developed procedure in the process of maintenance and repair of railway automation devices was carried out at a number of industrial railway transport stations equipped with the MPC-S system, including [7, 13 – 15]: “Peredacha-Donetsk” PrJSC “Donetskstal – Metallurgical Plant”, “Tranzitna” LLC “Dymyrovvanzhattrans”, “Poluhorky” PJSC “Yasynivskyi Coke Plant”, “Inzhenernaya” PrJSC “SK “Avlita” and “Vugilna” JSC “Zaporizhstal”. The most responsible is the application of the developed procedure at the “Poluhorky” and “Vugilna” stations, for which the MPC system can function in specialized technological modes of operation of the EC (non-routed maneuvers, fencing of rolling stock on station tracks, interaction with technological equipment of wagon pushers, etc.). In these modes, part of the functions for ensuring the safety of shunting operations is transferred from the POLZ to the IPC, therefore, more stringent requirements are imposed on the latter from the FB, which requires increasing the reliability of the functioning of their diagnostic subsystem [16].

Key words: microprocessor, signals, system, algorithms

CONCLUSION

The proposed procedure for periodic monitoring of the subsystem of technical diagnostics of the MPC and methods of its technical implementation allow to increase the reliability of the guaranteed detection of the pre-failure state of individual controllers before their dangerous failure occurs. This is achieved through timely verification and confirmation of the serviceability of the diagnostic subsystem within the framework of technical maintenance of the MPC during its operation. Further research in this direction consists in automating the process of performing the developed procedure and determining rational periods of its use.

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RECENT CHANGES IN TÜRKİYE'S BALANCE OF CURRENT ACCOUNTS AND EXPECTATIONS FROM BALANCE ON SECONDARY INCOME

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ABSTRACT

In this study, the current account deficit as related to the chronic structural problems of the Turkish economy is examined from the perspective of the secondary income balance, which is one of the basic components of this deficit. The main purpose of the study is to determine the place of the secondary income items (especially workers' remittances, donations, unrequited transfers and social aids) that directly or indirectly affect the formation of the current account deficit in the Turkish economy, to analyse the contribution levels of these items to the current account balance and to reveal the recent developments in this area. As is known, the current account deficit is one of the macroeconomic indicators that are of critical importance in terms of sustainability in a country's foreign economic relations, and in the case of Türkiye, this deficit takes place in the process by gaining concrete form in the form of an imbalance that increases the need for external financing and creates the need for external borrowing. The item in question includes elements that provide direct external resource inflows, such as workers' remittances abroad, social aid, donations, and grants. In particular, the fact that these transfers are "unrequited", that is, they occur without being dependent on any exchange of goods or services, creates a positive effect in terms of the current account balance. The approaches regarding the secondary income balance, which have a significant impact on reducing Türkiye's current account deficit, reveal that the changes experienced in this area over the recent period have made substantial contributions to the current account balance. In the process where the economic effects of the global pandemic became evident in the current account accounts in 2021 and beyond, the increase in donations, social aid, and remittances from abroad created a dynamic that strengthened Türkiye's foreign exchange reserves and diversified the resources available for financing the current account deficit.

Key Words: Current Accounts, Foreign Donations, Workers' Remittances, Secondary Income Balance, Unrequited Transfers.

JEL Codes: E44, E52, E62, E64.

1.INTRODUCTION

When the rapid growth targets adopted by the Turkish economy in recent years are evaluated together with some macroeconomic imbalances that sometimes contradict these targets, especially the simultaneous emergence of deficits in the current account balance and budget deficits, the issue of "twin deficits" has frequently come to the fore, and the acquisition of very low-cost external financial resources has once again been brought to the agenda. These twin deficits not only threaten the existing macroeconomic balances but also seriously increase Türkiye's external financing needs. In this context, the sustainable increase in foreign exchange revenues necessitates the creation of strategic options that will reduce external dependency. Social transfers, insurance compensation, humanitarian aid, and support from international organizations (such as the United Nations or European Union funds) have become essential sources of income, not only in macroeconomic terms but also in terms of social welfare (Cingano, 2014).

These income items, which are described as secondary income, have not only increased resilience against short-term crises, but also have the potential to create a secondary and complementary budget effect within public finances in the medium and long term, making the recent process inevitable, where impact values have come to the forefront more significantly based on current account balances. In this context, secondary income items—especially elements such as worker transfers from citizens living abroad, unrequited foreign exchange inflows, grants and aids—stand out as an important alternative in Türkiye's external financial resource structure (Gökçe et al., 2023). Incorporating these incomes into the economic structure will contribute to improving the current account balance and support fiscal discipline by reducing pressure on budget deficits. In addition, the foreign exchange supply generated by secondary incomes has the potential to enhance financial stability by mitigating exchange rate volatility.

When the impact of secondary incomes on current account deficits is evaluated, these incomes should be considered as a structural policy tool, as they are one of the sub-components in the balance of payments (Mankiw et al., 1992). Although these items are not directly controllable, Türkiye establishing more institutional relations with its global diaspora structure will enable the effective use of this potential. Foreign exchange transfers made by Turkish citizens living in Europe have strategic importance not only at the individual level but also at the public level. In addition, a secondary income strategy that can establish the expectations of market actors on a more solid basis in increasing transparency in Türkiye's balance of payments statistics and sharing the sources and balance characteristics of unrequited transfers with the public in detail,

strengthens the analysis of possible financial increases expected from the secondary income phenomenon on a macroeconomic basis by evaluating the place of secondary incomes in macroeconomic analyses more concretely (European Commission, 2016). To limit the vulnerabilities caused by Türkiye's externally dependent economic structure, secondary incomes are now considered as a priority objective not only as a short-term financing source but also as a long-term structural tool, and the phenomenon of secondary income comes to the forefront as a phenomenon that will make significant contributions to both achieving sustainable growth targets and strengthening macroeconomic stability, with the steps taken towards making it a structure that has become a strategic priority element in Türkiye's fiscal policies and has assumed a more prominent role within the current macroeconomic policy set (Akcigit et al., 2021).

2.THE POSITION OF THE SECONDARY INCOME ELEMENT IN TÜRKIYE AND THE CURRENT ACCOUNT DYNAMICS

In the Turkish economy, the current account is important as one of the basic indicators of the country's foreign economic relations. Although trade in goods and services and primary incomes are generally considered to be at the forefront among the items that make up this account, the impact of secondary incomes on both the current balance and their place in the macroeconomic context are increasingly drawing attention. In this context, the strategic importance of secondary incomes as a sub-item under the current account that has the nature of an unrequited transfer should be clearly emphasized. The increase in the number of Turkish citizens living abroad in recent years has increased the volume of Türkiye's secondary income items, while making the impact of these revenues on the current account balance more apparent. In particular, the increase in foreign exchange revenues and the regular channeling of these revenues to the country are in a position that cannot be ignored in partially meeting the foreign exchange needs of the Turkish economy (Pastor, 2022).

2.1. The Role of Secondary Income in Financing the Current Deficit in Türkiye: An Assessment of Alternative Resources

These alternative resources are increasingly gaining importance for Türkiye, which is among the developing countries. Among these alternative resources, the components of secondary incomes have a strategic importance in terms of their potential to increase the foreign exchange supply and reduce the pressure on financial institutions. Secondary incomes, unlike financial transactions such as direct investment, portfolio investment or borrowing, include unconditional transfers. When evaluated specifically for Türkiye, it is observed that such

transfers contribute to general economic stability through both the current account balance and the savings-investment balance (Akçay & Güngen, 2019).

Türkiye's tendency to have a structural foreign trade deficit makes the sustainability of the current account deficit an important topic of discussion. In this context, the contribution of secondary income to the financing of the current account deficit represents a cyclical phenomenon that has become a structural element. Within the framework of international definitions adopted by the European Union (EU) and the Organization for Economic Cooperation and Development (OECD), secondary income is systematically reported under the current account and is characterized as unilateral economic transfers. Türkiye has also been regularly reporting and analyzing this item for many years in line with this global definition system (Karaçimen, 2014). It is thought that these incomes serve as a kind of “economic buffer” in financing the current deficit; they increase financial resilience especially against possible economic crises at the global level. In the case of Türkiye, a significant portion of such incomes consists of remittances from citizens living abroad. In addition, grants, social assistance programs and disaster support provided by international organizations such as the European Union (EU) and the United Nations (UN) are also evaluated within this scope.

It is observed that secondary income sources have diversified in recent years:

- **Firstly**, external non-reciprocal transfers such as social projects, education and health investments and disaster aid carried out within the framework of EU and UN funds are noteworthy (European Commission, 2024).
- **Secondly**, international humanitarian aid provided through non-governmental organizations (NGOs) is also included in secondary income items and contributes to the strengthening of social support mechanisms in Türkiye. Such aid is especially important in terms of supporting disadvantaged groups and increasing social welfare.
- **Thirdly**, social transfers and retirement incomes are also among the secondary income items that are noteworthy for Türkiye. Retirement salaries and other social payments transferred to Türkiye by Turkish citizens who have retired abroad both contribute to household consumption and encourage foreign exchange inflows to the country. In this context, it is evaluated that external social transfers have positive effects on Türkiye's macroeconomic balances (Güngen, 2018).

Table 1 below provides up-to-date data on Türkiye's current account for the years 2023 and 2024. Through this table, the role of the secondary income item in the overall structure of the current account balance and its impact on the balance can be observed. However, the contribution of secondary incomes to the current account balance in Turkey is generally limited and it is understood that it is quite difficult to evaluate it as a structural solution tool. The data presented in Table 1 below for the years in question not only reflect the course of foreign

economic relations in the Turkish economy, but also allow for the analysis of the change in the contribution of secondary income to the current balance over time:

Table 1. Balance of Payments and Secondary Income Relationship in Türkiye (2023-2024)

Million USD	April			January-April		
	2023	2024	Change	2023	2024	Change
I- CURRENT ACCOUNT	-5,087	-5,285	-198	-29,671	-16,125	13,546
A. BALANCE ON GOODS	-7,122	-7,649	-527	-36,649	-22,102	14,547
B. BALANCE ON SERVICES	3,281	3,110	-171	10,790	10,310	-480
C. BALANCE ON PRIMARY INCOME	-1,306	-1,355	-49	-3,878	-4,669	-791
D. BALANCE ON SECONDARY INCOME	60	609	549	66	336	270
II- CAPITAL ACCOUNT	-8	-10	-2	-56	1	57
III- FINANCIAL ACCOUNT	-9,582	-5,622	3,960	-35,273	-31,109	4,164
Direct Investment	-813	-856	-43	-1,999	-1,141	858
Net Acquisition of Financial Assets	439	422	-17	1,865	1,613	-252
Net Incurrence of Liabilities	1,252	1,278	26	3,864	2,754	-1,110
Equity Capital	902	473	-429	1,871	1,267	-604
Inflow	931	477	-454	1,975	1,695	-280
Outflow	29	4	-25	104	428	324
Other Capital (Net)	118	353	235	391	239	-152
Real Estate (Net)	232	452	220	1,602	1,248	-354
Portfolio Investment	1,204	-2,023	-3,227	1,535	-5,780	-7,315
Other Investment	-3,100	-351	2,749	-13,654	922	14,576
Reserve Assets	-6,873	-2,392	4,481	-21,155	-25,110	-3,955
IV- NET ERRORS AND OMISSIONS	-4,487	-327	4,160	-5,546	-14,985	-9,439

As observed in Table 1 above, the effect of Secondary Income Items on the current account deficit in Turkey for the years 2023 and 2024 reveals that it is an important external balance indicator covering primary and secondary income items along with trade in goods and services. In this context, secondary incomes, especially for the Turkish economy, although often overlooked, can make positive contributions to the current account balance, albeit limited. When the data for the years 2023 and 2024 are examined, it is striking that the effect of secondary income items on the current account deficit is positive, albeit limited. When the data for 2023 is examined, it is seen that the secondary income balance has a surplus of approximately 60 million dollars as of April. Although this is considered a limited increase in the first months of the year, it has provided indirect relief in the financing of the current account deficit. On the other hand, according to the data for April 2024, it is evident that the surplus amount for the same item has reached approximately \$ 609 million.

This development represents an increase of approximately \$ 549 million compared to the same period in the previous year, corresponding to a significant rise of roughly 915%. It is thought

that seasonal and cultural factors are effective behind this increase. The periodic increase in foreign exchange transfers sent to Türkiye by Turkish citizens abroad, especially before religious holidays, has been a key factor in the rise of this item (CBRT, 2023). This situation not only positively affects the secondary income balance but also finds a place in the total current account as an indirect balancing element. However, it is important in terms of assuming a balancing role against short-term fluctuations. In fact, it can be said that the effect of such temporary and periodic incomes is not of strategic importance in the face of Türkiye's chronic current account deficit problem but has a function of relieving financial pressures. In summary, it is understood that secondary income items have created limited but measurable positive effects on the current account deficit in the Turkish economy during 2023 and 2024 in recent years. Considering that these items consist of elements that do not have a structural nature, such as foreign workers' remittances, but are important in terms of the economic cycle, it would be healthier to evaluate them as a short-term economic relief factor. For Turkey to achieve permanent improvements in its current account balance, more in-depth structural transformations are needed in the production structure and foreign trade balance (AIDA, 2022).

2.2. Main Components of Secondary Income Source in Türkiye and Periodic Alterations of Secondary Income Limits

In the Turkish economy, examining secondary income items, particularly in the period following 2010, is crucial for understanding the impact of these incomes on macroeconomic variables. In evaluating the effects of possible changes observed in this period, the variability limits that emerge to the values of secondary incomes should be carefully analysed. In emphasizing these income items, it is seen that secondary incomes, especially in subheadings such as remittances and international donations, contribute to the strengthening of economic ties within the financial structure of Türkiye and that the sustainability of this contribution increases (Atuk & Ozmen, 2009). This situation provides a critical analytical framework that enables the comparative evaluation of secondary incomes in relation to the level of economic development. Grants and donations obtained from international organisations, together with the fund inflows that are particularly notable in the post-disaster period, have necessitated a re-evaluation of the secondary income structure after 2010.

Such financial transfers support the economic balance not only during crisis periods but also on a structural level. In addition to foreign exchange transfers made by Turkish citizens from abroad, all secondary income items exhibit a variable variability that varies periodically (Çapan, 2024). This variability has become more evident, especially after 2023, as of April, and has gained a dimension that should be considered in macroeconomic analyses. Table 2 presented

below shows the amounts of worker remittances, one of the secondary income items, in the light of the said periodic evaluations, expressed in Million Dollars. Worker remittances hold a significant place in Turkey's secondary income structure and are considered of primary importance, both in terms of absolute size and economic impact. In this context, the volume of foreign exchange transfers sent to their country by Turkish workers working abroad draws attention in terms of their share in secondary incomes. The said remittance amounts can be followed in detail in Table 2:

Table 2. Periodic Values in Workers' Remittances Received by Türkiye (2010 - 2023)

Year	Remittances (Billion USD)
2010	7.6
2011	8.0
2012	8.3
2013	8.6
2014	9.0
2015	9.5
2016	10.0
2017	10.8
2018	11.3
2019	12.0
2020	12.6
2021	13.0
2022	13.5
2023	13.8

Source: World Bank (2023). Personal remittances, received (% of GDP) – Türkiye. <https://data.worldbank.org/indicator/BX.TRF.PWKR.DT.GD.ZS?locations=TR>, (Accessed May, 23.2025).

According to the data in Table 2 above, a continuously increasing trend has been observed in remittance inflows to Turkey since 2010. The remittance amounts, which were 7.6 billion USD in 2010, reached 13.8 billion USD by 2023. This situation represents an increase of approximately 82%. This increase shows that Turkey's labour force potential abroad and the economic contribution of this potential are increasing sustainably. In addition, the fact that remittances have increased continuously despite global economic fluctuations and regional crises during this period reveals how resilient and strategic this income item is for the Turkish economy. The fact that there was an increase in remittance inflows even in 2020, when the COVID-19 pandemic negatively affected global economic activities, is a clear indicator of this resilience. When evaluated in this context, remittances are not only an item that provides foreign exchange inflow, but also a fundamental variable that should be considered in the formation of

social and economic policies (Stock & Watson, 2016). Developing policies to increase secondary income in the coming period is of great importance in terms of meeting Turkey's external financing needs at lower costs and strengthening the financing structure of the current account deficit. It is also possible to follow the explanations we have analysed in Table 2 above as a process of variables in the following Graph 1:



Graphic 1. Variability of Remittance Values Received by Türkiye (2010 – 2023)

Source: World Bank (2023). Personal remittances, received (% of GDP) – Türkiye. <https://data.worldbank.org/indicator/BX.TRF.PWKR.DT.GD.ZS?locations=TR>, (Accessed May, 23.2025).

When Graph 1 above is considered as a Comparison of April 2023 and 2024, it is observed that the secondary income balance gave a surplus of 60 million dollars in April 2023. In the same period of 2024, the surplus in this item increased to 609 million dollars. This indicates an increase of 549 million dollars. In other words, in one year, there was an increase of approximately 915% in Türkiye's secondary income balance. Again, when Graph 1 is analysed as the January-April Period Analysis, the secondary income balance gave a surplus of only 66 million dollars in the January-April period of 2023. However, this figure reached 336 million dollars in the same period of 2024. Thus, there is an improvement of 270 million dollars in this four-month comparison. This increase also similarly indicates a structural or periodic revival in foreign exchange transfers. In this respect, the role of secondary income on the current balance, when the current account deficit in the same periods is considered, the total current account deficit was 5,285 million dollars in April 2024 and 5,087 million dollars in 2023. Despite the

deficit-generating effect of goods and primary income items, the restrictive effect of the secondary income item on this deficit is clearly seen. In particular, the fact that the secondary income surplus reached a remarkable level of 609 million dollars in April 2024 shows that this item compensated for approximately 11.5% of the current account deficit. Similarly, the secondary income surplus of 336 million dollars in the January-April 2024 period was an important factor that reduced the pressure on the current account deficit (CBRT, 2024).

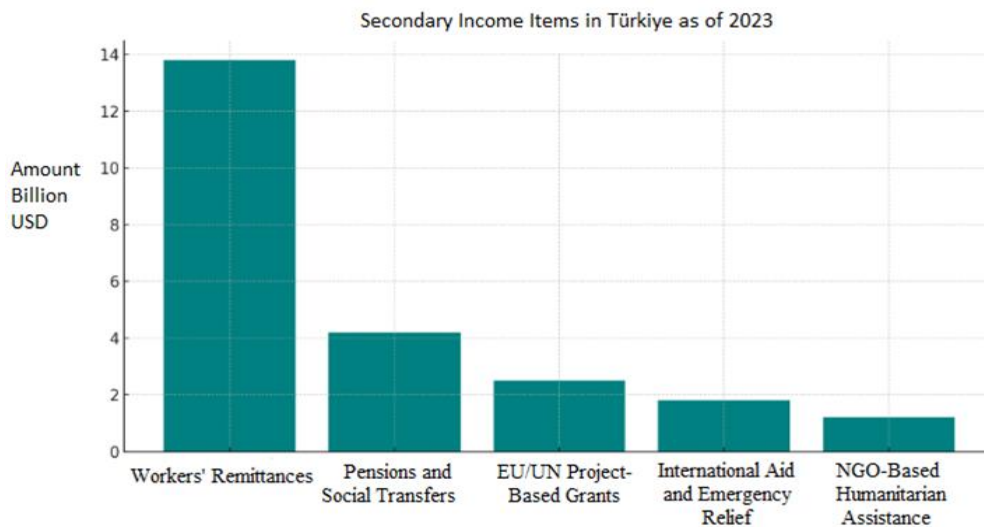
However, considering the position of secondary incomes, especially the evaluation of the years' history on this USD basis, is not sufficient only within the framework of the tables and graphs we have mentioned after 2010. It is also necessary to consider the same issue of secondary incomes, especially as the values that constitute its components. When the subcomponents of secondary income items are examined, revealing which items these incomes primarily consist of provides an important area of analysis in terms of the current account balance as well as macroeconomic evaluations in Turkey (Özüdoğru, 2023). In particular, the 2023 data revealed a remarkable change and trend in the structure of secondary incomes in Turkey, which necessitated a detailed analysis of these items. The re-evaluation of the items that stand out in secondary incomes as of 2023 is noteworthy in terms of emphasising the potential effects of this transformation on the current account balance and the importance it poses in terms of foreign exchange inflows and outflows (FDI, 2024). The distribution of the main elements constituting secondary incomes in real monetary value, USD, for 2023 has been an essential part of the political decision-making process. Table 3, presented below, shows the distribution of the relevant items as the main components of Turkey's 2023 secondary incomes in million US dollars and allows for a more concrete assessment of the components of secondary incomes:

Table 3. Main Components of Secondary Income to Türkiye (2023)

Component	Estimated Value (Billion USD)
Workers' Remittances	13.8
Pensions and Social Transfers	4.2
EU/UN Project-Based Grants	2.5
International Aid and Emergency Relief	1.8
NGO-Based Humanitarian Assistance	1.2

Sources: CBRT (2025). Balance of Payments Statistics - March 2025. Ankara: Central Bank of the Republic of Türkiye (CBRT) Data Governance and Statistics Department, 2025. Republic of Türkiye Ministry of Trade (2024). Economic Outlook December 2023. Ankara: Republic of Türkiye Ministry of Trade (RTMT), pp. 17-18; Presidency of the Republic of Turkey Strategy and Budget Presidency (2023). Pre-Accession Economic Reform Program 2023-2025. Ankara: Presidency of the Republic of Turkey Strategy and Budget Presidency, 2023; OECD (2023). OECD Economic Surveys: Türkiye 2023. Paris: OECD Publishing, 2023; World Bank (2022). Türkiye Climate and Development Report (CCDR). Washington, D.C.: World Bank, 2022.

As the primary income item of the secondary income components in Table 3 above, remittances (13.8 billion USD) stand out as the item with the highest share in secondary income. Remittances sent by Turkish citizens working abroad to their country account for approximately 59% of the country's total secondary income, reaching 13.8 billion USD in 2023. These monetary limit values clearly show the economic impact of Turkey's diaspora structure in Europe, which is concentrated in countries such as Germany, France and the Netherlands. Secondly, it reveals the secondary item transfers, which are the second largest item, as “Pension Salaries and Social Transfers (4.2 billion USD). These transfers, which consist of social security payments made to bank accounts in Turkey, especially by people who have lived abroad for a long time and retired, have generally found a place in the process as a result of individuals who have been included in the social security system in European countries continuing to live in Turkey or supporting their families (OECD, 2024). The graphical representation of the data regarding the components of the secondary income items presented in Table 3 allows for a more concrete and understandable evaluation of the analysis results. The Graphic 2 below visually presents the numerical values of the secondary income components in Table 3, thus providing a more holistic and comprehensible interpretation of the data:



Graphic 2. Secondary Income Amount as Foreign Remittance Amount in Türkiye as of 2023 (Billion USD)

Sources: CBRT (2025). Balance of Payments Statistics - March 2025. Ankara: Central Bank of the Republic of Türkiye (CBRT) Data Governance and Statistics Department, 2025. Republic of Türkiye Ministry of Trade (2024). Economic Outlook December 2023. Ankara: Republic of Türkiye Ministry of Trade (RTMT), pp. 17-18; Presidency of the Republic of Turkey Strategy and Budget Presidency (2023). Pre-Accession Economic Reform Program 2023-2025. Ankara: Presidency of the Republic of Turkey Strategy and Budget Presidency, 2023; OECD (2023). OECD Economic Surveys: Türkiye 2023. Paris: OECD Publishing, 2023; World Bank (2022). Türkiye Climate and Development Report (CCDR). Washington, D.C.: World Bank, 2022.

When Graph 2 is examined, the graphical distribution of the components of secondary income, particularly the fact that they are expressed in US Dollars (USD) on a quantity basis, reveals the structural importance of the income items in question. The graph visually reflects the quantitative dimensions of secondary incomes, making the place of these items in the Turkish economy more understandable. When these graphical data are considered together with the monetary distributions in Table 3, it enables a clearer assessment of the relative sizes of secondary incomes in the total. It establishes an analytical link between the graphic and table data. Thus, graphical representations provide not only a quantitative but also a qualitative assessment opportunity. According to the evaluations made on Graph 2, the secondary income groups in the Turkish economy have a size of approximately \$ 4.2 billion in terms of passive foreign exchange inflow. This situation reveals a significant foreign exchange inflow in the secondary income structure of the Turkish economy, indicating that this income can have considerable effects on macroeconomic indicators. The value of 4.2 billion USD is a secondary income component reflecting the passive foreign exchange input provided by this segment to the Turkish economy.

The third income component is EU and UN project-based grants, which are monetary transfers from international organizations such as the European Union and the United Nations. These project-based grants are transfers that provide significant financial contributions to Turkey, especially in areas such as development, migration management and environmental sustainability. In short, this item of \$ 2.5 billion is based on resources such as IPA funds and UN Development Program (UNDP) projects within the framework of EU-Turkey financial cooperation mechanisms, as well as grants provided by the EU within the framework of institutional migration policies, which constitute a significant part of this income contribution dynamic. In addition, “International Aid and Emergency Support” (1.8 billion USD) and “NGO-Based Humanitarian Aid (1.2 billion USD)” cover direct foreign aid provided to Turkey for extraordinary situations and are transfers made through approaches such as disasters, migration waves or humanitarian crises. The increase in this item in 2023 can be attributed to the funds directed to Turkey by the international community following the earthquakes centred in Kahramanmaraş. These funds contributed to the short-term economic balance and were also effective in increasing the humanitarian response capacity. The 1.2 billion USD worth of humanitarian aid directed to Turkey through civil society organisations is a small, but meaningful transfer provided by international NGOs (e.g. IFRC, MSF) and religious/foundation-based organisations. Such funds cover monetary values that come to the

fore in projects targeting migrant and refugee communities living in Türkiye's border regions (Açar & Yalçinkaya, 2023).

3.DISCUSSION

The current deficit has been on the agenda for many years as a structural issue in the Turkish economy. Factors such as a production structure dependent on foreign sources, a high share of energy imports, and low savings rates cause the current deficit to become chronic. In this context, financing the current deficit requires not only traditional external resources but also alternative financing channels. When evaluated within this framework, secondary incomes have far-reaching effects that extend beyond the current account deficit; they also have significant impacts, including increased savings, strengthened foreign exchange reserves, and enhanced financial stability. Therefore, it is evident that secondary incomes are a fundamental variable that should be considered in economic policies. In addressing the external imbalance issues of the Turkish economy, the inclusion of such factors in strategic planning is critically important for long-term stability.

Türkiye's current account balance has been in a structural deficit for many years, primarily due to foreign trade deficits in goods and primary income items, as well as imbalances in income transfers. In this context, the failure to meet global income expectations in foreign exchange is also considered a primary reason for these deficits. Inadequacies in exports of goods and low levels of foreign exchange reserves increase dependency on alternative resources to finance the current account deficit. In this context, it is evident that the secondary income item, particularly foreign exchange transfers made by individuals living abroad to Turkey, stands out as a significant source of financing. While the positive developments observed in secondary incomes contribute to limiting the deficits in the current account balance, the sustainability and adequacy of this contribution are issues open to various discussions (Ministry of Treasury and Finance, 2023).

The secondary income item, which has a limited structural capacity for generating income, struggles to provide a stable and robust solution for financing the current account deficit. Historically, labor migration from Türkiye to European countries has gained momentum since the 1960s, and this migration, which is concentrated primarily in Germany, Austria, the Netherlands, France and Belgium, etc., European countries, has reached a population of approximately 5 million Turkish workers. The remittances sent by this group continue to be an essential source of foreign exchange for Türkiye. According to Central Bank of the Republic of Türkiye (CBRT) data, the foreign exchange inflow was \$7.6 billion in 2010, and is expected to approach \$14 billion by 2025, clearly demonstrating the impact of workers' remittances on

the Turkish economy as secondary income. In the post-pandemic period, a significant increase has been observed in the support transfers of Turkish citizens living abroad to their families in Türkiye. Beyond supporting household incomes, these transfers also indirectly contribute to economic growth by sustaining domestic consumption dynamics. In this respect, it can be argued that secondary incomes not only reduce the need for external resources but also contribute to maintaining economic stability. On the other hand, projects financed by international organizations such as the World Bank and the United Nations also contribute to the increase in secondary incomes. Such a project supports areas such as agriculture, education, health and infrastructure, both encouraging local development and reducing Türkiye's external dependency in the long term. As a result, the importance of secondary incomes is increasing in terms of the sustainable financing of Türkiye's current account deficit. Effective evaluation of resources such as remittances, social assistance, retirement payments and international grants will not only increase the foreign exchange supply but will also contribute to reducing economic vulnerabilities and strengthening macroeconomic stability. In this context, monitoring and encouraging secondary incomes on an institutional basis will be a strategic step that will reduce Türkiye's dependency on external financing.

4.CONCLUSION

The secondary income item, which has a limited structural capacity for generating income, can be a solution for financing the current account deficit. Because these incomes are not directly based on production or trade, they are evaluated as short-term relief mechanisms rather than making a permanent contribution to economic growth and development. When the data for the period following the COVID-19 pandemic is examined, it is observed that the supportive effect of secondary incomes, especially in the form of remittances and international aid, on the current balance has increased significantly. Remittances, playing a crucial role in narrowing the current account deficit, sent by Turkish citizens living abroad have been a significant contributor to this item, . However, despite all these positive developments, it is difficult to say that the secondary income item has an absolute and constant effect on the current account deficit. Because the effect of this item varies largely depending on periodic and seasonal fluctuations. However, increases in secondary incomes serve as a “buffer mechanism” that reduces the need for external financing and, in this respect, play an important role in limiting the seasonal vulnerabilities of the financial system.

Strengthening the economic ties Türkiye has established with its diaspora abroad stands out as a strategic element that can increase the sustainability of secondary incomes. In this context, secondary income sub-items, such as overseas worker remittances and international grants and

donations, are of critical importance in terms of both providing foreign exchange inflows and supporting financial stability. Integrating these revenues into the financial structure and making them permanent is valuable not only for strengthening the current account balance but also for promoting general economic stability. The impact of the economic and financial transformations experienced in Turkey on secondary income items should be carefully analyzed. Because the fluctuations in secondary incomes directly affect not only the short-term financial statements but also the long-term external financing strategies. In this context, especially the institutionalization and encouragement of overseas worker remittances in economic terms, will contribute to establishing Turkey's economic ties on a more solid foundation at the international level. As a result, the secondary income balance is of strategic importance as an element that partially compensates for the vulnerabilities in Türkiye's current account balance and supports financial stability. However, ensuring the sustainability of this effect is not limited to analyzing current trends alone, but also requires policymakers to develop long-term strategic plans. In this context, institutional, diplomatic and economic initiatives to increase secondary incomes will contribute to Turkey building a more resilient financial structure against the current account deficit.

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RƏQƏMSALLAŞMANIN İNSAN AMİLİNİN SƏMƏRƏLİLİYİNİN ARTIRILMASINA TƏSİRİ

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XÜLASƏ

“Rəqəmsallaşmanın insan amilinin səmərəliliyinin artırılmasına təsiri” məqaləsində rəqəmsallaşma məsələləri araşdırılır, rəqəmsallaşmanın insan amilinin səmərəliliyinin artırılmasına təsiri, insan amilinin keyfiyyət komponentinin artırılması məsələləri. Rəqəmsallaşma indeksi bəzi ölkələr üçün də təhlil edilir. Qlobal proseslərin getdikcə mürəkkəbləşməsi insan amilindən istifadədə səmərəliliyin artırılmasına, ölkənin iqtisadi inkişafında davamlılığın və məhsuldarlığın artırılmasına kömək edən “bilik iqtisadiyyatı”nın inkişafı üçün şərait yaradılmasının məqsədə uyğunluğunu ortaya qoyur. Məlum olduğu kimi, rəqəmsallaşma mövcud və potensial resurslardan səmərəli istifadəyə şərait yaradır, əmək bazarında onların həyata keçirilməsi üçün bacarıq və bacarıqların inkişafı. Rəqəmsallaşma əmək bazarında rəqabət qabiliyyətini, texniki və texnoloji səmərəliliyi, məhsuldarlığı və performansını artırır.

Açar sözlər: rəqəmsallaşma, səmərəlilik, insan amili, iqtisadi artımın keyfiyyət komponenti, məhsuldarlıq.

THE IMPACT OF DIGITALIZATION ON INCREASING THE EFFICIENCY OF THE HUMAN FACTOR

ABSTRACT

The article "The Impact of Digitalization on Improving the Efficiency of the Human Factor" examines issues of digitalization, the impact of digitalization on improving the efficiency of the human factor, and issues of improving the qualitative component of the human factor. The digitalization index is analyzed for some countries. The increasing complexity of global processes reveals the advisability of creating conditions for the development of a “knowledge economy” that would contribute to increasing the efficiency of using the human factor, increasing sustainability in the country’s economic development and productivity. As is known, digitalization creates conditions for the effective use of existing and potential resources, the development of skills and abilities for their implementation in the labor market. Digitalization increases competitiveness in the labor market, technical and technological efficiency, productivity and performance.

Keywords: digitalization, efficiency, human factor, qualitative component of economic growth, productivity.

Giriş

Demək olar ki, rəqəmsallaşma təhsilin keyfiyyətini artırır, peşəkarlığı artırır, təhsilə investisiyanın artırılması, ixtisaslaşmanın genişləndirilməsi, cəmiyyətin sosial strukturunun dəyişdirilməsi, bərabər imkanlar prosesinin gücləndirilməsi (yəni inklüziv artım və inkişaf).

Məlumdur ki, insan amili təkcə göstərici deyil. İnsan amili göstəricisi ölkənin iqtisadi artım və inkişafının keyfiyyət komponentini, onun davamlılığı, səmərəliliyi, məhsuldarlığı və effektivliyi. Bu göstərici ölkənin iqtisadi inkişafında mövcud problemləri müəyyən etməyə, rəqəmsallaşma prosesi ilə yaranan problemlərin həllinə kömək edir, insan amilindən istifadənin səmərəliliyinin artırılması. Bəzi ölkələr üçün rəqəmsallaşma indeksini nəzərdən keçirək. (Cədvəl №1-ə baxın)

Ölkə (GDI)	Yer 2024	ölkə	Yer 2024
Azərbaycan	58	Türkiyə	87
Gürcüstan	72	Rusiya	43
Ukrayna	76	Belarusiya	31
Qazaxıstan	90	Finlandiya	4
Estoniya	18	Latviya	40
Sinqapur	2	Litva	22

* 1

Bu, dünyanın müxtəlif ölkələrində İKT-nin inkişaf səviyyəsinin müqayisəli təhlilidir. Beynəlxalq Telekomunikasiya İttifaqının (BTİ) məlumatına görə, Azərbaycan 2024-cü ildə 175 ölkə arasında 100-dən 80,4 indeksə (2023-cü ildə 76-cı yer) 58-ci yerdə qərarlaşıb. Ən yaxşı mövqelər Sinqapurdadır – 2-ci yer, Finlandiyada – 4-cü yer. Azərbaycanda aşağıdakılar inkişaf etdirilir:

e-hökumət (2024-cü ildə 74-cü yer) – onlayn xidmətlərin, telekommunikasiya infrastrukturunun və insan kapitalının təkmilləşdirilməsi;

- mobil rabitə – mobil rabitə indeksi 69,33 bal (inkişaf etmiş qrup)

- “Onlayn Azərbaycan” layihəsi çərçivəsində 2,9 milyon ev təsərrüfatı və biznes yüksəksürətli internetə çıxışla təmin edilib, kənd təsərrüfatı texnologiyaları sahəsində startapların sayının artması, İKT sahəsində kadrların hazırlanması üçün yeni təhsil proqramlarının tətbiqi və s. İKT sektorunun gəlirləri ÜDM-də 1,8% payla (2023-cü ildə – 1,7%) olmaqla 3,2 milyard manat təşkil edib. Bunun nəticəsidir ki, biznesin rəqəmsallaşması fəal şəkildə inkişaf edir, innovasiya və texnoloji tərəqqi üçün əlverişli şərait yaradır.

Rəqəmsallaşma indeksində prioritet Sinqapur, Danimarka, Finlandiya, Koreya Respublikası, Yeni Zelandiya, İslandiya, İsveçrə, Böyük Britaniya, Yaponiya, ABŞ və Honq-Konqa (Çin) məxsusdur. Rəqəmsallaşma indeksində prioritet Sinqapur, Danimarka, Finlandiya, Koreya Respublikası, Yeni Zelandiya, İslandiya, İsveçrə, Böyük Britaniya, Yaponiya, ABŞ və Honq-Konqa (Çin) məxsusdur. Finlandiyada kiçik və orta müəssisələrin 85,6%-i rəqəmsal yetkinliyin əsas səviyyəsinə malikdir (Aİ orta göstəricisi 57,7%-dən yuxarı). Estoniyada rəqəmsal xidmətlərin 98,9%-i biznes üçün əlçatandır. Latviyada bizneslərin 48,2%-i rəqəmsallaşmanın əsas səviyyəsinə malikdir (AB orta göstəricisindən 57,7%-dən aşağı). Litvada bizneslərin 53,5%-i bulud texnologiyaları, süni intellekt və kontaktsiz texnologiyalardan istifadə edir.

Bütün bunlar rəqəmsal texnologiyaların hərtərəfli və sistemli tətbiqinin mümkünlüyünü ortaya qoyur. Rəqəmsal texnologiyaların hərtərəfli və sistemli tətbiqi və rəqəmsallaşma prosesi real nəticələr yaradır, səmərəli və məhsuldar. Bu, rəqəmsallaşma prosesinin texniki və texnoloji dəyişikliklərin tətbiqi ilə iqtisadi transformasiyaya təkan verməsinin nəticəsidir. Odur ki, elm və təhsil əlaqələrini gücləndirməklə iqtisadiyyatın inkişaf etmiş ölkələrdən geri qalma səviyyəsini və texniki-texnoloji asılılığını azaltmaq vacibdir. Elmi tədqiqatların və təcrübələrin dəstəklənməsi, təhsilin səviyyəsinin yüksəldilməsi və elmi nailiyyətlərin iqtisadiyyatda tətbiqinin səmərəliliyinin artırılması elmlə təhsil arasında əlaqələrin möhkəmlənməsinə kömək edir. İndiki vaxtda elmə tam tələbat yoxdur ki, bu da rəqəmsal transformasiya prosesini çətinləşdirir. Rəqəmsallaşma prosesi insan amilinin səmərəliliyinin artırılmasına öz təsirini göstərir. Bu təsirin əsas xüsusiyyətlərini aşağıdakı kimi qeyd etmək olar:

- avtomatlaşdırma prosesi analitik və yaradıcı fəaliyyətlərə vaxt ayırmağa, insan amilindən daha yaxşı və səmərəli istifadə etməyə kömək edir;
- təkmilləşdirilmiş koordinasiya və şəffaflığın artırılması effektiv işçiləri müəyyən etməyə və yatırılan işin real qiymətləndirilməsini təmin etməyə kömək edir;
- rəqəmsallaşma rabitənin sürətini və keyfiyyətini artırmağa kömək edir;
- E-Learning platformaları və süni intellekt fərdiləşdirilmiş təlim, təlim və təkmilləşdirmə kursları üçün zəmin yaratdığından təlim və inkişafın fərdiləşdirilməsi prosesinin artması;
- süni intellekt və maşın emal imkanlarından istifadə etməklə böyük həcmdə məlumatı təhlil etmək və mövcud problemlərin həlli, işçilərin iş yükünün azaldılması üçün real təkliflər vermək mümkündür;
- iş prosesinin çevikliyi artır (uzaqdan iş, çevik iş qrafikləri, rəqəmsal texnologiyalardan istifadə) və iş və şəxsi vaxt, şəxsi həyat arasında tarazlıq yaxşılaşır (bu, hazırda problemdir);

- işçilərin işə cəlb edilməsi və motivasiya səviyyəsinin artması onların işindən məmnunluq səviyyəsinə kömək edir.

Rəqəmsallaşma xidmətlərin rəqəmsal formatda ixracını asanlaşdırır. Məsələn, 2023-cü ildə rəqəmsal formatda beynəlxalq xidmətlərin ixracının payı belədir: Azərbaycanda - 1,4 min dollar, Qazaxıstanda - 2,4 min dollar, Belarusda - 3,5 min dollar, Finlandiyada - 24,4 min dollar, Estoniyada - 6,3 min dollar, Litvada - 7,3 min dollar, Türkiyədə - 13,3 min dollar, Ukraynada - 13,9 min dollar. (məlumat [360.worldbank.org/en/indicator UNCTAD](https://360.worldbank.org/en/indicator/UNCTAD)) 2025-ci ilin sonuna qədər təxminən 3,85 milyon insan rəqəmsal ödənişlərdən istifadə edəcək. Əsas nailiyyətlərdən biri Azərbaycan Mərkəzi Bankının rəqəmsal ödənişlər strategiyası çərçivəsində hazırlanmış Ani Ödəniş Sisteminin (IPS) tətbiqi olub. (2) “Azərbaycan Respublikasında Rəqəmsal İnkişaf Konsepsiyası” ölkə Prezidentinin 16.01.2025-ci il tarixli Fərmanı ilə təsdiq edilmişdir, “Dövlət idarəçiliyinin təkmilləşdirilməsi, iqtisadi inkişafın sürətləndirilməsi və rəqəmsal texnologiyalardan istifadə vasitəsilə həyat keyfiyyətinin yaxşılaşdırılması” məqsədi daşıyır. (3)

Rəqəmsallaşma əmək məhsuldarlığının 20-40% artırılmasını təmin edir, xidmətlərin qəbulu müddəti 3 gündən 109 dəqiqəyə qədər azaldılır (ASAN xidmətlər). “2025-ci ildə Azərbaycan insan kapitalının inkişafı, innovasiyaların təşviqi və smart yanaşmaların tətbiqi kimi əsas sahələr üzrə 51 əsas təşəbbüsü özündə əks etdirən hərtərəfli rəqəmsal iqtisadiyyatın inkişaf strategiyasına start verməyi planlaşdırır. Onun həyata keçirilməsi çərçivəsində Azərbaycan üçün prioritet olan rəqəmsal iqtisadiyyatın və ekosistemin dayanıqlı inkişafının qiymətləndirilməsi və təmin edilməsi üçün tədqiqat və təhlillər aparılacaq”, - Nəcəfli qeyd edib.(4) Rəqəmsallaşma insan kapitalının inkişafının mənbəyinə çevrilir, lakin müəyyən problemlər var. Bunlara gənclər və yaşlılar arasında rəqəmsal bacarıqlar sahəsində mövcud boşluq və ucqar ərazilərdə İKT-yə qeyri-bərabər çıxış daxildir. Odur ki, məktəb kurikulumuna rəqəmsal platformaların geniş şəkildə daxil edilməsi, tibb, təhsil, sosial xidmət sahələrində süni intellektdən istifadə edilməsi, rəqəmsal savadlılıq kurslarının əhəmiyyətinin artırılması vacibdir.

Nəticə.

Nəticə olaraq qeyd etmək olar ki, rəqəmsallaşma təkcə səmərəliliyin artırılmasına kömək etmir, həm də insan amilinin (icraçı - novator) transformasiyası və insan kapitalının artımı prosesinə kömək edir. Qeyd etmək lazımdır ki, müsbət hadisələrlə yanaşı, mənfi hallar da müəyyən edilir. Bunlar rəqəmsallaşmanın bir hissəsi olan iqtisadiyyatın rəqəmsal transformasiyası prosesində nəzərə alınmalı olan risklərdir. Rəqəmsallaşma bahalı resurslar növlərindən biridir (maliyyə, insan, maddi, innovativ). Transformasiya prosesində rəqəmsallaşma resursları – İKT, idarəetmə sistemi, istehsalat, elm və təhsilin mövcud və

potensial insan potensialının gücləndirilməsinə və aşkarlanmasına təsiri müəyyən edilir. Buna görə də davamlılıq və effektivliyi artırmaq, elmi bilik və mövcud bacarıqlarla birləşən insan amilinin səmərəliliyini artırmaq, çeviklik və real proseslərə uyğunlaşmaq üçün rəqəmsallaşma prosesinin inkişafı və şaxələndirilməsi prosesində yaranan risklərin nəzərə alınması vacibdir. Rəqəmsallaşmanın inklüzivlik olmadan və ya aşağı səviyyədə inkişafı işçiləri perspektivsiz qoyur və inkişafın davamlılığını azaldır.

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JAPANESE SOX VERSUS AMERICAN SARBANES-OXLEY ACT**Associate Professor, PhD. Iffet KESIMLI**

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ORCID ID: 0000-0002-2082-5515**ABSTRACT**

Japanese Financial Instruments and Exchange Law is considered as the Japanese version of Sarbanes-Oxley Act of United States (SOX), and is called J SOX. This study makes a comparison between J SOX and original SOX. For the sake of the comparison Japan's and United States of America's (US) GDPs, stock markets' situations, the organizations they have like SEC, SESC, and PCAOB are handled. Since the main focus is J SOX; emphasis is given to Japanese position. The findings suggest that stock market depth and breadth of Japan is not less than US's. In Japan, the market capitalization in the Stock market is projected to reach USD6.30 trillion in 2025; projected total amount of USD6.32 trillion by 2026. The market volume in the Stock market the United States amounts to USD11.36 trillion in 2025. Market cap of US stock exchange is USD28.33 trillion as of July 2024. US GDP is 6.5 times of the GDP of Japan. However, regarding the market capitalization in the Stock markets, the ratio drops to 4.50. However, Japan has lived less accounting scandals and/or fraudulent cases than US. As conclusion it can be said that Japanese oversight looks like to be efficient enough to protect the markets.

Keywords: J-SOX, SOX, comparison, stock markets, fraud.

JAPON SARBANES-OXLEY YASASI İLE AMERİKAN SOX KARŞILAŞTIRMASI**ÖZET**

Japon Finansal Araçlar ve Borsa Yasası, Amerika Birleşik Devletleri Sarbanes-Oxley Yasası'nın (SOX) Japon versiyonu olarak kabul edilir ve J SOX olarak adlandırılır. Bu çalışma J SOX ile orijinal SOX arasında bir karşılaştırma yapmaktadır. Karşılaştırma amacıyla Japonya ve Amerika Birleşik Devletleri'nin (ABD) GSYİH'leri, borsa piyasalarının durumları, SEC, SESC ve PCAOB gibi sahip oldukları organizasyonlar ele alınmıştır. Ana odak J SOX olduğundan; Japonya'nın durumu vurgulanmıştır. Bulgular, Japonya'nın borsa derinliğinin ve genişliğinin ABD'den daha az olmadığını göstermektedir. Japonya'da, Borsa'daki piyasa değerinin 2025 yılında 6,30 trilyon ABD dolarına ulaşması; 2026 yılına kadar toplam 6,32 trilyon ABD doları olması öngörülmektedir. ABD Borsa'sındaki piyasa hacmi 2025 yılında 11,36 trilyon ABD dolarıdır. ABD borsasının piyasa değeri Temmuz 2024 itibarıyla 28,33

trilyon ABD dolarıdır. ABD GSYİH'si Japonya GSYİH'sinin 6,5 katıdır. Ancak, Borsa'daki piyasa değeri açısından oran 4,50'ye düşmektedir. Ancak Japonya, ABD'den daha az muhasebe skandalı ve/veya dolandırıcılık vakası yaşamıştır. Sonuç olarak, Japon denetiminin piyasaları korumak açısından yeterince etkili olduğu söylenebilir.

Anahtar kelimeler: J-SOX, SOX, karşılaştırma, borsa piyasaları, dolandırıcılık.

INTRODUCTION

Japanese Financial Instruments and Exchange Law is considered as the Japanese version of Sarbanes-Oxley Act of United States (SOX), and is called J-SOX. Even though Australia, Canada, United Kingdom, Netherlands, Germany, and Italy are said to have SOX equivalents; this is not the exact case. Situation determination regarding the countries mentioned follows.

Australia: The statutory bodies responsible for developing standards and monitoring and enforcing the financial reporting requirements of the Corporations Act are created under the Australian Securities and Investments Commission Act 2001 (ASIC Act). These bodies include Australian Securities and Investments Commission (ASIC), the Financial Reporting Council (FRC), Australian Accounting Standards Board (AASB), Auditing & Assurance Standards Board (AUASB), and the Companies Auditors Disciplinary Board (CADB). The role of the non-statutory body, the Accounting Professional and Ethical Standards Board (APESB) is also illustrated, as are the previously mentioned bodies, in the Appendix 2 ([ParliamentAustr](#)). From the legislation it is understood that Australia does not have a direct equivalent of SOX.

Canada: Under the Securities Act (Alberta), the Alberta Securities Commission (ASC) recognized the Canadian Public Accountability Board (CPAB) as an auditor oversight organization on July 22, 2022. CPAB is an independent oversight body for public accounting firms that audit financial statements of reporting issuers. The purpose of CPAB's oversight activities is to promote high quality external audits of reporting issuers. It is responsible for developing and implementing an oversight program that includes regular inspections of participating audit firms. CPAB's primary means of assessing the quality of audits is through the inspection of selected high-risk sections of audit files and elements of a participating audit firm's system of quality control ([Alberta](#)). From the legislation it is openly understood that Canada has the counterpart of PCAOB. Furthermore, **Bill 198, Keeping the Promise for a Strong Economy Act (Budget Measures), 2002** is also called as **C-SOX**. All businesses that are publicly listed in Canada are required to comply with C-SOX. Not very different from its American counterpart SOX, Bill 198 or C-SOX, requires organizations to spend money on

compliance with legislation (www.ola.org). Again, from Bill 198 it is openly understood that Canada has its own SOX.

United Kingdom: The 2018 Corporate Governance Code (the Code) was updated in January 2024 following a consultation which concentrated on a limited number of changes. The 2024 Code was said to apply to financial years beginning on or after 1 January 2025. The 2018 Code remains in place until then. Provision 29 will apply to financial years beginning on or after 1 January 2026 (www.frc.org.uk). Le Mare (2025) summarizes: (1) 2018 Kingman review offered guidance about external audits and internal controls, (2) the 2019 Brydon report outlined the overarching need for audit to be transformed into a service that meets the expectations of UK stakeholders, increases accountability for directors and introduces new rigor and suspicion to the qualities of auditing, (3) Department for Business, Energy & Industrial Strategy (BEIS) whitepaper laid out which firms would be impacted and indicated that directors would need to conduct an annual review of their internal control effectiveness and new disclosures, and that external audits will be allowed if it is determined that extra assurance would be proportionate, (4) an Auditing, Reporting & Governance Authority (ARGA) is going to be established to replace the existing Financial Reporting Council (FRC) and that this new organization will be sharing *best practices* for businesses to follow (Le Mare, Feb 7, 2025). From here, it is understood that UK-SOX is already partly in action.

Netherlands: Committee of European Auditing Oversight Bodies has sub-groups, the members of which are given in Appendix 1. According to its lists, Netherlands Authority for the Financial Markets (AFM) is responsible for international equivalence & adequacy, auditing standards, enforcement (observation only), and inspections. From here it is understood that Netherlands does not have her own SOX.

Germany: Auditor Oversight Body (AOB) is the equivalent of PCAOB. Like the other European Union EU) countries, Germany follows EuroSox, the components of which are listed below (www.complianceonline.com):

1	FSAP	The European Union's Financial Services Action Plan
2	78/660/EEC	The 4th directive Annual Accounts of specific type of companies
3	83/349/EEC	The 7th directive Consolidated accounts
4	84/253/EEC&2006/43/EC	The 8th directive of Company Law 1984 and 2006
5	2001/34/EC	The Consolidated Admissions and Reporting directive (CARD)
6	2004/109/EC	The Transparency directive
7	1989/592/EEC	The Insider Dealing directive
8	2003/6/EC	The Market Abuse directive
		The interaction between EU directives and other regulatory initiatives

Italy: Committee of European Auditing Oversight Bodies has sub-groups, the members of which are given in Appendix 1. According to its lists, Italy's Commissione Nazionale per le Società e la Borsa (CONSOB) is the public authority responsible for regulating the Italian financial markets. Its activity is aimed at the protection of the investing public. In this connection, the CONSOB is the competent authority for ensuring transparency and correct behavior by financial market participants; disclosure of complete and accurate information to the investing public by listed companies; accuracy of the facts represented in the prospectuses related to offerings of transferable securities to the investing public; compliance with regulations by auditors entered in the Special Register. It conducts investigations with respect to potential infringements of insider dealing and market manipulation law (www.consob.it). From here it is understood that Italy does not have her own SOX.

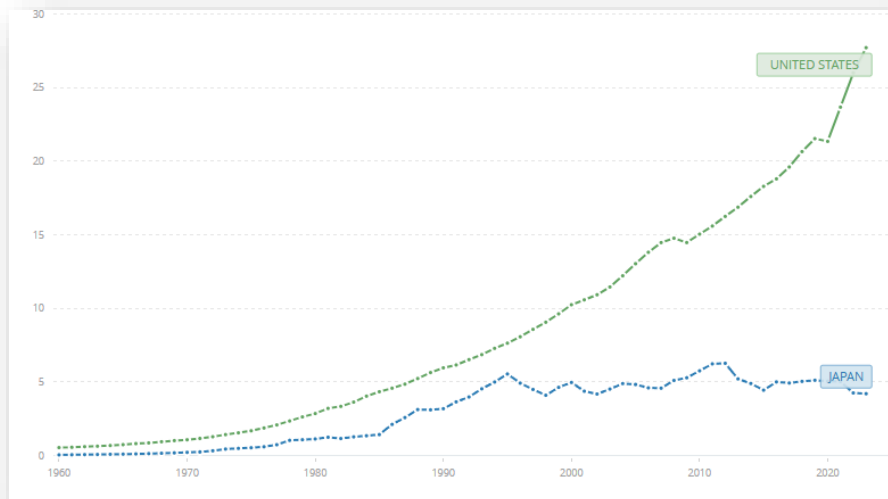
Australia and United Kingdom are Anglo-Saxon examples; where Germany, Italy, and Netherlands are Continental European samples. Canada is usually put aside than Anglo-Saxon countries, just because it also carries effects of France, which in fact is an EU country. When academia talks about business world, the way to make business, i.e. the style; it usually mentions this way: (1) the Anglo-Saxon World, (2) the Continental Europe & Japan, and (3) Canada. Japan is usually known as a country of responsibility, respect, and honesty. These may be clichés; but the resemblance of pre-80s' Türkiye to Japan, and deep gaps between US and Japan inspired this research. In order to shed light for future Turkish steps in legislation based on the similarity mentioned above, this study makes a comparison between J-SOX and original SOX.

THE STATE OF THE STOCK MARKETS IN JAPAN AND US

In this section Japanese and US stock markets are compared. Financial markets are the core to the businesses and SOX act followed collapses in the financial markets. Therefore, such a comparison is justified. Once the states of both stock markets are observed, J-SOX will follow. In Japan, the market capitalization in the Stock market is projected to reach USD6.30 trillion in 2025. It is expected to show an annual growth rate (Compound Annual Growth Rate CAGR 2025-2026) of 0.37%, resulting in a projected total amount of USD6.32 trillion by 2026 (www.statista.com). The market volume in the Stock market the United States amounts to USD11.36 trillion in 2025. Market cap of US stock exchange is USD28.33 trillion as of July 2024 (www.statista.com). Market depth refers to the ability of the market to sustain a substantially larger order without making an impact on the security's market price. It also refers to the number of shares of a given company that may be purchased without creating a significant level of price appreciation of the particular stock. Market breadth refers to how many stocks

are participating in a market move, while market depth refers to the number of buy and sell orders at different prices for a given stock (Hayes, 2022).

Gross Domestic Product (GDP) of Japan is 4.26 Trillion USD as of 2023, and GDP of US is 27.72 Trillion USD as of 2023 (Worldbank). Graph 1 displays both countries' GDPs.

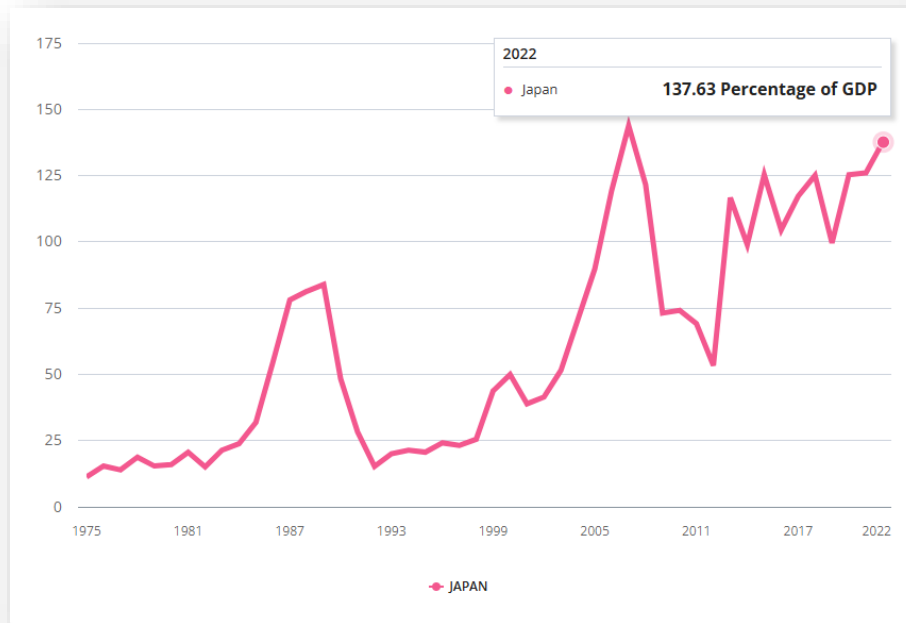


Graph 1. GDP (current USD) Japan

Source: Worldbank (26.05.2025).

https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?contextual=default&end=2023&locations=JP-US&name_desc=false&start=1960&view=chart

The comparison of GDP of Japan and US, shows that US GDP is 6.5 times of the GDP of Japan. However, regarding the market capitalization in the Stock markets, the ratio drops to 4.50. Stocks traded, total value as percentage of GDP of both countries are given in Graph 2 and 3.

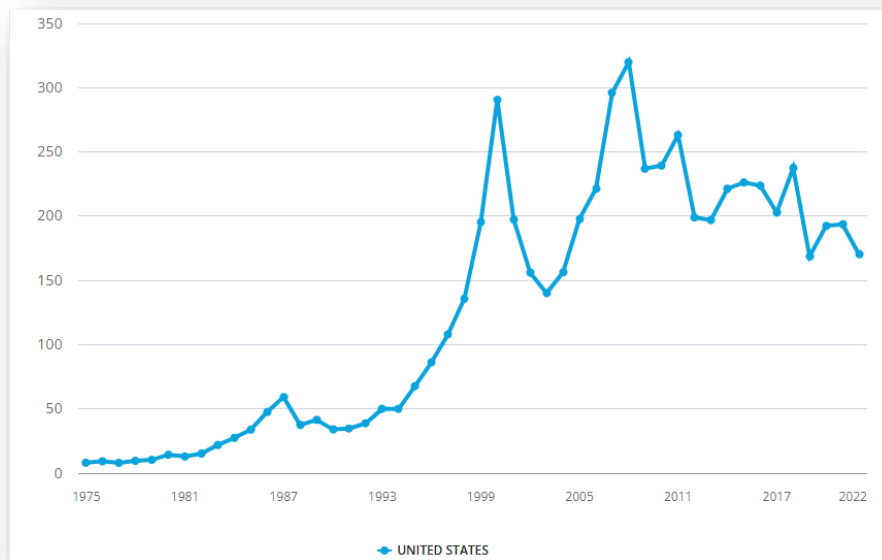


Graph 2. Stocks traded, total value (% of GDP) Japan

Source: Worldbank (26.05.2025).

https://data360.worldbank.org/en/indicator/WB_WDI_CM_MKT_TRAD_GD_ZS?view=trend&country=JPN

Stocks traded in US makes 170.40% of GDP) US as of 2022; the ratio for Japan is 137.63%.

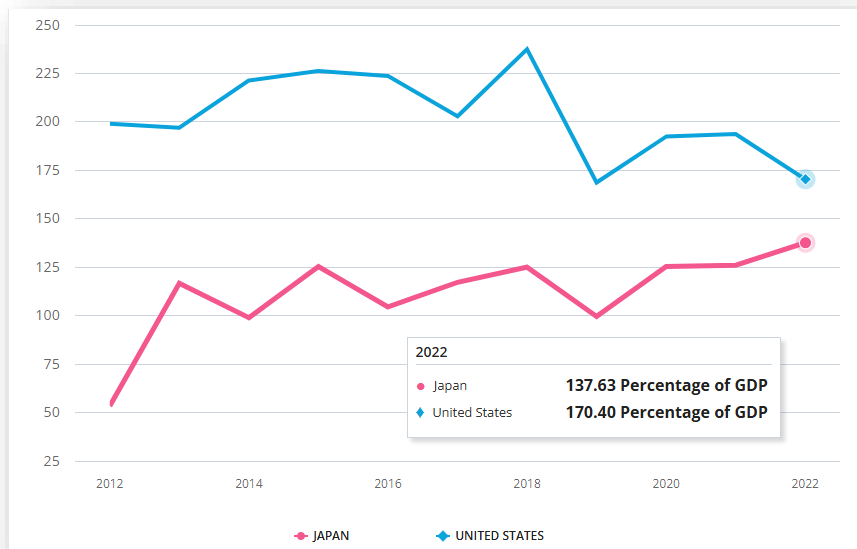


Graph 3. Stocks traded, total value (% of GDP) US

Source: Worldbank (26.05.2025).

https://data360.worldbank.org/en/indicator/WB_WDI_CM_MKT_TRAD_GD_ZS?view=trend&country=USA

When the last decade is taken into consideration, the two countries' stocks traded as percentage of GDP are displayed in Graph 4.

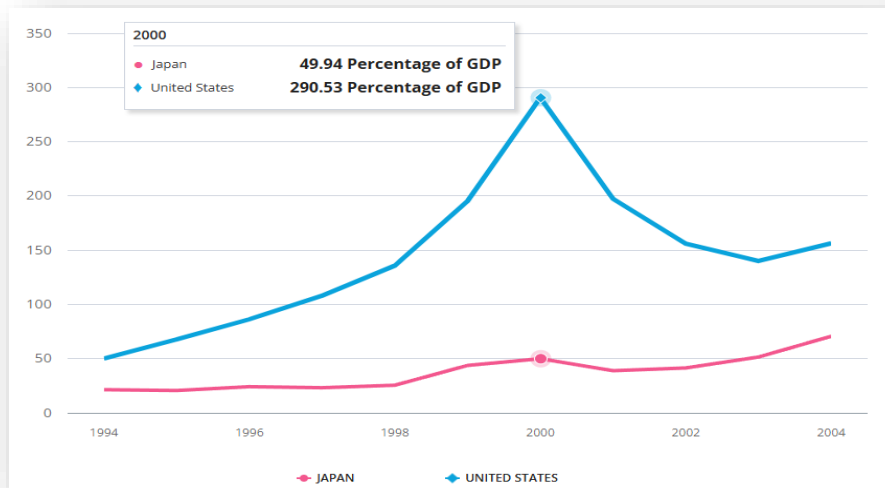


Graph 4. Stocks traded, total value (% of GDP) US and Japan 2012–2022

Source: Worldbank (26.05.2025).

https://data360.worldbank.org/en/indicator/WB_WDI_CM_MKT_TRAD_GD_ZS?view=trend&country=USA%2CJPN&minYear=2012

Graph 5 displays pre- and post-Enron era. In 2000, there is a very striking gap between US and Japanese stock traded as percentage of GDP; 290.53% of GDP for US, and 49.94 % of GDP for Japan. It functions as the harbinger of the bubble that will burst. One of the rare Japanese events—tax evasion by reporting fictitious costs for company software of Gainax from 1996 to 1999 is also observed in Graph 5. Year 1998 also has an importance, because there has been a fracture of the ratio, which was around 20% and jumps to percentages around 40. The peak for Japan was reached in 2007 with 143.80% of GDP; where US reached its peak next year with 319.88%. As well-known, 2007–2008 is the time span when global financial crisis burst out.

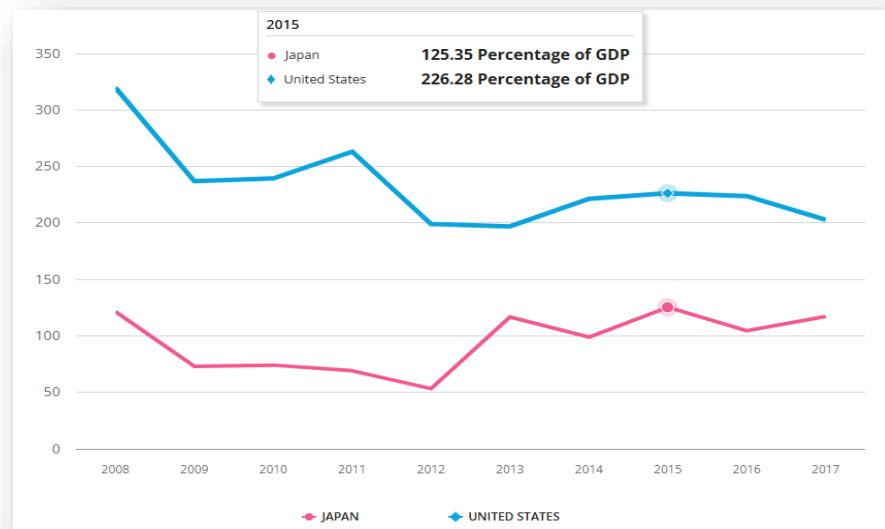


Graph 5. Stocks traded, total value (% of GDP) US and Japan 1994–2004

Source: Worldbank (26.05.2025).

https://data360.worldbank.org/en/indicator/WB_WDI_CM_MKT_TRAD_GD_ZS?view=trend&country=USA%2CJPN&minYear=1994&maxYear=2004

Graph 6 is generated in order to display the position of the stocks traded in an era when Japanese Toshiba (2015) and Olympus (2011) scandals are lived. The rate of Japanese stocks to GDP was 69.15% in 2011, and 125.35% in 2015. There is no data available for 2024, when Tokyo stock market crashed on Aug 5.

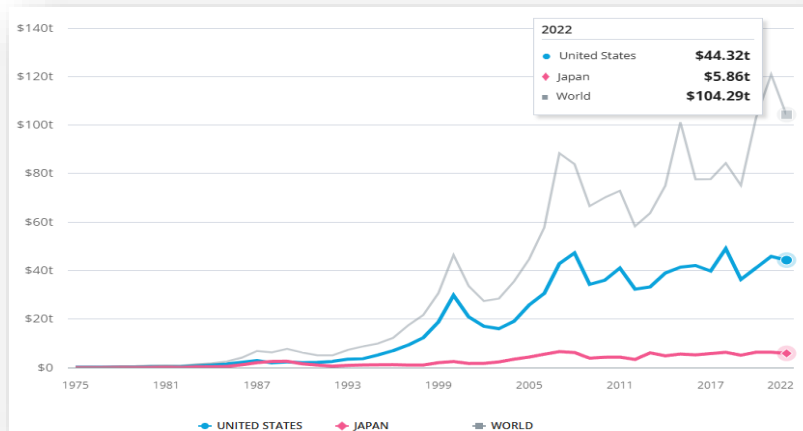


Graph 6. Stocks traded, total value (% of GDP) US and Japan 2008–2017

Source: Worldbank (26.05.2025).

https://data360.worldbank.org/en/indicator/WB_WDI_CM_MKT_TRAD_GD_ZS?view=trend&country=USA%2CJPN&minYear=2008&maxYear=2017

As seen from the Graph 7, US with 44.32 Trillion USD, composes 42.50% of the World stocks traded in dollars in 2022; Japan does 5.62%.

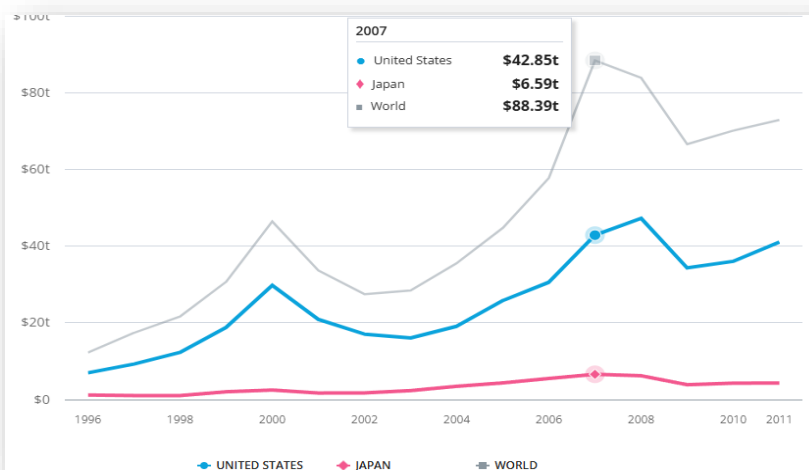


Graph 7. Stocks traded, total value current USD) US, Japan, and the World 1975–2022

Source: Worldbank (26.05.2025).

https://data360.worldbank.org/en/indicator/WB_WDI_CM_MKT_TRAD_CD?view=trend&average=global&country=USA%2CJPN

Graph 8 on the other hand, displays the position of the two countries in the global crisis era and Enron era. In 2007, when the global financial crisis became known by everyone in the world, 48.48% of the world stock trade was done by US and 7.46% by Japan. From this data it is understood that Japan's share dropped between these years. So did US's share. In 2007 China had a share of 7.14%, which rose to 31.12% in 2022.



Graph 8. Stocks traded, total value current USD) US, Japan, and the World 1996–2011

Source: Worldbank (26.05.2025).

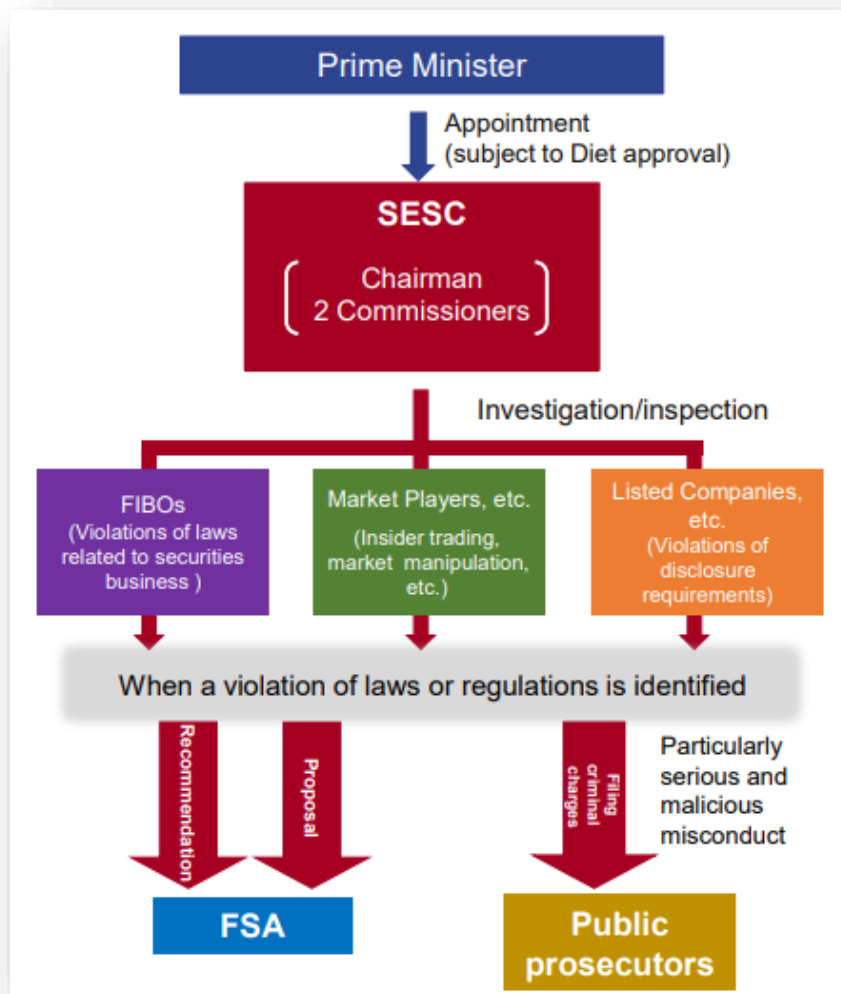
https://data360.worldbank.org/en/indicator/WB_WDI_CM_MKT_TRAD_CD?view=trend&average=global&country=USA%2CJPN&minYear=1996&maxYear=2011

In a list of stock market crashes and bear markets (en.wikipedia.org, 2025), there are 21 American originated crashes, and two Japanese ones. List of biggest accounting scandals (en.wikipedia.org, 2025) bears 59 American originated scandals and three Japanese ones. List of major corporate collapses (en.wikipedia.org, 2025) has 24 American originated collapse; Japanese—none. There may be overlapping instances; when the total of all categories disregarding the overlaps—if any—is taken, it makes 104 American cases vs. five Japanese cases. In three lists there are 225 cases in total. This means American cases make 46.22% of all cases. Is this domination to be explained by the quality of transparency of American system; by the effectiveness of monitoring and oversight; by the sensitivity of the stakeholders; by the depth and breadth of the stock markets; or the health of the system? If these hypotheses are to be accepted, then it is to be reversed for the Japanese system. The Japanese system is opaque; monitoring and oversight are not effective; stakeholders are insensitive; the stock markets are narrow and shallow; or the system is unhealthy. Another hypothesis would be the cultural differences; may be they live it and don't let it out of the room. Each one of these hypotheses opens a chapter for comparative studies in the future—some might have already been conducted. GDP comparisons and the depths and breadths of both stock markets prove that Japan is not a tiny country to bite. Instead, it deserves to be compared with US. The question here could be the scale of the effectiveness of both countries' oversight and legislation. This research takes a look at both from the scope of effectiveness of Japanese Sarbanes-Oxley Act—J-SOX and American Sarbanes-Oxley Act, which is called just SOX.

J-SOX

This section tells more detailed information about J-SOX. The Securities and Exchange Surveillance Commission (SESC) is a collegiate organization within the Financial Services Agency (FSA), founded in 1992.

Figure 4. Organization of SESC



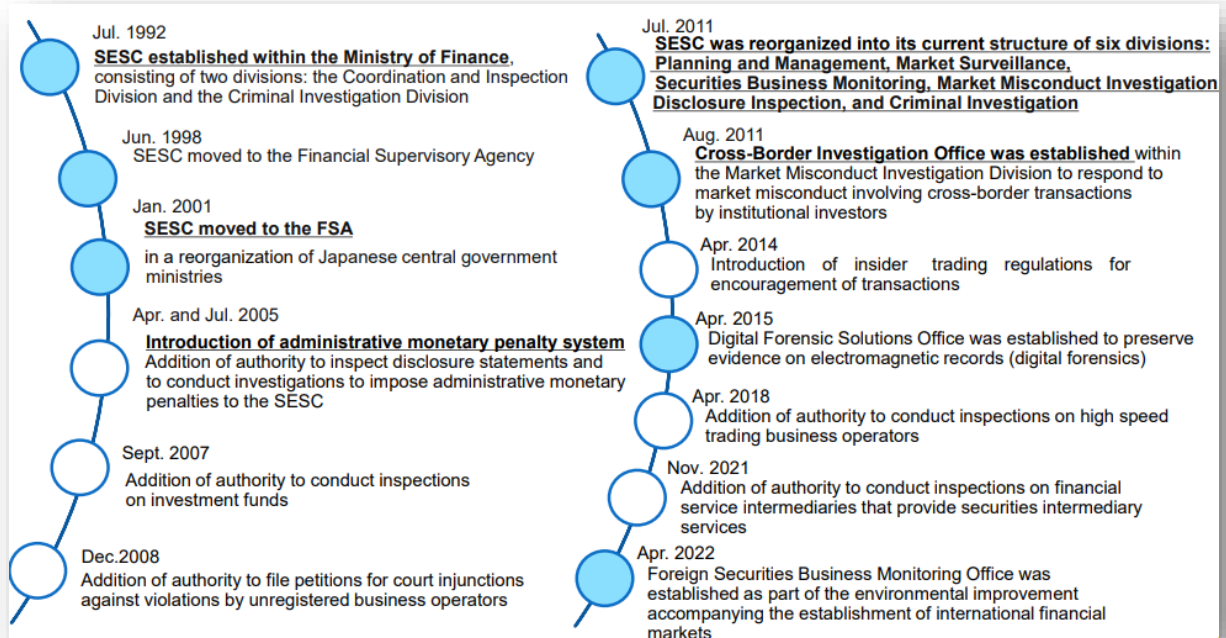
Source: SESC (2024). About SESC. <https://www.fsa.go.jp/sesc/english/aboutsesc/all.pdf>

A Chairman and two Commissioners are appointed by the Prime Minister and function as independent agents for a term of office for 3 years. SESC defines itself as (www.fsa.go.jp/sesc/):

The SESC aims to ensure the fairness and transparency of markets and to protect investors.

- Inspections of violations of laws and regulations related to securities business by Financial Instruments Business Operators (FIBOs)*
- Investigations of market misconduct, including insider trading and market manipulation
- Inspections of violations in disclosure requirements by listed companies
- Recommendations for administrative actions or administrative monetary penalty payment orders, policy proposal, or filing criminal charges based on the results of the above investigations or inspections

Since its establishment in 1992, the SESC has expanded its administrative investigations beyond its investigation of criminal cases to strengthen its functions as a market surveillance organization (www.fsa.go.jp/sesc/):



Activities of the SESC are described as (www.fsa.go.jp/sesc/): (1) Market Surveillance—Gathering and analyzing a wide range of information on markets, (2) Monitoring of Financial Instruments Business Operators (FIBOs¹)—The SESC implements effective and efficient monitoring to ensure an environment in which investors can invest with confidence—Selection of FIBOs for Inspection Based on a Risk-based Approach, (3) Investigation of Market Misconduct (a) Investigations of Domestic Transactions, (b) Investigation of Cross-Border Transactions and Trades by Institutional Investors (4) Inspection of Disclosure Statements—The SESC ensures appropriate disclosure by inspecting disclosure statements of listed companies, etc., and (5) Investigation of Criminal Cases—The SESC reveals facts of serious and malicious violations and demands criminal prosecution by filing charges.

Reference cases and statistics in the 2024 report of SESC mentions **Recommendation for Administrative Action** (Inspection of FIBOs); **Petition to the Court for Prohibition and Stay Orders**; **Recommendations for Administrative Penalty Payment Orders** (Investigation of Domestic Transactions); **Recommendations for Administrative Monetary**

¹ **FIBOs**: Financial Instruments Business Operators and includes any business operator subject to inspections, such as registered financial institutions, financial instruments intermediary service providers, and qualified institutional investors.

Penalty Payment Orders (Cross-border Transactions and Trades by Institutional Investors) **Recommendation for Administrative Monetary Penalty Payment Orders** (The Disclosure Inspection); **Filing of Criminal Charges** (Investigation of Criminal Cases) for recent major cases. Some examples for Investigation of Criminal Cases are (1) Spreading of Rumors and Using Fraudulent Means in Relation to the Shares, (2) Committing Transaction Recommendation of Shares, (3) Committing Insider Trading of Shares, and (4) Market Manipulation against a company.

The number of cases where the SESC analyzed trading order data from securities companies and financial instrument exchanges and examined whether transactions amounted to market misconduct are listed in Figure 2. As seen from the figure, most of the cases are insider trading cases, next is market manipulation. As a foot note it is given that the figures of fiscal 2023 are for the period from April 1, 2023 to December 31, 2023.

The number of tips and information received are tabulated in Figure 3. As seen from the, figure, internet is dominantly the most preferred means for transmitting information to SESC, next one is telephone calls. Individual stocks are the most transmitted topic to SESC.

Figure 5. Number of Cases Examined

Fiscal Year Category	2019	2020	2021	2022	2023 (*2)
Total	1,061	965	969	1,065	868
Market Manipulation	78	60	43	29	21
Insider Trading	976	900	922	1,024	839
Others (e.g., Use of Fraudulent Means)	7	5	4	12	8
(Ref.) Breakdown by Entity					
SESC	453	429	377	448	342
Local Finance Bureaus	608	536	592	617	526

Source: SESC (2024). <https://www.fsa.go.jp/sesc/english/aboutsesc/all.pdf>, p. 26

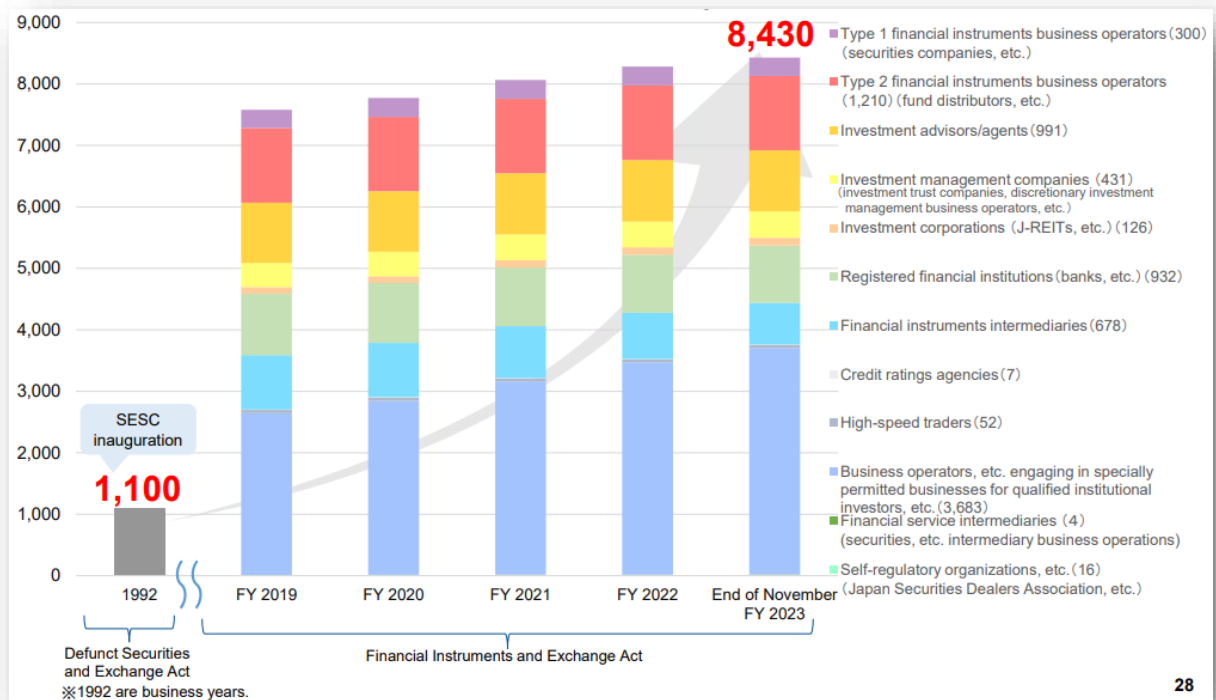
Figure 6. Number of Tips and Information Received

Fiscal Year	2019	2020	2021	2022	2023 (*2)
Category					
Total	5,798	6,300	6,324	6,713	5,771
Breakdown by providing means					
By Internet	4,114	4,529	4,630	5,127	4,400
By Telephone Call	1,295	1,328	1,279	1,087	1,008
By Letter	275	385	386	392	347
By Visitation	10	11	12	11	5
From Local Finance Bureaus and Others	104	47	17	96	11
Breakdown by Topic					
Individual Stock	4,095	4,703	4,927	5,061	4,347
Issuer	233	270	261	250	224
Conduct of Financial Instruments Business Operators	497	408	358	563	435
Others (opinions and inquiries)	973	919	778	839	765

Source: SESC (2024). <https://www.fsa.go.jp/sesc/english/aboutsesc/all.pdf>, p. 26

The number of businesses operators subject to SESC inspections for the fiscal years 2019–2023 are given in Figure 4.

Figure 7. Trend of Number of Business Operators Subject to Securities Inspections



Source: SESC (2024). <https://www.fsa.go.jp/sesc/english/aboutsesc/all.pdf>, p. 28

From the figure a steady increase is observed. As of end of November 2023, the number of businesses operators subject to SESC inspections reached 8,430. Out of this, 3,683 are Business operators, engaging in specially permitted businesses for qualified institutional investors. Type 2 financial instruments business operators make up 1,210 of this. Third comes Investment advisors/agents—991.

The SESC strategy and policy 2023–2025 are announced on Jan 23, 2023. SESC hopes achieving a virtuous cycle of I. Information Gathering and Analysis for Comprehensive Market Oversight, II. Effective and Efficient Investigations and Inspections, III. Effective Initiatives to Enhance Market Discipline. These concrete measures are given in Table 1.

The SESC announces it will further enhance its ability as a professional market oversight agency to make it the basis for achieving a virtuous cycle of market oversight.

- More advanced and efficient market oversight with digitalized technologies
- Strategic development and utilization of human resources
- Promotion of cooperation with Local Financial Bureaus.

Table 3. SESC Strategy & Policy 2023–2025 Concrete Measures

I. Information Gathering and Analysis for Comprehensive Market Oversight	(1) Gathering of useful information
	(2) Appropriate understanding and analyzing of changes in the markets
	(3) Enhancing international cooperation
II. Effective and Efficient Investigations and Inspections	(4) Securities inspections based on a risk-based approach
	(5) Prompt responses against market misconduct and disclosure violations
	(6) Rigorous enforcement of criminal investigation against serious and malicious cases
	(7) Proactive response to cases where investors are harmed
	(8) Strengthening of the capability to address non-traditional and new types of violations
III. Effective Initiatives to Enhance Market Discipline	(9) Enhancement of dissemination of Information
	(10) Further enhancement of cooperation with relevant organizations

Source: Created based on the information on SESC (2023).
https://www.fsa.go.jp/sesc/news/c_2023/2023/20230127-1/01_english.pdf.

CHAPTERS OF J-SOX

As seen from the explanations about J-SOX, it is understood that SESC is almost exactly the counterpart of PCAOB of US. *The Financial Instruments and Exchange Act (Act No. 25 of 1948)* comes forth as the equivalent of *An Act to protect investors by improving the accuracy and reliability of corporate disclosures made pursuant to the securities laws, and for other purposes*, the nickname of which is Sarbanes-Oxley Act of 2002. As stated in the translation of the original J-SOX and given in Text Box 1, Chapter I General Provisions Article 1 states the purpose of the Act (www.fsa.go.jp).

Text Box 1. Chapter I General Provisions Article 1

Article 1 (Purpose)

The purpose of this Act is, inter alia, by developing systems for disclosure of corporate affairs and other related matters, providing for necessary matters relating to persons who engage in Financial Instruments Business and securing appropriate operation of Financial Instruments Exchanges, to ensure fairness in, inter alia, issuance of the Securities and transactions of Financial Instruments, etc. and to facilitate the smooth distribution of Securities, as well as to aim at fair price formation of Financial Instruments, etc. through the full utilization of functions of the capital market, thereby contributing to the sound development of the national economy and protection of investors.

J-SOX has nine chapters with 227 articles, and supplementary provisions. The most relevant ones are highlighted in bold (www.fsa.go.jp):

- Chapter I General Provisions (Article 1 and Article 2)
- Chapter II Disclosure of Corporate Affairs and Other Related Matters (Article 2-2 - Article 27)
- Chapter II-II Disclosure Required for Tender Offer
- Chapter II-III Disclosure of Status of Large Volume Holding of Share Certificates, etc. (Article 27-23 - Article 27-30)
- Chapter II-IV Special Provisions, etc. for Procedures by Use of Electronic Data Processing System for Disclosure (Article 27-30-2 - Article 27-30-11)
- **Chapter III Financial Instruments Business Operators, etc.**
 - Section 1 General Provisions
 - Subsection 1 General Rules (Article 28)
 - Subsection 2 Financial Instruments Business Operators (Article 29 - Article 31-5)
 - Subsection 3 Major Shareholders (Article 32 - Article 32-4)
 - Subsection 4 Registered Financial Institutions (Article 33 - Article 33-8)
 - Subsection 5 Professional Investors (Article 34 - Article 34-5)
 - Section 2 Businesses
 - Subsection 1 General Rules (Article 35 - Article 40-3)
 - Subsection 2 Special Provisions Concerning Investment Advisory Business (Article 41 - Article 41-5)
 - Subsection 3 Special Provisions Concerning Investment Management Business (Article 42 - Article 42-8)
 - Subsection 4 Special Provisions Concerning Securities, etc. Management Business (Article 43 - Article 43-4)
 - Subsection 5 Preventive Measures against Adverse Effects (Article 44 - Article 44-4)
 - Subsection 6 Miscellaneous Provisions (Article 45)
 - **Section 3 Accounting**
 - Subsection 1 Financial Instruments Business Operator Engaged in Type I Financial Instruments Business (Article 46 - Article 46-6)
 - Subsection 2 Financial Instruments Business Operators not Engaged in Type I Financial Instruments Business (Article 47 - Article 47-3)
 - Subsection 3 Registered Financial Institutions (Article 48 - Article 48-3)

- Subsection 4 Special Provisions for Foreign Juridical Persons, etc. (Article 49 - Article 49-5)
- **Section 4 Supervision (Article 50 - Article 57)**
- Section 5 Special Provisions for Foreign Business Operators
 - Subsection 1 Foreign Securities Brokers (Article 58 - Article 58-2)
 - Subsection 2 Permission of Part of Underwriting Business (Article 59 - Article 59-6)
 - Subsection 3 Permission of Transaction-at-Exchange Operation (Article 60 - Article 60-13)
 - Subsection 4 Person Who Conducts Investment Advisory Business or Investment Management Business in Foreign State (Article 61)
 - Subsection 5 Establishment of an Institution for Collecting Information (Article 62)
- Section 6 Special Provisions Concerning Specially Permitted Businesses for Qualified Institutional Investor, etc. (Article 63 - Article 63-4)
- Section 7 Sales Representatives (Article 64 - Article 64-9)
- Section 8 Miscellaneous Provisions (Article 65 - Article 65-6)
- Chapter III-II Financial Instruments Intermediary Service Providers
- Chapter IV Financial Instruments Firms Association
- Chapter IV-II Investor Protection Fund
- Chapter V Financial Instruments Exchange
- Chapter V-II Foreign Financial Instruments Exchange
- Chapter V-III Financial Instruments Clearing Organization, etc.
- Chapter V-IV Securities Finance Company (Article 156-23 - Article 156-37)
- Chapter VI Regulations on Transactions, etc. of Securities (Article 157 - Article 171)
- Chapter VI-II Administrative Monetary Penalty
- Chapter VII Miscellaneous Provisions (Article 186 - Article 196-2)
- Chapter VIII Penal Provisions (Article 197 - Article 209)
- Chapter IX Investigation into a Criminal Case, etc. (Article 210 - Article 227)
- Supplementary Provisions

SOX

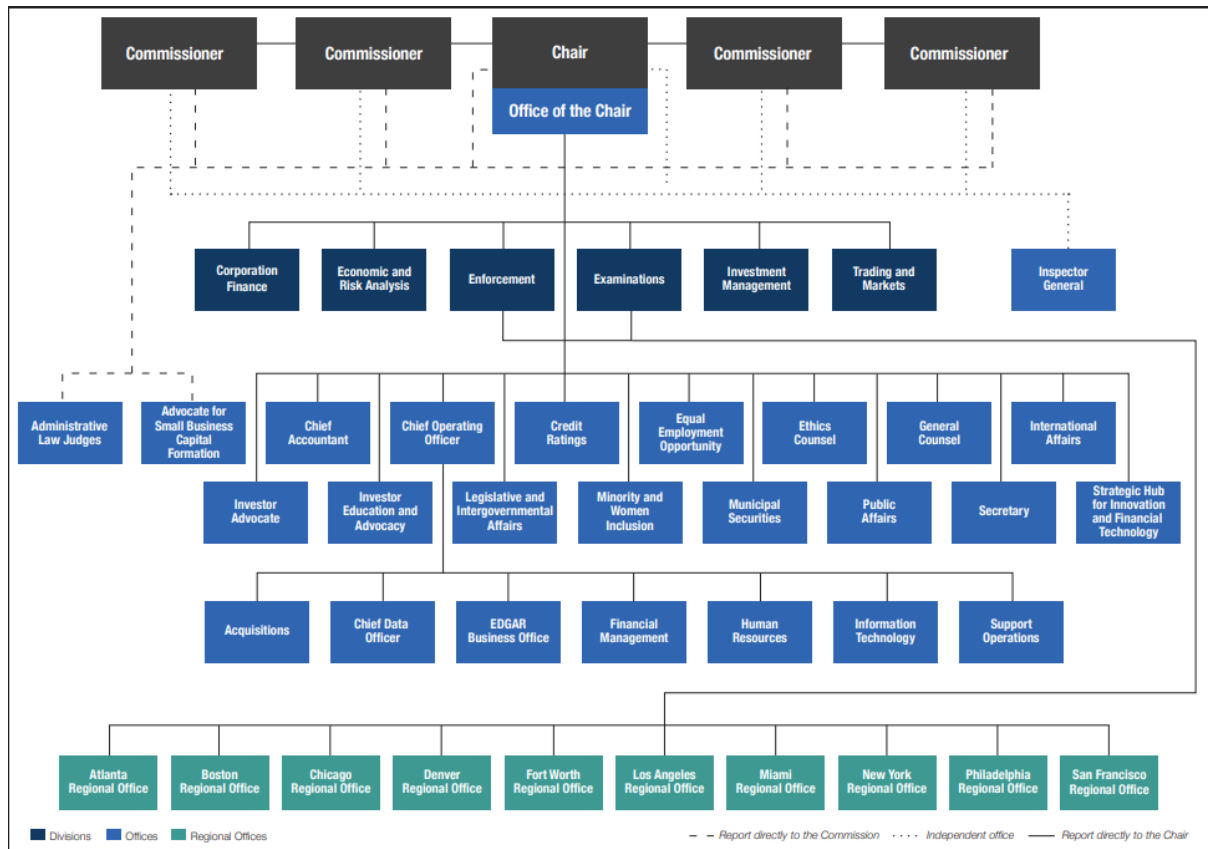
The American counterpart of the Japanese Securities and Exchange Surveillance Commission (SESC) is Securities and Exchange Commission (SEC) and PCAOB together. The PCAOB is a nonprofit corporation established by Congress to oversee the audits of public companies in

order to protect investors and further the public interest in the preparation of informative, accurate, and independent audit reports. The PCAOB also oversees the audits of brokers and dealers registered with the SEC, including compliance reports filed pursuant to federal securities laws. The PCAOB has four primary duties (pcaobus.org/about):

- Register public accounting firms that prepare audit reports for issuers, and SEC-registered brokers and dealers.
- Establish or adopt auditing and related attestation, quality control, ethics, and independence standards.
- Inspect registered public accounting firms' audits and quality control systems.
- Investigate and discipline registered public accounting firms and their associated persons for violations of specified laws, rules, or professional standards.

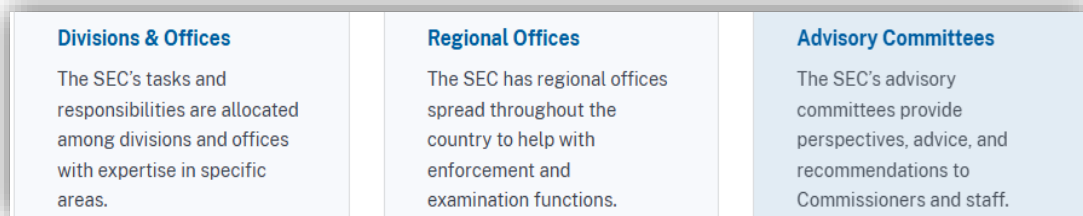
In support of its mission, PCAOB also conducts economic research and risk analysis, engages with its stakeholders and other domestic and international regulators, and manages the workforce, the technology and resources it needs to perform its duties. The SEC has oversight authority over the PCAOB, including the approval of the PCAOB's rules, standards, and budget. The Official Organization Chart of SEC, which has oversight authority over the PCAOB, as of 2024, is given in Figure 5.

Figure 8. 2024 SEC Official Organization Chart



Source: SEC (2025). <https://www.sec.gov/files/secorg.pdf>

Figure 9: Divisions & Offices, Regional Offices, and Advisory Committees



Source: SEC (2025). <https://www.sec.gov/about>

As seen from the Figure 5, Inspector General is an office, which is independent, as are the Administrative Law Judges. Some of the divisions of SEC are explained below.

The mission of the Office of Inspector General (OIG) is to promote the integrity, efficiency, and effectiveness of the critical programs and operations of the SEC. OIG accomplishes this mission by (www.sec.gov/office-inspector-general/about-office-inspector-general):

- conducting independent and objective audits, evaluations, and other reviews of SEC programs and operations;

- conducting independent and objective investigations of potential criminal, civil, and administrative violations that undermine the ability of the SEC to accomplish its statutory mission;
- preventing and detecting fraud, waste, and abuse in SEC programs and operations;
- identifying vulnerabilities in SEC systems and operations and making recommendations to improve them;
- communicating timely and useful information that facilitates management decision making and the achievement of measurable gains; and
- keeping Congress, the Chair, and the Commissioners fully and currently informed of significant issues and developments.

The Division of Enforcement oversees the SEC's civil law enforcement function by conducting investigations into possible securities law violations, filing hundreds of enforcement actions each year against wrongdoers, and returning money to harmed investors whenever possible (www.sec.gov/about/divisions-offices/division-enforcement). Division of Examinations conducts the SEC's National Exam Program using risk-focused strategies to improve industry practices and compliance, prevent fraud, monitor risk, and inform policy. Enforcement actions include federal court filings and administrative proceedings (www.sec.gov/about/divisions-offices/division-examinations). Office of Administrative Law Judges (ALJs) conducts hearings, issues initial decisions, and adjudicates ancillary matters in administrative proceedings. ALJs serve as independent adjudicators who determine whether allegations against respondents in SEC enforcement proceedings are true. The judges conduct public hearings, issue subpoenas, hold conferences with parties, rule on motions, and rule on the admissibility of evidence. ALJs prepare an initial decision that sets forth factual findings and legal conclusions while determining whether sanctions are warranted (www.sec.gov/about/divisions-offices/office-administrative-law-judges). The Office of the Ethics Counsel is responsible for advising and counseling all SEC employees and members on such issues as personal and financial conflicts of interest, securities holdings and transactions of SEC employees and their immediate families, gifts, seeking and negotiating other employment, outside activities, financial disclosure, and post-employment restrictions. It also provides advice and action on a normal or expedited basis to all former SEC employees on post-employment restrictions as well as post-employment notices required under SEC Conduct Rule 8(b), 17 CFR 200.735-8(b) prior to appearing before the Commission. The Ethics staff also drafts, comments on, and implements regulations concerning ethical conduct issues. The Ethics

Office assists Presidential appointees with various aspects of financial disclosure to the Senate and the US Office of Government Ethics in connection with the confirmation process. Annually, the Office handles approximately 9,000 ethics counseling matters for Commission officials and staff (www.sec.gov/about/divisions-offices/office-ethics-counsel).

CHAPTERS OF SOX

The main chapters of Sarbanes-Oxley Act are summarized below (<https://www.sox-online.com/the-sarbanes-oxley-act-full-text/>):

Section 1. Short Title; Table of Contents.

- Title I-Public Company Accounting Oversight Board
- Title II-Auditor Independence
- Title III-Corporate Responsibility
- Title IV-Enhanced Financial Disclosures
- Title V-Analyst Conflicts Of Interest
- Title VI-Commission Resources and Authority
- Title VII-Studies and Reports
- Title VIII-Corporate and Criminal Fraud Accountability
- Title IX-White-Collar Crime Penalty Enhancements
- Title X-Corporate Tax Returns
- Title XI-Corporate Fraud and Accountability

Section 2. Definitions.

Section 3. Commission Rules and Enforcement

As seen from the sections of SOX depicted above, they are neither exactly in the same order, nor do they carry the same titles as J-SOX does. However, it can be assumed that they function similarly.

CONCLUSION

Japanese Financial Instruments and Exchange Law is considered as the Japanese version of Sarbanes-Oxley Act of United States (SOX), and is called J-SOX. This study makes a comparison between J-SOX and original SOX. For the sake of the comparison; Japan's and United States of America's (US) GDPs, stock markets' situations, the organizations they have like SEC, SESC, and PCAOB are handled. Since the main focus is J-SOX; emphasis is given to Japanese position. The findings suggest that stock market depth and breadth of Japan is not less than US's; however, Japan has lived less accounting scandals and/or fraudulent cases than

US. Since conditions sometimes become totally different; the two countries and their system and organizations cannot undergo an exact comparison. Yet, as conclusion it can be said that Japanese oversight looks like efficient enough to protect the markets. Further research can be done in the future, where much more thorough analyses would be possible.

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APPENDICES

Appendix 1. Members of the Committee of European Auditing Oversight Bodies (CEAOB) sub-groups

International Equivalence and Adequacy sub-group

- 1) [European Securities and Markets Authority](#) - ESMA– Chair
- 2) [Auditor Oversight Body](#) – AOB (Germany)
- 3) [Irish Auditing and Accounting Supervisory Authority](#) – IAASA (Ireland)
- 4) [Hellenic Accounting and Auditing Standards Oversight Board](#) – HAASOB (Greece)
- 5) [Haut Conseil du Commissariat aux Comptes](#) – H3C (France)
- 6) [Commissione Nazionale per le Società e la Borsa](#) – CONSOB (Italy)
- 7) [Cyprus Audit Oversight Board](#) – CYPAOB (Cyprus)
- 8) [The Netherlands Authority for the Financial Markets](#) – AFM (Netherlands)

International Auditing Standards sub-group

- 1) [Haut Conseil du Commissariat aux Comptes](#) – H3C (France) – Chair
- 2) [Public Audit Oversight Board](#) – PAOB (Czech Republic)
- 3) [Danish Business Authority](#) – DBA (Denmark)
- 4) [Auditor Oversight Body](#) – AOB (Germany)
- 5) [Irish Auditing and Accounting Supervisory Authority](#) – IAASA (Ireland)
- 6) [Instituto de Contabilidad y Auditoría de Cuentas](#) – ICAC (Spain)
- 7) [Commissione Nazionale per le Società e la Borsa](#) – CONSOB (Italy)
- 8) [Cyprus Audit Oversight Board](#) – CYPAOB (Cyprus)
- 9) [Commission de Surveillance du Secteur Financier](#) – CSSF (Luxembourg)
- 10) [The Netherlands Authority for the Financial Markets](#) – AFM (Netherlands)
- 11) [Austrian Auditing Oversight Authority](#) - APAB (Austria)
- 12) [Authority for Public Oversight of the Statutory Audit Activity](#) – ASPAAS (Romania)
- 13) [Finnish Patent and Registration Office - Auditor Oversight Unit](#) – PRH (Finland)
- 14) [Polish Agency for Audit Oversight](#)- PANA (Poland)
- 15) [Auditing Oversight Authority - UDVA](#) (Slovakia)
- 16) [Authority of Audit, Accounting, Property Valuation and Insolvency](#)- AVNT (Lithuania)

Enforcement sub-group

- 1) [Polish Agency for Audit Oversight- PANA \(Poland\) - Chair](#)
- 2) [Finnish Patent and Registration Office - Auditor Oversight](#) – PRH (Finland)
- 3) [Commission for public oversight of statutory auditors](#) – CPOSA (Bulgaria)
- 4) [Public Audit Oversight Board](#) – PAOB (Czech Republic)
- 5) [Danish Business Authority](#) – DBA (Denmark)
- 6) [Auditor Oversight Body](#) – AOB (Germany)
- 7) [Irish Auditing and Accounting Supervisory Authority](#) – IAASA (Ireland)
- 8) [Instituto de Contabilidad y Auditoría de Cuentas](#) – ICAC (Spain)
- 9) [Haut Conseil du Commissariat aux Comptes](#) – H3C (France)
- 10) [Commissione Nazionale per le Società e la Borsa](#) – CONSOB (Italy)
- 11) [Cyprus Audit Oversight Board](#) – CYPAOB (Cyprus)
- 12) [Commission de Surveillance du Secteur Financier](#) – CSSF (Luxembourg)
- 13) [Accountancy Board](#) – AB (Malta)
- 14) [Austrian Auditing Oversight Authority](#) - APAB (Austria)
- 15) [Authority of Audit, Accounting, Property Valuation and Insolvency- AVNT](#) (Lithuania)
- 16) [Auditors' Public Oversight Authority - Ministry for National Economy of Hungary](#) – APOA (Hungary)
- 17) [Authority for Public Oversight of the Statutory Audit Activity](#) – ASPAAS (Romania)
- 18) [Agency for Public Oversight of Auditing](#) – APOA (Slovenia)

Observers:

- [Auditing Oversight Authority - UDVA](#) (Slovakia)
[The Netherlands Authority for the Financial Markets](#) – AFM (Netherlands)

Inspections sub-group

- 1) [Commission de Surveillance du Secteur Financier](#) – CSSF (Luxembourg) - Chair
- 2) [Austrian Auditing Oversight Authority](#) - APAB (Austria)
- 3) [Belgian Audit Oversight Board](#) – BAOB (Belgium)
- 4) [Commission for public oversight of statutory auditors](#) – CPOSA (Bulgaria)
- 5) [Audit Public Oversight Committee](#) – APOC (Croatia)
- 6) [Cyprus Audit Oversight Board](#) – CYP AOB (Cyprus)
- 7) [Public Audit Oversight Board](#) – PAOB (Czech Republic)
- 8) [Danish Business Authority](#) – DBA (Denmark)
- 9) [Estonian Auditing Activities Oversight Board](#) – EAA (Estonia)
- 10) [Finnish Patent and Registration Office - Auditor Oversight Unit](#) – PRH (Finland)
- 11) [Haut Conseil du Commissariat aux Comptes](#) – H3C (France)
- 12) [Auditor Oversight Body](#) – AOB (Germany)
- 13) [Hellenic Accounting and Auditing Standards Oversight Board](#) – HAASOB (Greece)
- 14) [Auditors' Public Oversight Authority - Ministry for National Economy of Hungary](#) – APOA (Hungary)
- 15) [Commissione Nazionale per le Società e la Borsa](#) – CONSOB (Italy)
- 16) [Irish Auditing and Accounting Supervisory Authority](#) – IAASA (Ireland)
- 17) [Ministry of Finance of Latvia – Audit Oversight Commission](#) – AOC (Latvia)
- 18) [Authority of Audit, Accounting, Property Valuation and Insolvency](#) – AVNT (Lithuania)
- 19) [Accountancy Board](#) – AB (Malta)
- 20) [The Netherlands Authority for the Financial Markets](#) – AFM (Netherlands)
- 21) [Polish Agency for Audit Oversight](#) - PANA (Poland)
- 22) [Comissão do Mercado de Valores Mobiliários](#) – CMVM (Portugal)
- 23) [Authority for Public Oversight of the Statutory Audit Activity](#) – ASPAAS (Romania)
- 24) [Agency for Public Oversight of Auditing](#) – APOA (Slovenia)
- 25) [Auditing Oversight Authority](#) – UDVA (Slovakia)
- 26) [Instituto de Contabilidad y Auditoría de Cuentas](#) – ICAC (Spain)
- 27) [Swedish Inspectorate of Auditors - Revisorsinspektionen](#) – (Sweden)
- 28) [European Securities and Markets Authority](#) - ESMA

Observers:

[Financial Market Authority – FMA](#) (Liechtenstein),
[Finanstilsynet](#) – (Norway),
[Federal Audit Oversight Authority – FAOA](#) (Switzerland)

Members of Organising Committee:

Representatives from [Auditor Oversight Body](#) – AOB (Germany), [Haut Conseil du Commissariat aux Comptes](#) – H3C (France), [Cyprus Audit Oversight Board](#) – CYP AOB (Cyprus), [Irish Auditing and Accounting Supervisory Authority](#) – IAASA (Ireland) [Commission de Surveillance du Secteur Financier](#) – CSSF (Luxembourg), and [The Netherlands Authority for the Financial Markets](#) – AFM (Netherlands)

Source: Finance.ec. (OCR) (Jan, 2025). https://finance.ec.europa.eu/document/download/6dc39f60-ef34-4617-8f1b-34ae55cf56d4_en?filename=ceaob-subgroups-composition_en.pdf Accessed May 28, 2025.

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graph TD; CA2001[Corporations Act 2001  
Primary legislation outlining financial reporting and auditing framework]; ASIC[ASIC — Regulatory oversight of Corporations Act]; CADB[Companies Auditor Disciplinary Board — Administrative Disciplinary Body for auditors. Cases are referred by ASIC]; FRC[Financial Reporting Council — Advisory role to ASIC, and Government and Strategic guidance to AASB and AUASB]; AASB[Australian Accounting Standards Board (AASB) and Auditing and Assurance Standards Board (AUASB) — Standard setting bodies for accounting and auditing standards]; AASB_Ethical[Accounting Professional and Ethical Standards — Code of Ethics for Professional Accountants]; AASB_Standards[Accounting Professional and Ethical Standards Board — Set the Code of Ethics for auditors]; PBA[Professional Bodies: Chartered Accountants Australian & New Zealand, CPA Australia, Institute of Public Accountants — Set professional standards for their members]; CA2001 <--> ASIC; CA2001 <--> AASB_Ethical; ASIC --> CADB; ASIC --> FRC; ASIC --> AASB; CADB --> AASB; FRC --> AASB; AASB --> AASB_Ethical; AASB --> AASB_Standards; AASB_Standards --> PBA; PBA --> AASB_Standards;
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The diagram illustrates the regulatory framework for financial reporting and auditing in Australia. It shows the flow from primary legislation to standard setting bodies and professional bodies.

Corporations Act 2001
Primary legislation outlining financial reporting and auditing framework

ASIC Act 2001
Creates statutory bodies

ASIC — Regulatory oversight of Corporations Act

Companies Auditor Disciplinary Board — Administrative Disciplinary Body for auditors. Cases are referred by ASIC

Financial Reporting Council — Advisory role to ASIC, and Government and Strategic guidance to AASB and AUASB

Australian Accounting Standards Board (AASB) and Auditing and Assurance Standards Board (AUASB) — Standard setting bodies for accounting and auditing standards

Accounting and Auditing Standards
Legislative instruments outlining Australia's Accounting and Auditing standards
Include a requirement to comply with the APES code

Accounting Professional and Ethical Standards — Code of Ethics for Professional Accountants

Accounting Professional and Ethical Standards Board — Set the Code of Ethics for auditors

Professional Bodies: Chartered Accountants Australian & New Zealand, CPA Australia, Institute of Public Accountants — Set professional standards for their members

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THE RELATIONSHIP BETWEEN CORPORATE STOCK PERFORMANCE AND SUSTAINABILITY INDICES: EVIDENCE FROM EURO STOXX 50

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ABSTRACT

The importance of sustainability-based indicators in financial markets is increasing day by day. Especially the inclination of large-scale investors towards sustainability indices to identify companies with long-term value creation potential has made the impact of these indices on the market more visible.

In this study, the relationship between the stock prices of firms included in the EURO STOXX 50 index, one of Europe's leading stock market indicators, and the sustainability index created based on the same index was examined using panel regression analysis, utilizing daily frequency data obtained between 2012 and 2025. The main objective of the research is to determine whether the movements in the sustainability index have a significant impact on a firm's stock prices. Various firm-specific control variables have also been included in the analysis to enhance the reliability of the model. Considering the assumption violations, the Parks-Kmenta robust estimator has been used.

According to the analysis results, the model was found to be statistically significant overall, with an R^2 value of 0.6679 indicating the level of explanatory power. All the variables included in the model were found to be significant, and a positive and significant relationship was particularly identified between the sustainability index and stock prices. Each unit increase in the sustainability index causes an average increase of 0.084 units in the stock prices of the firms. This finding indicates that investors take into account sustainability-focused indices and the companies included in these indices during their valuation processes. In this context, firms' compliance with sustainability criteria can create a strategic advantage not only in terms of social responsibility but also in terms of financial performance in the long run. From the investors' perspective, this study provides an important reference for evaluating sustainability indices as a market signal.

Keywords: Sustainability, Stock Prices, Sustainability Index, Sustainable Finance

1. INTRODUCTION

The global environmental crises, social inequalities, and governance failures have necessitated that companies be evaluated not only based on their financial performance but also on their sustainability performance. Today, investors increasingly consider sustainability criteria when

assessing a company's potential for long-term value creation. This shift has generated a new paradigm in financial markets, positioning sustainability as an integral component of risk management and valuation processes. As a result, the impact of sustainability practices on firm market value, stock returns, and investor interest has emerged as a strategic topic of discussion. In this context, sustainability indices serve as vital tools that enable investors to identify companies with high sustainability performance. Indices such as the Dow Jones Sustainability Index (DJSI), FTSE4Good, and STOXX ESG Leaders highlight companies that meet specific criteria, thus increasing their visibility in the market. Firms included in these indices are generally perceived as less risky, more transparent, and possessing greater long-term profit potential. Consequently, such inclusion can influence investor behaviour, potentially resulting in positive reflections in stock prices. Entry into or continued presence in these indices, as well as the indices' movements, may have significant short- and long-term effects on stock price dynamics, with market reactions often directly linked to a company's perceived credibility among investors.

In recent years, the effect of sustainability indices on stock prices and returns has garnered increasing interest in the financial literature. There is a consensus that a company's inclusion in sustainability indices signals credibility and long-term value creation potential, which can generate positive investor reactions. Accordingly, sustainability indices are believed to influence both short-term market responses and long-term performance.

Eccles, Ioannou, and Serafeim (2014) found that firms with strong sustainability practices tend to exhibit superior stock performance over time, attributing this to enhanced corporate processes. Khan, Serafeim, and Yoon (2016) further noted that firms focusing on material sustainability factors experience higher risk-adjusted returns compared to those that do not. A study by Pernamasari et al. (2024), examining the period between 2017 and 2021, identified a positive and statistically significant relationship between ESG scores—especially the social sustainability component—and stock returns. Similarly, Zhang et al. (2018) analysed firms listed on the Shanghai and Shenzhen Stock Exchanges between 2007 and 2018 and concluded that the publication of sustainability-related news is perceived positively by investors, leading to significant and positive impacts on stock returns. These findings suggest that investors value not merely sustainability rhetoric but concrete sustainability efforts that generate financial impact.

Studies focusing on Europe have revealed comparable outcomes. Collison et al. (2009) reported that the FTSE4Good index exerts a short-term positive pricing effect on company stocks. However, some research argues that this relationship varies across markets and does not always

produce a positive effect. Auer and Schuhmacher (2016), in their comparison of sustainability-focused indices in Europe, observed that firms with a sustainability orientation in certain sectors achieved similar returns with lower volatility, though no consistent excess return advantage was found (Auer & Schuhmacher, 2015).

In conclusion, the literature generally views sustainability indices as conveying a positive market signal that can influence both short-term price reactions and long-term risk-return profiles. However, the magnitude of this impact may vary depending on the index structure, market characteristics, investor sentiment, and the firm's sectoral position.

This study aims to analyse the relationship between sustainability performance and stock prices in European financial markets. Specifically, it investigates the dynamic relationship between the stock prices of companies listed on the Euro Stoxx 50 index and the EURO STOXX® ESG Leaders 50 Index, which is regarded as an indicator of sustainability performance. The movements of the sustainability index over time reflect evolving investor sentiment and expectations surrounding sustainability in Europe. Accordingly, this study assesses the impact of the index's fluctuations on stock prices.

2. RESEARCH DESIGN

2.1. Data

This study analyses the impact of sustainability performance on stock prices, focusing on leading European companies listed in the EURO STOXX 50 index. Owing to their high market capitalization and broad sectoral representation, the firms included in this index have the capacity to reflect the dynamics of European capital markets. However, due to data limitations for some firms, the analysis includes only 47 companies. All firm-level data were obtained from the Bloomberg database.

Stock price data were collected as daily closing prices and were used as the dependent variable in the analysis. As the independent variable, the daily closing values of the EURO STOXX ESG Leaders 50 Index were used to represent sustainability performance. This index is a sub-index composed of companies within the EURO STOXX 50 that have high ESG (Environmental, Social, and Governance) scores. Changes in this index serve as a suitable reference point for analysing the market's valuation of sustainability and its potential influence on stock prices.

To enhance the statistical reliability of the model and control for potential confounding effects, four control variables were included in the analysis. The first, beta, reflects the sensitivity of a stock to systematic market risk. Volatility captures daily price fluctuations and aims to control for intra-market risk. The Price-to-Earnings ratio and Price-to-Book ratio are valuation metrics

that indicate whether a company is relatively overvalued or undervalued. Including these variables helps isolate the effect of the sustainability indicator and contributes to producing more robust and accurate results.

Table 1. Variable List

Variable Name	Model Abbreviation	Variable Type
Sustainability Performance	SX5EESGIndex	Independent Variable
Stock Price (Closing Price)	PXLAST	Dependent Variable
Beta Coefficient	BETA	Control Variable
Volatility	VOLATILITY	Control Variable
Price-to-Earnings Ratio	PE	Control Variable
Price-to-Book Value Ratio	PXB	Control Variable

All variable data were collected at a daily frequency covering the period from 2012 to 2025. This extended time frame allows for the observation of both short-term fluctuations and long-term trends, thereby enhancing the time-series dimension of the study.

2.2. Method

In this study, all variables were initially transformed into a comparable format using the min-max normalization method, as they are expressed in different scales. The normalization process was carried out using the following formula:

$$x' = \frac{x_i - x_{min}}{x_{max} - x_{min}}$$

This transformation rescaled all data values into the range of 0 to 1, allowing for a more accurate and unbiased comparison among variables in the econometric analysis.

Following the normalization of the data, a panel data regression model was constructed to measure the impact of sustainability performance on stock prices. This model allows for the simultaneous evaluation of both the time dimension and the cross-sectional unit dimension (i.e., firm-level), thereby enabling the generation of more robust and generalizable results.

The panel data structure of the study comprises daily frequency observations for the period 2012–2025, including data from 47 firms and the sustainability index.

The regression model is specified as follows:

$$PXLAST_{it} = \alpha + \beta_1. SX5EESGIndex_{it} + \beta_2. BETA_{it} + \beta_3. VOLATILITY_{it} + \beta_4. PE_{it} + \beta_5. PXB_{it} + \varepsilon_{it}$$

3. ANALYSIS AND FINDINGS

After the data were organized and the model specified, the panel regression analysis was conducted. Prior to the regression analysis, several preliminary tests were carried out to assess the fundamental characteristics of the panel data structure.

As part of this process, the first test applied was the cross-sectional dependence test developed by Pesaran (2004). In panel data analysis, the assumption that cross-sectional units (in this case, firms) are completely independent of one another is critical for the validity of classical models. Therefore, before proceeding with the panel regression, the presence of cross-sectional dependence was examined.

The test results for the variables used in the analysis are presented below:

Table 2. Cross-Sectional Dependency Test Results

	PXLAST	SX5EESGIndex	BETA	VOLATILITY	PE	PXB
Paseran CD-test	681.44	1871.76	26.63	1012.65	180.92	204.19
p-value	0.000	0.000	0.000	0.000	0.000	0.000

According to the test results, the p-values for all variables were found to be below the 0.05 significance level. These findings indicate that there is statistically significant cross-sectional dependence among all series used in the analysis. In other words, firm-level stock prices and financial ratios do not move independently across the panel; instead, they likely respond similarly to common external shocks, sectoral dynamics, or macroeconomic conditions. This issue was duly considered in the subsequent stages of the analysis.

Considering the findings obtained from the cross-sectional dependence test, it was determined that there is dependency among the variables in the panel dataset. Since this violates the assumptions of first-generation panel unit root tests, the application of second-generation tests became necessary. Therefore, to test the stationarity of each variable in the panel, the Cross-sectionally Augmented IPS (CIPS) test developed by Pesaran (2007) was employed.

The CIPS test is a second-generation unit root test that accounts for cross-sectional dependence. It evaluates the stationarity of series by considering both common factor effects and time-series lags within the panel data structure. In the CIPS framework, a test statistic smaller than the critical value (i.e., more negative) indicates that the corresponding series is stationary and does

not contain a unit root. In this study, the critical value was set at -2.15, corresponding to a 95% confidence level.

The calculated CIPS test statistics for each variable are presented below:

Table 3. Unit Root Test Results

Variable	Level	1.Difference
Test	CIPS	CIPS
PXLAST	-1.566	-6.190
SX5EESGIndex	2.610	-3.710
BETA	-1.331	-6.190
VOLATILIT	-6.190	Stationary at the level
PE	-1.827	-6.190
PXB	-1.912	-6.190

According to the table, only the VOLATILITY variable has a CIPS test statistic lower than the critical value, indicating that it is stationary in levels. For all other variables, the test statistics exceed the critical value, suggesting the presence of unit roots and thus non-stationarity in their level forms. Therefore, the first differences of all non-stationary variables were taken to achieve stationarity and ensure their suitability for panel regression analysis.

In panel data analysis, identifying the appropriate model specification is crucial for obtaining reliable and valid results. In this context, a series of model selection tests were conducted, including the Chow test, the Breusch–Pagan Lagrange Multiplier (LM) test, and the Hausman test.

Table 4. Chow, Breusch-Pagan and Hausman Test Results

Test	t-stat	p-value
Chow(F)	48.99	0.0000
Breusch- Pagan	74.09	0.0000
Hausman	13.81	0.017

First, the Chow test was employed to compare the pooled effects model and the fixed effects model. The p-value obtained from the test was below the 0.05 significance level, indicating that the fixed effects model is preferable.

In the second step, the Breusch–Pagan LM test was applied to compare the pooled model with the random effects model. The p-value in this case was also less than 0.05, suggesting that the random effects model is more appropriate than the pooled model.

Finally, the Hausman test was conducted to compare the fixed effects and random effects models. The p-value again fell below 0.05, indicating that the fixed effects model is the appropriate specification.

Considering the results of all three tests, both the Chow and Hausman tests support the use of the fixed effects model. Therefore, the panel regression analysis in this study proceeds with the fixed effects specification.

The results of the fixed effects regression model are presented below. However, before interpreting these results, diagnostic tests were conducted to verify the validity of the model's assumptions.

Table 5. Fixed Effects Regression Model

DPXLAST	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]
DESGINDEX	.03	0	103.00	0	.03	.031
DBETA	-.002	.001	-1.89	.059	-.005	0
DPE	.004	.001	6.31	0	.003	.006
DPXB	.084	.001	122.54	0	.082	.085
VOLATILITY	0	0	-1.66	.098	0	0
Constant	0	0	2.46	.014	0	0
Mean dependent var		0.000	SD dependent var			0.001
R-squared		0.168	Number of obs			155664
F-test		6280.325	Prob > F			0.000

To assess the fundamental assumptions of the model, several diagnostic tests were conducted. The Wald test was used to detect heteroskedasticity, the Wooldridge test for autocorrelation, the Pesaran CD test for cross-sectional dependence, and the Variance Inflation Factor (VIF) test for multicollinearity. The results of these diagnostic tests are presented in the table below. According to the results, the model exhibits evidence of heteroskedasticity and cross-sectional dependence. These issues were taken into account in the subsequent estimation procedure to ensure robust and reliable results.

Table 6. Regression Assumption Test Results

Assumptions	Test	T-stat	P-value	Variable	VIF
Heteroskedasticity	Wald	45.2260	0.000	DPXLAST	1.04
Autocorrelation	Wooldridge	1.479	0.2303	DESGINDEX	1.03
Cross-Sectional Dependence	Paseran CD	1871.76	0.0000	DBETA	1.01
				DPE	1.00
				DPXB	1.01
				VOLATILITY	1.01
				MEAN VIF	1.02

Since the model demonstrated issues of heteroskedasticity and cross-sectional dependence, it was necessary to employ robust estimators that account for these structural problems. In this study, the Parks-Kmenta estimator was selected, as it is well-suited to the time–cross-sectional dimensions of the dataset and sensitive to model-specific regression issues (Hoechle, 2007). The results of the panel regression analysis, based on the fixed effects model estimated using the Parks-Kmenta robust estimator, are presented in the table below.

Table 7. Regression with Parks-Kmenta Robust Estimator Results

DPXLAST	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]
DESGINDEX	.084	0.002	4.270	0	.045	.122
DBETA	0	0.004	-3.64	0	0	0
DPE	.001	0.002	10.79	0	.001	.001
DPXB	.077	0.020	280.09	0	.077	.078
VOLATILITY	0	0.000	-5.06	0	0	0
Constant	0	0.000	0.55	.005	0	0
Mean dependent var		0.000	SD dependent var		0.001	
Number of obs		155664	Chi-square		105090.144	
R-squared		0.6679	Prob > F		0.0000	

The results of the fixed effects panel regression model estimated using the Parks-Kmenta robust estimator reveal that sustainability performance has a statistically significant impact on stock prices. According to the regression result, the coefficient of the DESGINDEX variable is 0.084, and this value is statistically significant ($p < 0.01$). This finding indicates that a one-unit increase in the sustainability index is associated with an average 8.4% increase in firm stock prices. The result suggests that investors actively price in sustainability-related developments, and improvements in ESG performance enhance market confidence, which is reflected

positively in firm valuation. This underscores the decisive role of the sustainability index in shaping investor behaviour and validates the financial value-creation potential of ESG-oriented strategies.

When examining the control variables, the coefficient of BETA, which represents systematic risk, is found to be negative and statistically significant. This indicates that firms with higher levels of risk tend to experience declines in their stock prices. Both the Price-to-Earnings (PE) and Price-to-Book (PXB) ratios exhibit positive and significant effects, suggesting that these valuation metrics are important drivers of stock price movements. Notably, the PXB ratio demonstrates a particularly strong influence, as evidenced by its high t-value, emphasizing the substantial impact of firm valuation on stock prices.

In contrast, the VOLATILITY variable has a negative and significant coefficient, implying that the market perceives high volatility as a risk factor, which exerts downward pressure on stock prices.

The overall fit of the model is considerably strong, with an R^2 value of 0.6679, indicating that approximately 66.8% of the total variance in stock prices is explained by the model. These findings indicate that sustainability performance is incorporated into market valuations, and variations in sustainability indices can substantially affect stock returns. Results are consistent with the broader literature supporting the financial relevance of sustainability investments and suggest that ESG-driven financial strategies can generate meaningful impacts within European capital markets.

4. CONCLUSIONS

This study aimed to examine the relationship between sustainability performance and stock prices in European capital markets. Based on an analysis of firms listed in the EURO STOXX 50 index and their corresponding sustainability performance as reflected in the EURO STOXX ESG Leaders 50 index, the results indicate that changes in sustainability indicators have a significant impact on stock prices. These findings suggest that investors are responsive to sustainability-related developments and that sustainability performance is indeed priced by the market.

The growing integration of sustainability criteria into financial performance highlights the need for companies to prioritize sustainability policies within their long-term value creation strategies. In markets like Europe—where sustainability-oriented policies are more prominent—investor behaviour increasingly extends beyond traditional financial metrics, favouring companies that demonstrate strong environmental and social responsibility. In this context, it is essential for firms to report their sustainability performance regularly and

transparently, while investors should systematically incorporate sustainability criteria into their long-term risk-return assessments.

The findings of this study also provide important implications for regulatory authorities. For sustainability performance to be adequately reflected in market valuations, there is a pressing need to standardize sustainability reporting, enhance disclosure requirements, and promote the use of sustainable financial instruments. These steps would strengthen both market transparency and efficiency and ultimately support a financial ecosystem in which sustainability policies contribute not only to social and environmental well-being but also to financial value creation.

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THE EFFECT OF ESG SCORES ON FIRM VALUE: AN EMPIRICAL ANALYSIS OF EUROPE'S LARGEST COMPANIES

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ABSTRACT

Environmental, Social, and Governance (ESG) scores have gained increasing attention as indicators of corporate sustainability and ethical performance. As these scores become more integrated into investment strategies and valuation frameworks, their potential influence on firm value has emerged as a critical area of analysis. The aim of this study is to determine the effect of ESG scores on firm value. In this context, the relationship between ESG scores and firm value indicators—FCFF and FCFE—was examined through panel regression analysis using data from the 30 largest companies operating in the European Union. The model incorporates control variables and is based on annual data covering the period from 2005 to 2024. To account for potential violations of classical regression assumptions, the analysis employed the Driscoll-Kraay robust estimator.

Two separate models were developed to examine the effect of ESG scores on firm value, using FCFF and FCFE as dependent variables. Both models were found to be statistically significant, with an R^2 value of 0.6280 for the FCFF model and 0.4250 for the FCFE model. The results reveal a significant and positive relationship between ESG scores and both firm value indicators. Specifically, a one-unit increase in the ESG score leads to an increase of 0.031 units in FCFF and 0.026 units in FCFE. The findings of this study highlight the significant role ESG scores play in enhancing firm value. The stronger impact observed on FCFF suggests that ESG practices may contribute directly to a firm's operational efficiency and long-term cash flow generation, beyond mere investor perception. This indicates that sustainability-oriented strategies are not only favored by stakeholders but also have measurable financial benefits, making ESG integration a critical component of value creation in modern corporate finance.

Keywords: ESG Score, Firm Value, FCFF, FCFE

1. INTRODUCTION

In recent years, Environmental, Social, and Governance (ESG) scores have become a fundamental indicator for assessing corporate sustainability performance. Initially developed to guide socially responsible investment decisions, ESG criteria are now recognized by investors, regulators, and stakeholders as key indicators reflecting a firm's long-term strategic value and

risk profile. Rising awareness of climate change, social justice, and corporate transparency has necessitated the integration of ESG principles into corporate governance structures.

In the European context, regulations such as the European Green Deal, the Sustainable Finance Disclosure Regulation (SFDR), and the Corporate Sustainability Reporting Directive (CSRD) have contributed to the systematic and mandatory inclusion of ESG practices in corporate reporting processes. Accordingly, ESG performance is increasingly seen not only as a reputational indicator but also as a potential driver of firm value.

Firm value is typically assessed using financial indicators such as Free Cash Flow to the Firm (FCFF) or Free Cash Flow to Equity (FCFE), which reflect a company's future profitability potential and financial health. Theoretically, firms with strong ESG performance may achieve higher market valuations due to advantages such as reduced cost of capital, enhanced operational efficiency, lower regulatory risk, and increased investor confidence. However, the direction and strength of this relationship remain subjects of debate in the literature, due to variations across sectors and corporate structures.

A growing body of recent literature has explored the impact of ESG performance on firm value from multiple perspectives. A comprehensive meta-analysis conducted by Friede, Busch, and Bassen (2015) found that ESG criteria are generally positively associated with financial performance (Friede et al., 2015). These findings are supported by more recent studies. For example, Khan, Serafeim, and Yoon (2016) demonstrated that firms focusing on material ESG factors achieved higher stock returns and market value (Khan et al., 2016). Lins, Servaes, and Tamayo (2017) found that firms with high social capital exhibited stronger market performance during periods of crisis (Lins et al., 2017). A panel data analysis by Atan, Alam, Said, and Zamri (2018) showed that ESG performance had a significant and positive effect on firm value, particularly in emerging markets (Atan et al., 2018). Similarly, Albuquerque, Koskinen, and Zhang (2019) found that ESG practices reduced firm risk, thereby indirectly increasing market value (Albuquerque et al., 2019). Overall, these findings suggest that while the impact of ESG on firm value is context-dependent and multidimensional, the prevailing trend is generally positive.

This study aims to empirically examine the effect of ESG scores on firm value. To this end, the relationship between annual ESG scores and firm value indicators of the 30 largest publicly traded companies operating in Europe was analysed. Firm value was assessed using two cash-flow-based measures: Free Cash Flow to the Firm (FCFF) and Free Cash Flow to Equity (FCFE). A panel data analysis approach was employed to control for cross-sectoral differences and macroeconomic influences, and robustness tests were applied to enhance the validity of the

findings. Through this analysis, the study seeks to clarify the impact of sustainability performance on the valuation of leading European firms.

2. RESEARCH DESIGN

2.1. Data

This study aims to analyse the impact of Environmental, Social, and Governance (ESG) scores on firm value, focusing on the 30 largest publicly listed companies operating in Europe. Annual data covering the period from 2005 to 2024 were obtained from the Bloomberg Terminal.

Table 1. Variable List

Variable Name	Model Abbreviation	Variable Type
ESG Score	ESG	Independent Variable
Free Cash Flow to the Firm	FCFF	Dependent Variable
Free Cash Flow to Equity	FCFE	Dependent Variable
Firm Size	SIZE	Control Variable
Leverage Ratio	LEV	Control Variable
Profit Margin	PROF_MARGIN	Control Variable
Sales Growth	SALES_GROWTH	Control Variable

The annual ESG scores of firms were used as the independent variable. The ESG score is a composite index that numerically evaluates sustainability performance by encompassing environmental responsibility, social impact, and corporate governance practices.

The dependent variable is firm value, represented by two distinct measures: Free Cash Flow to the Firm (FCFF) and Free Cash Flow to Equity (FCFE). FCFF reflects the total cash flow available to all capital providers of the firm, while FCFE indicates the net cash flow remaining solely for equity investors. The use of both indicators aims to provide a comprehensive and balanced assessment of firm value.

To enhance the explanatory power of the model and control for potential external influences, five control variables were included in the analysis. The first, firm size, was calculated as the natural logarithm of total assets, to account for scale effects. Leverage ratio was defined as the ratio of total debt to total assets, representing the firm's financial risk level. Profit margin was computed as the ratio of net income to sales, indicating the firm's profitability performance.

Sales growth was measured by the annual growth rate in sales, representing the firm's future growth potential.

2.2. Method

All variables used in this study were expressed on different scales; therefore, to ensure comparability, they were normalized to a 0–1 range. The normalization process was performed using the following formula:

$$x' = \frac{x_i - x_{min}}{x_{max} - x_{min}}$$

To analyse the effect of ESG scores on firm value, a panel data regression method was employed in this study. Since firm value is represented by two distinct dependent variables—Free Cash Flow to the Firm (FCFF) and Free Cash Flow to Equity (FCFE)—separate panel regression models were constructed for each. This approach was chosen to provide a more comprehensive understanding of how ESG performance influences different dimensions of firm value.

The panel regression equations are presented below:

$$FCFF_{it} = \alpha + \beta_1. ESG_{it} + \beta_2. SIZE_{it} + \beta_3. LEV_{it} + \beta_4. PROF\_MARGIN_{it} + \beta_5. SALES\_GROWTH_{it} + \varepsilon_{it}$$

$$FCFE_{it} = \alpha + \beta_1. ESG_{it} + \beta_2. SIZE_{it} + \beta_3. LEV_{it} + \beta_4. PROF\_MARGIN_{it} + \beta_5. SALES\_GROWTH_{it} + \varepsilon_{it}$$

3. ANALYSIS AND FINDINGS

Before proceeding with the panel regression analysis, several preliminary tests were conducted to assess the fundamental assumptions of the dataset. In this context, the first test applied was the cross-sectional dependence test developed by Pesaran (2004), in order to determine the degree of interdependence among cross-sectional units in the panel structure. The results of the cross-sectional dependence test for each variable are presented below:

Table 2. Cross-Sectional Dependency Test Results

	FCFF	FCFE	ESG	SIZE	LEV	PROF_MARGIN	SALES_GROWTH
Paseran	26.34	24.66	83.13	56.58	20.47	7.91	9.38
CD-test	0.000	0.000	0.000	0.000	0.000	0.000	0.000
p-value							

All variables yielded p-values below 0.05, indicating the presence of cross-sectional dependence among the variables used in the analysis. This result suggests that cross-sectional dependence exists and will be taken into account in the subsequent stages of the analysis.

Given the presence of cross-sectional dependence in the dataset, the second-generation panel unit root test developed by Pesaran (2007), namely the Cross-sectionally Augmented IPS (CIPS) test, was applied to examine the stationarity of the series. This test accounts for common shocks and lag dependencies across the panel while determining whether the variables contain unit roots. In the CIPS test, a test statistic lower than the critical value indicates that the series is stationary. In this study, all tests were conducted at a 95% confidence level, with the critical value set at -2.15.

The results of the CIPS test are presented in the table below:

Table 3. Unit Root Test Results

Variable	Level	1.Difference
Test	CIPS	CIPS
ESG	-2.170	Stationary at the level
FCFF	-2.440	Stationary at the level
FCFE	-2.541	Stationary at the level
SIZE	-1.435	-3.530
LEV	-2.674	Stationary at the level
PROF_MARGIN	-2.925	Stationary at the level
SALES GROWTH	-3.861	Stationary at the level

According to the unit root test results, all variables were found to be stationary at level, except for firm size. The firm size variable became stationary after taking its first difference.

As a first step, a regression model was constructed using FCFF as the dependent variable to analyse the effect of ESG scores on firm value. To determine the appropriate panel data structure for this model, the Chow test, the Breusch–Pagan Lagrange Multiplier (LM) test, and the Hausman test were sequentially applied.

Table 4. Chow, Breusch-Pagan and Hausman Test Results

Test	t-stat	p-value
Chow(F)	1.97	0.0000
Breusch- Pagan	130.31	0.0000
Hausman	12.83	0.118

The results of the tests are presented in the table above. According to the Chow test, the fixed effects model is appropriate; the Breusch–Pagan test indicates that the random effects model is suitable; and the Hausman test also supports the random effects model. Since both the Breusch–Pagan and Hausman tests favour the random effects model, the analysis proceeds using a random effects panel regression model.

The regression results obtained from the random effects model are presented below. Before interpreting the findings, diagnostic tests were conducted to ensure that the model satisfies the underlying assumptions of regression analysis.

Table 5. Random Effects Regression Model

FCFF	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]
ESG	.031	.012	2.67	.008	.008	.054
DSIZE	.592	.127	4.66	0	.343	.84
LEV	.018	.016	1.12	.262	-.014	.05
PROF_MARGIN	-.016	.039	-0.41	.682	-.092	.06
SALES_GROWTH	-.048	.026	-1.87	.061	-.099	.002
Constant	.399	.016	25.20	0	.368	.43
Mean dependent var		0.448	SD dependent var			0.051
Overall r-squared		0.128	Number of obs			570
Chi-square		58.267	Prob > chi2			0.000
R-squared within		0.083	R-squared between			0.270

The results of the diagnostic tests for regression assumptions are presented in the table below. According to the findings, the model exhibits issues of heteroskedasticity, autocorrelation, and cross-sectional dependence.

Table 6. Regression Assumption Test Results

Assumption	Test	T-stat	P-value	Variable	VIF
Heteroskedasticity	Levene Brown Forsythe	W0:14.46 W50: 12.96 W10: 14.21	0.000 0.000 0.000	ESG	1.10
Autocorrelation	Wooldridge	52.364	0.000	DSIZE	1.07
Cross-Sectional Dependence	Paseran CD	90.91	0.0000	LEV	1.39
				PROF_MARGIN	3.01
				SALES_GROWTH	1.08
				MEAN VIF	2.10

Since the model exhibits heteroskedasticity, autocorrelation, and cross-sectional dependence, it is necessary to use a robust estimator. Therefore, the analysis was continued using the Driscoll-Kraay estimator, which accounts for these issues and is well-suited for datasets with both cross-sectional and time-series dimensions. The regression results estimated using the Driscoll-Kraay approach are presented below.

Table 7. Regression with Driscoll-Kraay Robust Estimator Results

Regression with Driscoll-Kraay standard errors Number of groups = 30
 Prob > chi2 = 0.0000
 Overall R-squared = 0.6280

FCFF	Coef.	Std.Err.	t	P>t	[95%Conf.	Interval]
ESG	0.031	0.009	3.480	0.003	0.012	0.050
DSIZE	0.592	0.540	1.090	0.000	-0.544	1.727
LEV	0.018	0.024	0.770	0.030	-0.032	0.069
PROF_MARGIN	0.016	0.063	0.250	0.000	-0.149	0.117
SALES_GROWTH	0.048	0.036	1.340	0.009	-0.124	0.027
_cons	0.399	0.019	20.870	0.000	0.359	0.439

The panel regression model estimated using the Driscoll-Kraay estimator is statistically significant overall, and the independent variables demonstrate a high level of explanatory power ($R^2 = 0.6280$). This indicates that the model has a strong capacity to explain firm value. The key independent variable, ESG score, has a positive and statistically significant effect on firm value ($\beta = 0.031$; $p < 0.01$). This finding suggests that a one-unit increase in ESG performance leads to an average increase of 0.031 units in firms' free cash flow, highlighting that firms with higher sustainability scores tend to have stronger cash generation capacities. This result confirms that ESG is a decisive factor not only in terms of social or environmental responsibility but also in its ability to create financial value.

When examining the control variables, firm size, leverage ratio, profit margin, and sales growth are all found to be statistically significant.

Finally, to analyse the effect of ESG scores on firm value, a regression model was constructed with FCFE as the dependent variable. Based on the tests conducted to determine the appropriate panel data structure, the fixed effects model was identified as the suitable model.

Table 8. Chow, Breusch-Pagan and Hausman Test Results

Test	t-stat	p-value
Chow(F)	2.46	0.0000
Breusch- Pagan	82.07	0.0000
Hausman	20.657	0.008

Subsequently, diagnostic tests were conducted to evaluate whether the regression model estimated using the fixed effects approach satisfied the classical regression assumptions. The results indicated the presence of heteroskedasticity, autocorrelation, and cross-sectional dependence in the model.

Table 9. Regression Assumption Test Results

Assumption	Test	T-stat	P-value	Variable	VIF
Heteroskedasticity	Wald	21.35	0.000	ESG	1.10
Autocorrelation	Wooldridge	26.74	0.000	DSIZE	1.07
Cross-Sectional Dependence	Paseran CD	80.92	0.0000	LEV	1.39
				PROF_MARGIN	3.01
				SALES_GROWTH	1.08
				MEAN VIF	2.10

Since the model exhibited heteroskedasticity, autocorrelation, and cross-sectional dependence, the panel regression analysis was re-estimated using the Driscoll-Kraay robust estimator, which accounts for these issues. The regression results are presented below.

Table 10. Regression with Driscoll-Kraay Robust Estimator Results

Regression with Driscoll-Kraay standard errors Number of groups = 30
 Prob > chi2 = 0.0000
 Overall R-squared = 0.4250

FCFE	Coef.	Std.Err.	t	P>t	Interval] [95%Conf.	
ESG	0.026	0.007	3.640	0.002	0.011	0.041
DSIZE	0.837	0.540	1.550	0.000	-0.298	1.972
LEV	0.077	0.035	2.200	0.006	0.003	0.150
PROF_MARG IN	0.062	0.037	-1.660	0.000	-0.140	0.017
SALES_GRO WTH	0.038	0.025	-1.500	0.008	-0.091	0.015
_cons	0.394	0.021	18.830	0.000	0.350	0.437

The panel regression model with FCFE as the dependent variable yielded statistically significant results, with an overall explanatory power of 42.5% ($R^2 = 0.425$). This value indicates that the independent variables explain a considerable portion of the variation in firm value. The main independent variable, ESG score, was found to have a positive and statistically significant effect on firm value ($\beta = 0.026$; $p < 0.01$). A one-unit increase in ESG performance is associated with an average increase of 0.026 units in free cash flow to equity. This finding demonstrates that sustainability practices generate not only operational benefits but also financial returns for equity investors. Regarding the control variables, all—firm size, leverage ratio, profit margin, and sales growth—were found to be statistically significant.

4. CONCLUSIONS

Sustainability is increasingly becoming a central component in modern financial decision-making processes, influencing not only a firm's environmental or ethical responsibilities but also its long-term financial performance. This study aimed to examine the effect of sustainability performance, represented by ESG scores, on firm value. To this end, data from the 30 largest firms operating in Europe between 2005 and 2024 were analyzed using a panel data approach. Firm value was measured using two indicators—Free Cash Flow to the Firm

(FCFF) and Free Cash Flow to Equity (FCFE)—and ESG scores were found to have a significant and positive effect in both models.

The findings indicate that ESG performance plays a critical role in enhancing firm value. This suggests that sustainability practices not only contribute to social and environmental outcomes but also reinforce investor confidence and support the creation of financial value. In particular, the FCFF model highlights ESG scores as the strongest and most consistent explanatory variable, underscoring the positive impact of sustainability investments on operational cash generation. While financial structure variables were more prominent in the FCFE model, ESG performance still emerged as a noteworthy factor in value creation.

Considering these findings, it is important for policymakers and regulatory authorities to promote practices that encourage firms to engage in sustainability reporting. Similarly, investors are advised to adopt analytical approaches that extend beyond traditional financial statements to incorporate ESG performance, thus enabling more robust and forward-looking investment decisions. For businesses, it is essential to view sustainability strategies not only as tools for reputation management but also as value-enhancing components that should be integrated into a comprehensive corporate governance framework.

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2020'DEN SONRA GÜNEY KAFKASYA'DA BATI AVRUPA JEOPOLİTİK DOKTRİNLERİNİN YENİDEN AYARLANMASI: STRATEJİK BELİRSİZLİKLER VE ORTAYA ÇIKAN YENİDEN YAPILANDIRMALAR

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ÖZET

2020'deki İkinci Karabağ Savaşı'nın ardından, kolektif Batı, özellikle Batı Avrupa, normatif diplomasi ve pragmatik korunmanın yeni bir füzyonu yoluyla bölgeye yönelik stratejik doktrinlerini yeniden kalibre etmeye çalıştı. Tarihsel olarak, özellikle Avrupa Komşuluk Politikası ve Doğu Ortaklığı girişimi aracılığıyla koşulluluğa ve demokratik dönüşüme vurgu yapan normatif bir yaklaşımla karakterize edilen Batı Avrupa, büyük ölçüde yumuşak güç ve teknokratik etki projeksiyonu yoluyla faaliyet gösterdi. Ancak, 2020 sonrası durum, değişen güç dengesi ve Güney Kafkasya'daki yeni jeopolitik gerçekler nedeniyle doktrinel bir değişiklik gerektirdi. Bu bağlamda, nominal olarak Fransa ve Almanya tarafından yönetilen Avrupa Birliği, stratejik belirsizlik, zorlayıcı diplomasi ve seçici angajman unsurlarını iç içe geçiren karma bir doktrin benimsedi. Batı yanlısı bir yabancı olarak Gürcistan, AB normlarıyla kurumsal yakınlaşmasını değerlendirerek Avro-Atlantik entegrasyon yolunda ilerlemeye devam ediyor, ancak iç demokratik gerileme tarafından engelleniyor. Öte yandan Ermenistan, Rusya ile tarihi güvenlik uyumu ile Avrupa güvenlik garantilerinin ortaya çıkan cazibesi arasında gidip gelerek stratejik bir atalet paradoksunun içinde sıkışmış halde buluyor kendini; kapsamlı bir barış çerçevesi konusunda içeride bir fikir birliğinden yoksun olmasına rağmen. Aynı zamanda Azerbaycan, Karabağ'da askeri-diplomatik bir oldubitti ile egemenliğini yeniden iddia ederek, AB'nin geleneksel arabuluculuk mekanizmalarına meydan okumuş ve önceki "tarafsız kolaylaştırıcı" statüsünü diplomatik olarak geçersiz kılmıştır. Bazı Batı Avrupa aktörleri (Fransa gibi) Azerbaycan'ın savaş sonrası toprak restorasyonunu tam olarak meşrulaştırma konusunda çekingen davranmış, insan hakları söylemlerini ve Ermeni iddialarına gizli desteği öne sürmüş olsalar da, bu direnişin etkinliği 2025'e kadar azaldı. Azerbaycan'ın yüksek profilli çok taraflı etkinlikleri başarılı bir şekilde düzenlemesi ve AB ile stratejik enerji ortaklıkları, daha önceki Batı şüpheciliğini susturdu ve Avrupa duruşlarının isteksizce yeniden ayarlanmasını hızlandırdı. Bununla birlikte, Avrupa içi ayrışmalar devam ediyor ve birleşik bir stratejik uzlaşının yokluğunu ortaya koyuyor. Güney Kafkasya'nın çevresel normatif bir alandan tartışmalı bir jeostratejik arayüze dönüşümü, Batı Avrupa'yı beyan politikalarının

ötesine geçmeye, bölgede daha çoğulcu, hala parçalanmış olsa da, jeopolitik bir angajman mimarisini benimsemeye zorladı.

Anahtar Kelimeler: Stratejik belirsizlik, Batı Avrupa doktrinleri, Güney Kafkasya, Jeopolitik yeniden ayarlama, Karabağ Savaşı sonrası dinamikler.

RECALIBRATING WESTERN EUROPEAN GEOPOLITICAL DOCTRINES IN THE SOUTH CAUCASUS AFTER 2020: STRATEGIC AMBIGUITIES AND EMERGING RECONFIGURATIONS

ABSTRACT

In the aftermath of the Second Karabakh War in 2020, the collective West, particularly Western Europe, has attempted to recalibrate its strategic doctrines towards the region through a new fusion of normative diplomacy and pragmatic hedging. Historically characterized by a normative approach emphasizing conditionality and democratic transformation, especially through the European Neighbourhood Policy and the Eastern Partnership initiative, Western Europe has largely operated through soft power and technocratic influence projection. However, the post-2020 situation required a doctrinal change due to the shifting balance of power and the new geopolitical realities in the South Caucasus. In this context, the European Union, nominally led by France and Germany, has adopted a hybrid doctrine that intertwines elements of strategic ambiguity, coercive diplomacy and selective engagement. Georgia, as a pro-Western outsider, continues on its path of Euro-Atlantic integration, capitalizing on its institutional convergence with EU norms, although hampered by internal democratic backsliding. Conversely, Armenia finds itself entrapped in a paradox of strategic inertia, vacillating between its historical security alignment with Russia and the emerging allure of European security guarantees—despite lacking consensus domestically on a comprehensive peace framework. Simultaneously, Azerbaijan has reasserted its sovereignty through a military-diplomatic *fait accompli* in Karabakh, challenging the EU's traditional mediation mechanisms and rendering its prior “neutral facilitator” status diplomatically obsolete. While some Western European actors—such as France—have been reticent to fully legitimize Azerbaijan's post-war territorial restoration, invoking human rights discourses and latent support for Armenian claims, the efficacy of this resistance has waned by 2025. Azerbaijan's successful orchestration of high-profile multilateral events and its strategic energy partnerships with the EU have muted earlier Western skepticism, catalyzing a reluctant recalibration of European postures. Nevertheless, intra-European divergences persist, revealing the absence of a unitary strategic consensus. The transformation of the South Caucasus from a peripheral normative space into a contested

geostrategic interface has forced Western Europe to move beyond its declaratory policies, embracing a more pluralistic, if still fragmented, and geopolitical engagement architecture in the region.

Keywords: Strategic ambiguity, Western European doctrines, South Caucasus, Geopolitical recalibration, Post-Karabakh War dynamics.

INTRODUCTION

The South Caucasus has long occupied an ambiguous position in the European strategic consciousness—a liminal space alternately regarded as a peripheral zone of normative outreach or a marginal buffer against systemic volatility. However, the post-2020 regional reordering, catalyzed by the Second Karabakh War, has irrevocably altered the functional and symbolic role of the region in the architecture of European foreign policy. This transformation has not merely shifted tactical priorities but has prompted an ontological challenge to the very premises upon which Western European engagement has historically rested.

In the past, the European Union, alongside its leading member states, approached the South Caucasus through a teleological lens that presumed the eventual convergence of regional polities with EU-defined political, legal, and normative standards. This model, centered on conditionality and value diffusion, operated within a framework of presumed asymmetry—wherein European institutions served as reference points, and regional actors as aspirants. Yet the events of 2020 and their aftermath exposed the fragility and obsolescence of this model. The rapid consolidation of Azerbaijan's sovereignty, the attenuation of Armenia's traditional strategic alignments, and Georgia's increasingly ambivalent democratic trajectory have disrupted the assumed linearity of transformation.

What emerges is a region that can no longer be interpreted through the binary prisms of democratic transition versus authoritarian stagnation, or East versus West. Instead, the South Caucasus now functions as a complex and pluralistic strategic interface in which localized agency, infrastructural geopolitics, and multivectoral diplomacy coalesce to produce outcomes independent of, and often resistant to, Western expectations. Against this backdrop, Western Europe's inability to articulate a coherent and adaptive doctrine has led to a crisis of both credibility and capacity.

This study seeks to interrogate the structural and epistemological disjunctions that have rendered Western European doctrines misaligned with post-war realities in the South Caucasus. It examines how the erosion of traditional instruments—normative leverage, conditionality-based partnerships, and multilateral mediation frameworks—has compelled a reluctant yet

necessary recalibration. Moreover, it explores the implications of emerging regional architectures spearheaded by actors such as Azerbaijan, which no longer operate within externally imposed paradigms but define their own strategic priorities, interlocutors, and modalities of engagement.

By analyzing the doctrinal paralysis of Western Europe, the strategic reassertion of Azerbaijan, and the shift toward infrastructural and geoeconomic modes of influence, this paper contributes to a broader understanding of how geopolitical agency is being reconfigured in the contemporary international system. It posits that the South Caucasus is not merely a site of strategic ambiguity, but a crucible in which the future relevance of Western European foreign policy is being tested.

I. STRATEGIC DISLOCATION AND DOCTRINAL PARALYSIS: WESTERN EUROPE'S DIMINISHING AGENCY

The collapse of the normative order that had undergirded Western European engagement in the South Caucasus since the early 2000s is no longer a theoretical proposition but an observable empirical reality. What was once a semi-structured, values-driven policy ecosystem—rooted in the language of democratic transformation, market liberalization, and rule-of-law conditionalities—has encountered profound systemic fatigue. The region's post-2020 transformation, catalyzed by the Second Karabakh War and the concurrent unraveling of Euro-Atlantic consensus on peripheral diplomacy, has starkly revealed the structural limitations of this once-dominant paradigm. Western Europe, and particularly the EU, has found itself conceptually unprepared and institutionally under-equipped to navigate the abrupt recalibration of power centers in the South Caucasus.

This strategic inertia is compounded by the internal fragmentation of Western foreign policymaking itself. With divergent national interests, incompatible risk perceptions, and varying levels of political investment in the region, Western European states have failed to articulate a unified doctrinal vision. While France oscillates between normative posturing and identity-driven advocacy, Germany privileges macroeconomic stability and energy diversification over political entanglement. The UK's policy towards the region remains loosely articulated, transactional, and structurally ad hoc. These incongruences have rendered Western Europe reactive rather than proactive—a geopolitical posture fundamentally misaligned with the pace and complexity of South Caucasus transformations.

The post-2020 configuration has brought to the surface an even deeper ontological crisis for Western Europe's geopolitical self-perception: whether it seeks to be a normative power, a pragmatic broker, or a geopolitical actor with strategic assets in its periphery. In the South

Caucasus, such ambivalence is no longer tenable. The assertion of military-political agency by regional actors—particularly Azerbaijan and Turkey—has invalidated the normative monopoly long presumed by the EU. The efficacy of “soft power” has been severely curtailed by its detachment from enforceable strategic commitments and its inability to meaningfully influence conflict trajectories or post-conflict reconstruction.

Moreover, Western Europe’s traditional instruments of engagement have been overtaken by events. The demise of the OSCE Minsk Group—once the institutional embodiment of Euro-Atlantic multilateralism in the conflict—is not merely a symptom of regional realignments, but a case study in the obsolescence of declaratory diplomacy. The rhetorical commitments of Brussels to stability and dialogue remain unmatched by operational presence or policy specificity. This asymmetry between discourse and capability has resulted in diminishing returns in influence, thereby facilitating an environment in which alternative frameworks—anchored by Russia, Turkey, and increasingly China—occupy the strategic void.

Crucially, the epistemic dissonance within Western European narratives about the region continues to impede coherent policy formation. The reliance on outdated binary framings—civilized democracy versus authoritarian regression, victim versus aggressor, pro-Western versus revisionist—no longer corresponds to the empirical complexity of the South Caucasus. In fact, these framings often serve as heuristic shortcuts that obscure rather than illuminate the region’s political fluidity and strategic diversity. For Azerbaijan, whose foreign policy has deftly combined assertive diplomacy, energy leverage, and multivectoral partnerships, Western misreadings risk not only misunderstanding Baku’s strategic calculus but misaligning the very premises of engagement.

In this context, the first step toward a credible Western European recalibration is intellectual: the abandonment of normative dogmatism in favor of an adaptive strategic grammar. This does not entail the forfeiture of values, but rather their reconceptualization within a realist framework that acknowledges agency, sovereignty, and regional specificity. Without such a shift, Western Europe will remain trapped in a doctrinal paralysis—deploying obsolete tools in a strategic theatre that has already moved beyond them.

II. FROM PERIPHERAL INFLUENCE TO STRATEGIC REASSESSMENT: WESTERN EUROPE’S SHIFTING POLICY TERRAIN

The post-2020 evolution of the South Caucasus has not merely tested Western Europe’s instruments of influence—it has compelled a foundational reassessment of the region’s place in the European strategic imagination. No longer viewed as a peripheral neighborhood passively awaiting normative transformation, the South Caucasus has emerged as a dynamic geostrategic

interface where narratives of transition and democratization have been overtaken by imperatives of security, connectivity, and sovereignty. This shift has disrupted Western Europe's ability to act through established technocratic modalities and has required a recalibration of both the content and instruments of engagement.

Historically, Western European policy approaches were embedded in a temporal logic of gradualism: assuming that time, institutional alignment, and the promise of conditional incentives would produce internal convergence among the South Caucasus states with EU-defined norms. However, this linear framework has proven ill-suited to the region's post-war tempo. The rapid resolution of the Karabakh issue by Azerbaijan, and the consequent redefinition of inter-state power relations, introduced a discontinuity that invalidated the logic of slow transformation. In its place, a more agile and interest-driven form of engagement has begun to surface—albeit in a fragmented, inconsistent fashion.

One of the most striking developments has been the emergence of selective functionalism as a *de facto* *modus operandi* for Western Europe. Rather than pursuing comprehensive political transformation or deep integration, engagement now occurs along sectoral lines: energy security, border management, humanitarian oversight, and digital connectivity. These areas offer concrete deliverables and minimize political friction, but they also fragment the EU's presence, reducing its capacity to articulate a coherent strategic vision. The result is an engagement architecture based less on overarching doctrine and more on bureaucratic inertia and policy compartmentalization.

Moreover, the geopolitical revaluation of the region has heightened the salience of infrastructural geopolitics. Western Europe's reliance on the South Caucasus as a transit node in the evolving East-West connectivity landscape—particularly through the Trans-Caspian International Transport Route (TITR)—has embedded geoeconomic logic into what was previously an ideologically structured foreign policy. This materialization of strategic interests has generated a paradox: as the region becomes more economically significant to European calculations, the EU's ability to shape political outcomes within it appears to diminish proportionally.

The regional asymmetry of state capacities further complicates the picture. Azerbaijan's growing agency in setting the terms of regional engagement, bolstered by energy partnerships and logistical leverage, has altered the nature of dialogue. No longer treated as a recipient of European tutelage, Azerbaijan increasingly operates as a co-constructor of the new regional order. This status is reflected in Baku's posture towards European initiatives: cooperative when strategically beneficial, assertively autonomous when political alignment is at stake. Such

calibrated flexibility challenges traditional European approaches predicated on asymmetrical influence and hierarchical conditionality.

In contrast, Armenia's post-war foreign policy oscillations have created a site of latent competition among external actors. Western Europe's increased diplomatic footprint in Yerevan—ranging from EU civilian missions to increased financial instruments—illustrates a desire to capitalize on Armenia's tentative pivot away from Russian security guarantees. Yet this engagement remains highly contingent, not only on internal Armenian consensus but also on the evolving nature of Yerevan's relations with Moscow and Tehran. Here, Western Europe risks repeating a familiar pattern: overinvesting in symbolic visibility while underestimating structural dependencies and geopolitical vulnerabilities.

What is notably absent from Western Europe's approach is a capacity for anticipatory governance. The lack of early institutional adaptation to post-war realities, the failure to rethink frameworks such as the Eastern Partnership in light of the new strategic environment, and the persistent lag between discourse and deployment underscore a crisis of political imagination. While other actors—chiefly Turkey and China—have operationalized long-term strategies that align infrastructure with influence, Western Europe remains constrained by a reactive mode of engagement tethered to past policy legacies.

In essence, the post-2020 moment has exposed not only the limitations of existing Western European mechanisms in the South Caucasus, but also the absence of intellectual infrastructure to generate alternatives. Without a deliberate shift toward strategic foresight and region-specific policymaking, Western engagement risks becoming structurally obsolete—even where its presence is nominally visible. The challenge, therefore, lies not simply in recalibrating doctrine, but in fundamentally reconstituting the epistemological assumptions that have long governed Western perceptions of the South Caucasus.

III. AZERBAIJAN AS A SYSTEM-MAKER: STRATEGIC SOVEREIGNTY AND THE COLLAPSE OF EXTERNAL MEDIATION

One of the most underappreciated outcomes of the post-2020 geopolitical reordering in the South Caucasus has been the irreversible transformation of Azerbaijan's international profile—from that of a conflict-affected actor to a regional system-maker. This metamorphosis has not only recalibrated the balance of power in the South Caucasus but has also invalidated many of the foundational premises upon which Western European diplomatic architectures were historically constructed. In particular, the assumption that conflict resolution in the region necessitated perpetual external mediation has been conclusively challenged.

The Second Karabakh War, while brief in duration, was strategically decisive. Azerbaijan's integrated application of military precision, diplomatic sequencing, and narrative control demonstrated a level of sovereign capacity that Western policymakers neither anticipated nor adequately interpreted. By engineering a military-diplomatic fait accompli and simultaneously managing external reactions, Baku not only reasserted territorial integrity but also rendered obsolete the decades-old logic of externally sustained "frozen conflict management." In doing so, Azerbaijan exhibited a rare synthesis of hard power calculus and strategic communication—elements traditionally reserved for larger, globally integrated powers.

What followed was not simply post-conflict stabilization but the active construction of a new regional grammar, one in which Azerbaijan plays the role of a pivotal gatekeeper. The leadership in Baku, marked by institutional continuity, diplomatic coherence, and geopolitical foresight, has avoided the twin traps of triumphalism and isolationism. Instead, it has opted for a calibrated post-victory strategy centered on multidimensional partnerships, economic interlinkages, and narrative legitimacy. This has included expanding relations with non-Western powers while simultaneously deepening engagement with EU institutions on pragmatic terms—most notably in the energy sector and logistical infrastructure.

In contrast to Western Europe's fragmented doctrinal landscape, Azerbaijan's foreign policy has displayed rare internal consistency and strategic depth. It has leveraged normative ambiguity within the EU to extract functional cooperation without compromising on sovereign prerogatives. The energy dialogue with Brussels, the hosting of global climate and connectivity summits, and the articulation of Baku as a logistics and security hub have allowed Azerbaijan to reposition itself from the margins to the center of Eurasian strategic corridors. This elevation has created a dynamic in which European actors increasingly operate in Azerbaijan-defined frameworks, rather than vice versa.

The West's inability to recognize and adapt to this shift has had structural consequences. The EU's earlier positioning as a neutral facilitator—exemplified through the OSCE Minsk Group—has collapsed under the weight of its own irrelevance. European rhetorical gestures toward balance and fairness have lost traction in a geopolitical environment that no longer tolerates declaratory diplomacy without operational substance. While certain European capitals have attempted to revive normative leverage—often under pressure from diaspora lobbies or historical narratives—such efforts have yielded diminishing returns and, in some cases, counterproductive reputational costs.

Azerbaijan's strategic behavior has also introduced a new conceptual challenge for Western foreign policy institutions: how to engage with a regional actor that combines normative

independence with functional indispensability. This configuration defies the traditional tools of conditionality, asymmetrical aid diplomacy, or normative benchmarking. It requires the recognition that influence is increasingly earned through relevance and capacity—not conferred through alignment or institutional mimicry.

Moreover, the Baku-led model of post-conflict management—centered on sovereign agency, regional ownership, and infrastructural integration—presents a viable alternative to externally imposed templates of peacebuilding. The country’s calibrated handling of sensitive issues such as enclave reintegration, border delimitation, and civilian normalization has demonstrated that regional solutions, when grounded in state capacity and forward-looking leadership, can outperform externally led conflict transformation models that rely on moral arbitration and technocratic sequencing.

In light of these dynamics, any future Western European engagement in the South Caucasus must begin with a realistic assessment of power dispersion and a recalibration of its assumptions about hierarchy, leverage, and legitimacy. Azerbaijan’s trajectory suggests that strategic respect, not pedagogical diplomacy, constitutes the only viable basis for sustainable partnership in the region’s emerging multipolar landscape. Without a fundamental revision of both language and posture, Western Europe will remain a spectator in a geopolitical space increasingly shaped by others—and most notably, by the sophisticated and self-assured diplomacy of Baku.

IV. GEOECONOMICS AS STRATEGY: INFRASTRUCTURE, ENERGY, AND AZERBAIJAN’S LEVERAGED CENTRALITY

In an era of fragmented multilateralism and intensifying geopolitical competition, the ability of states to shape regional outcomes increasingly hinges not on ideological alignment but on infrastructural centrality and geoeconomic utility. Nowhere is this more evident than in Azerbaijan’s post-2020 strategic calculus. By repositioning itself as a logistical epicenter and indispensable energy partner, Azerbaijan has fundamentally altered the power geometry of the South Caucasus. This transformation has had significant implications for Western Europe, which now finds itself economically intertwined with a regional actor whose strategic autonomy defies conventional frameworks of engagement.

The development of multimodal infrastructure—anchored by the Baku–Tbilisi–Kars railway, the Alat Free Economic Zone, and the Trans-Caspian International Transport Route (TITR)—has allowed Azerbaijan to reconfigure its geography into an instrument of strategic leverage. These infrastructural corridors are not merely logistical conduits; they are mechanisms of geopolitical agency. By facilitating East–West trade independent of Russian and Iranian

chokepoints, Azerbaijan has created a spatial alternative that directly serves European strategic diversification goals.

From the European perspective, the significance of this connectivity is no longer abstract. The war in Ukraine and the subsequent disruption of Eurasian transit routes via Russia have elevated the South Caucasus to an infrastructural pivot. Brussels' deepening engagement with Azerbaijan on energy and transport is therefore not an act of ideological convergence but one of strategic necessity. However, this necessity is asymmetrically distributed. While the EU needs Azerbaijan to operationalize its diversification strategy, Azerbaijan retains multiple vectors of cooperation—Eastward with China via the Belt and Road, and Southward with the Gulf via Middle Corridor extensions.

This asymmetry has been further institutionalized through bilateral energy diplomacy. The July 2022 Memorandum of Understanding between the EU and Azerbaijan on a strategic energy partnership, aimed at doubling gas exports by 2027, exemplifies a reconfiguration of the EU's external energy strategy. What is striking, however, is the absence of normative conditionality in this arrangement—a departure from previous European practice. This silence is not coincidental but symptomatic of a broader recalibration: European capitals are increasingly aware that their normative toolkit holds diminishing traction in contexts where infrastructural indispensability supersedes governance benchmarks.

Table 1. Major Infrastructure and Energy Projects of Azerbaijan and Their Strategic Value for the EU

Project/Initiative	Description	Strategic Value for the EU
Baku–Tbilisi–Kars Railway	Connects Azerbaijan with Turkey via Georgia	An alternative land route bypassing Russia
Alat Free Economic Zone	A logistics and industrial hub in the Caspian region	A node for the distribution of Trans-Caspian flows
Southern Gas Corridor (TANAP–TAP)	A gas pipeline system delivering Caspian gas to the EU	Energy security and reduction of dependence on Russia
Zangazur Multimodal Link (planned)	A connection to Nakhchivan and Turkey	Reconfiguration of intra-continental transit
Trans-Caspian International Transport Route	Corridor from China through the Caspian, the Caucasus, and on to Europe	A key component of EU–China connectivity bypassing Russia and Iran

The sophistication of Azerbaijan's infrastructural strategy is further evidenced by its integration into climate diplomacy. Hosting COP29 in 2024 was not merely an act of global visibility—it was a strategic maneuver to position Baku as a convening power at the intersection of environmental governance and energy geopolitics. For European actors facing internal energy

transitions and external supply uncertainties, Azerbaijan has become both a supplier and a platform, a rare dual role that expands Baku's influence beyond hard assets.

Crucially, these dynamics have produced a qualitative shift in how partnership is conceptualized. The traditional European model—anchored in asymmetry, where aid and access were granted in return for reform—is no longer operative. In its place emerges a horizontal logic of mutual indispensability, wherein Azerbaijan is not a petitioner, but a provider. The implication is clear: Europe must now calibrate its expectations and rhetoric in line with Azerbaijan's strategic value, or risk forfeiting influence to more adaptable actors such as China or Türkiye.

Azerbaijan's leadership, characterized by long-term vision and diplomatic coherence, has not merely responded to shifts in global supply chains—it has anticipated them. This anticipatory governance, coupled with domestic political stability and economic diversification, constitutes a rare case in Eurasia of sustained strategic depth. While the EU continues to debate frameworks and conditionalities, Baku builds corridors, signs contracts, and hosts summits. In the language of power, Azerbaijan speaks with fluency; Western Europe, too often, remains caught in translation.

CONCLUSION

The post-2020 transformation of the South Caucasus marks a decisive rupture in the trajectory of Western European foreign policy toward the region. No longer a passive arena for normative experimentation or peripheral engagement, the region has become a site of active geopolitical contestation, shaped as much by indigenous strategic vision as by external interest. In this evolving landscape, Western Europe finds itself ill-equipped—doctrinally fragmented, operationally limited, and strategically hesitant.

This disjuncture is not merely the result of miscalculation or policy inertia. Rather, it reflects a deeper misalignment between the epistemic frameworks through which Western Europe interprets the region and the empirical realities that now define it. The assumption that regional transformation can be induced through soft power, institutional mimicry, and hierarchical tutelage has been decisively undermined by the emergence of actors—most notably Azerbaijan—that assert their sovereignty not as aspirational alignment with Europe, but as autonomous construction of alternative strategic orders.

Azerbaijan's transition from a conflict-affected state to a regional system-maker embodies the broader shift from normative dependence to strategic self-determination. Its orchestration of logistical, diplomatic, and energy-centric influence—framed not within Western normative templates but through infrastructural agency and geopolitical leverage—has introduced a new

logic into regional interactions. This logic is one of horizontal interdependence, transactional legitimacy, and pragmatic pluralism. It renders obsolete the conditionalities and declaratory diplomacy that once structured EU engagement.

The failure of Western Europe to anticipate or adequately respond to this shift has consequences that go beyond the South Caucasus. It signals a broader erosion of Western influence in regions where strategic value is increasingly defined by connectivity, capacity, and context, rather than ideological conformity. The EU's continued reliance on outdated instruments, coupled with its internal incoherence, has created a vacuum that is rapidly being filled by more agile actors such as Türkiye, China, and to a waning extent, Russia. In contrast, Western Europe risks becoming a declarative observer—visible yet ineffective, engaged yet peripheral.

If Western Europe is to remain a relevant actor in the South Caucasus and analogous regions, it must undertake a profound rethinking of its strategic grammar. This entails abandoning the dichotomies of democracy versus authoritarianism, integration versus exclusion, and instead embracing a more nuanced, flexible, and responsive model of engagement. Such a shift does not require the abdication of values but their recontextualization within frameworks that respect local agency, acknowledge plural strategic identities, and prioritize mutual relevance over ideological alignment.

In sum, the South Caucasus represents not only a challenge to Western European doctrines but a diagnostic space in which the viability of post-Cold War foreign policy paradigms is being reevaluated. The lessons emerging from the region compel a move from prescriptive universalism to contextual realism—a transition that will determine whether Western Europe remains a credible geopolitical actor or resigns itself to marginality in an increasingly multipolar world.

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ANAYASAL HAKLARIN KORUNMASINDA ANAYASA MAHKEMELERİNİN ROLÜ: TÜRKİYE VE AVRUPA ÖRNEĞİ

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Özet

Bu çalışma, anayasal hakların korunmasında anayasa mahkemelerinin rolünü Türkiye ve Avrupa ülkeleri örneğinde karşılaştırmalı olarak ele almaktadır. Anayasa mahkemeleri, anayasal düzenin ve bireylerin temel hak ve özgürlüklerinin korunmasında kritik bir role sahiptir. Türkiye ve Avrupa'daki anayasa mahkemelerinin yapısı, işleyişi ve bireysel başvuru mekanizmaları ayrıntılı olarak incelenmiş, bu mekanizmaların anayasal hakların korunmasındaki etkinliği analiz edilmiştir. Türkiye'de Anayasa Mahkemesi, 1961 Anayasası ile kurulmuş ve bireysel başvuru hakkı 2010 yılında kabul edilmiştir. Bu mahkeme, bireylerin anayasal haklarını koruma konusunda merkezi bir rol üstlenmektedir. Avrupa'da ise Almanya, Fransa ve İspanya gibi ülkeler, gelişmiş anayasa mahkemeleri ve bireysel başvuru hakları ile insan hakları ve temel özgürlüklerin korunmasında öncü rol oynamaktadır. Avrupa İnsan Hakları Mahkemesi'nin etkisi, bu ülkelerdeki anayasal hakların korunmasında belirleyici olmuştur.

Karşılaştırmalı analiz yöntemi kullanılarak, Türkiye ve Avrupa'daki anayasa mahkemelerinin anayasal hakları koruma kapasiteleri değerlendirilmiştir. Türkiye'nin anayasa mahkemesi, bireysel başvuru mekanizması ile hak ihlallerine karşı bireylerin doğrudan başvurabilmesini sağlarken, Avrupa'da bu mekanizma daha köklü bir geçmişe sahiptir ve anayasa mahkemelerinin içtihatları ile güçlendirilmiştir. Almanya'da Federal Anayasa Mahkemesi, Fransa'da Anayasa Konseyi ve İspanya'da Anayasa Mahkemesi, bireylerin haklarını koruma konusunda güçlü ve etkili birer araç olarak işlev görmektedir. Avrupa İnsan Hakları Mahkemesi'nin içtihatları ise anayasa mahkemelerinin hak koruma kapasitesini artıran önemli bir faktör olmuştur.

Bu çalışma, Türkiye ve Avrupa örneğinden yola çıkarak, anayasa mahkemelerinin anayasal hakların korunmasındaki rollerini ve etkinliklerini değerlendirmekte, Türkiye'nin anayasa mahkemesi uygulamalarının Avrupa'daki iyi örneklerle daha uyumlu hale getirilmesi gerektiğini vurgulamaktadır. Anayasa mahkemelerinin tarafsızlığı, bağımsızlığı ve bireysel başvuruların etkin bir şekilde değerlendirilmesi, anayasal hakların korunmasında kritik bir öneme sahiptir.

Son olarak, teknolojik gelişmelerin ve dijital hakların korunmasının anayasa mahkemelerinin gündemine daha fazla girmesi gerektiği önerilmektedir.

Anahtar Kelimeler: Anayasa Mahkemesi, Anayasal Haklar, Bireysel Başvuru, Türkiye, Avrupa, İnsan Hakları

THE ROLE OF CONSTITUTIONAL COURTS IN THE PROTECTION OF CONSTITUTIONAL RIGHTS: THE CASE OF TURKEY AND EUROPE

Abstract

This study examines the role of constitutional courts in the protection of constitutional rights through a comparative analysis of Turkey and European countries. Constitutional courts play a critical role in safeguarding the constitutional order and the fundamental rights and freedoms of individuals. The structure, functioning, and individual application mechanisms of constitutional courts in Turkey and Europe have been analyzed in detail, and the effectiveness of these mechanisms in protecting constitutional rights has been assessed. In Turkey, the Constitutional Court was established under the 1961 Constitution, and the right to individual application was introduced in 2010. This court plays a central role in protecting the constitutional rights of individuals. In Europe, countries such as Germany, France, and Spain are leading in the protection of human rights and fundamental freedoms through well-established constitutional courts and the right to individual application. The influence of the European Court of Human Rights has been decisive in the protection of constitutional rights in these countries.

Using a comparative analysis method, the capacities of constitutional courts in Turkey and Europe to protect constitutional rights have been evaluated. While the Turkish Constitutional Court allows individuals to directly apply in cases of rights violations through the individual application mechanism, this mechanism has a longer history in Europe and is reinforced by the jurisprudence of constitutional courts. In Germany, the Federal Constitutional Court, in France, the Constitutional Council, and in Spain, the Constitutional Court function as strong and effective tools for protecting individual rights. The jurisprudence of the European Court of Human Rights has been an essential factor in enhancing the rights protection capacity of constitutional courts.

This study emphasizes the need for Turkey's Constitutional Court practices to become more aligned with the best practices in Europe. It evaluates the roles and effectiveness of constitutional courts in protecting constitutional rights in Turkey and Europe. The impartiality,

independence, and effective evaluation of individual applications by constitutional courts are of critical importance in the protection of constitutional rights. Finally, it is recommended that technological developments and the protection of digital rights should become more prominent on the agenda of constitutional courts.

Keywords: Constitutional Court, Constitutional Rights, Individual Application, Turkey, Europe, Human Rights.

Giriş

Anayasa mahkemeleri, anayasal hakların korunmasında temel bir güvence mekanizması olarak işlev görür. Anayasal haklar, bireylerin devlet karşısında sahip olduğu koruma kalkanını oluşturur ve bu hakların korunması, demokratik bir hukuk devletinin olmazsa olmaz koşuludur. Anayasa mahkemeleri, yasaların, idari işlemlerin ve hatta anayasal değişikliklerin anayasal düzenle uyumlu olup olmadığını denetleyerek, bireylerin temel hak ve özgürlüklerini güvence altına alır. Bu bağlamda anayasa mahkemeleri, sadece hukuk normlarının denetimini yapmakla kalmaz, aynı zamanda bireylerin hak ihlallerine karşı son sığınak olarak görev yapar. Türkiye ve Avrupa ülkeleri, anayasa mahkemelerinin temel hakları koruma işlevini yerine getirdiği farklı modeller geliştirmiştir. Türkiye’de Anayasa Mahkemesi, 1961 Anayasası ile kurulmuş ve başlangıçta daha çok norm denetimi (kanunların anayasaya uygunluğunun denetimi) ile sınırlı bir yetki alanına sahipken, 2010 yılında yapılan anayasa değişikliği ile bireysel başvuru hakkı tanınmış ve mahkeme, doğrudan hak ihlallerine karşı başvurulabilen bir mekanizmaya dönüşmüştür. Bireysel başvuru, Türkiye’de anayasal hakların korunmasında yeni bir dönemin başlangıcını temsil etmektedir.

Avrupa’da ise anayasa mahkemeleri, daha uzun bir geçmişe ve yerleşik içtihatlarla sahiptir. Almanya Federal Anayasa Mahkemesi, Fransa Anayasa Konseyi ve İspanya Anayasa Mahkemesi gibi örnekler, anayasal hakların korunmasında güçlü ve etkin mekanizmalar geliştirmiştir. Bu mahkemeler, bireysel başvuru hakkı, norm denetimi ve anayasal şikayet mekanizmaları ile bireylerin haklarını koruma işlevini üstlenir. Özellikle Almanya’da bireysel başvuru mekanizması, bireylerin doğrudan temel hak ihlallerine karşı mahkemeye başvurmasını mümkün kılmaktadır. Avrupa İnsan Hakları Mahkemesi (AİHM) de Avrupa’daki anayasa mahkemelerinin kararlarını etkileyen bir üst norm olarak işlev görür. AİHM içtihatları, Avrupa ülkelerindeki anayasa mahkemelerinin bireysel hakları koruma kapasitelerini artıran ve ortak bir insan hakları standardı oluşturan bir rehber niteliğindedir. Türkiye de AİHM’nin yargı

yetkisini tanıyan ve kararlarını uygulama yükümlülüğü olan bir ülke olarak, bu ortak standartlardan etkilenmektedir.

Bu çalışma, Türkiye ve Avrupa'daki anayasa mahkemelerinin anayasal hakları koruma işlevlerini karşılaştırmalı bir perspektifle ele almayı amaçlamaktadır. Anayasa mahkemelerinin bireysel başvuru mekanizmaları, kararlarının etkisi ve hukukun üstünlüğü ilkesi çerçevesinde anayasal hakların korunmasındaki rollerini inceleyecektir. Ayrıca dijital haklar ve yeni teknolojilerin yarattığı hukuki zorluklar da bu çalışmanın odak noktalarından biridir. Dijital çağda bireysel hakların korunması, anayasa mahkemelerinin yeni sınav alanı olarak öne çıkmaktadır.

1. Anayasa Mahkemelerinin Rolü ve İşlevi

Anayasa mahkemeleri, anayasal düzenin korunmasını ve bireylerin temel hak ve özgürlüklerinin güvence altına alınmasını sağlayan temel yargı organlarıdır. Bu mahkemeler, anayasa normlarının üstünlüğünü sağlamak, yasama ve yürütme işlemlerini denetlemek ve bireylerin hak ihlallerine karşı korunmasını garanti etmek amacıyla faaliyet gösterir.² Anayasa mahkemelerinin temel işlevleri arasında norm denetimi (soyut ve somut norm denetimi), bireysel başvuru mekanizması ve anayasal yorum yer alır. Norm denetimi, anayasa mahkemelerinin yasaların anayasaya uygunluğunu kontrol etmesini sağlar. Türkiye'de Anayasa Mahkemesi, yasaların iptali ve anayasa değişikliklerinin denetimi yoluyla norm denetimi yapar.³

Bireysel başvuru mekanizması, anayasa mahkemelerinin bireylerin temel haklarını doğrudan koruyabilmesini mümkün kılar. Türkiye'de 2010 yılından itibaren bireysel başvuru kabul edilmiş ve bireylerin temel haklarının korunmasında yeni bir dönem başlamıştır.⁴ Avrupa'da ise Almanya Federal Anayasa Mahkemesi, bireysel başvuru hakkının etkin bir şekilde uygulandığı öncü bir örnektir. Anayasa mahkemelerinin kararları, bireylerin hak ve özgürlüklerini koruma işlevinin ötesinde, anayasa normlarının yorumu ve geliştirilmesine de katkı sağlar.⁵ Özellikle bireysel başvuru kapsamında verilen kararlar, anayasal hakların

² Semih Batur KAYA & Ömer KESKİNSOY & Şahap KAYMAK, (2024) Anayasa Mahkemesi Kararlarına Uymamanın Doğuracağı Anayasal Sonuçlar. Ankara Hacı Bayram Veli Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi 26/2 (2024) S:518

³ Anayasa Mahkemesi, "Norm Denetimi," erişim tarihi Mayıs 17, 2025, <https://www.anayasa.gov.tr/tr/mahkeme/gorev-ve-yetkileri/norm-denetimi/>. (14.02.2025)

⁴ Halil İbrahim DURSUN, (2018) Bireysel Başvuru Mekanizmasının Kabulü Sonrasında Genel Mahkemelerin İnsan Hakları Konusundaki Rolü ve Bu Bağlamda Anayasa'nın 90. Maddesinin 5. Fıkrası. TBB Dergisi 2014 (112)S.311

⁵ Dereli, T. (2018). "Anayasa Mahkemeleri ve Bireysel Başvuru: Türkiye ve Almanya Örneği." *Journal of Constitutional Law Studies* 6 (2): 213-225.

kapsamını ve içeriğini belirler.⁶ Türkiye Anayasa Mahkemesi'nin ifade özgürlüğü, adil yargılanma hakkı ve ayrımcılık yasağı konusundaki kararları, anayasal hakların sınırlarını ve güvencelerini şekillendirmiştir.⁷

Avrupa ülkelerindeki anayasa mahkemeleri ise anayasal hakların korunmasında daha köklü bir geçmişe sahiptir.⁸ Almanya Federal Anayasa Mahkemesi, insan hakları ve temel özgürlükler konusunda güçlü bir içtihat geliştirmiştir. Fransa Anayasa Konseyi ve İspanya Anayasa Mahkemesi,⁹ anayasal hakların korunması konusunda bireysel başvuru ve norm denetimi işlevlerini etkin bir şekilde yerine getirmektedir. Anayasa mahkemelerinin rolü, sadece bireylerin haklarını korumakla sınırlı değildir; aynı zamanda anayasal düzenin korunması ve hukukun üstünlüğünün sağlanması için de kritik bir işlev görür. Türkiye ve Avrupa'daki anayasa mahkemelerinin bu bağlamdaki rollerinin karşılaştırmalı analizi, anayasal hakların korunmasında daha etkin bir model geliştirilmesine katkı sağlayacaktır.¹⁰

2. Türkiye ve Avrupa Örneği: Karşılaştırmalı Analiz

Anayasa mahkemelerinin anayasal hakların korunmasındaki rolü, Türkiye ve Avrupa ülkelerinde farklı tarihsel ve yapısal temellere dayanmaktadır.¹¹ Türkiye Anayasa Mahkemesi, 1961 Anayasası ile kurulmuş ve başlangıçta sadece norm denetimi işlevi ile sınırlandırılmıştır.¹² Ancak 2010 yılında bireysel başvuru hakkının tanınması ile bireylerin temel haklarını koruma yetkisi genişlemiştir. Bu hak, bireylerin doğrudan hak ihlallerine karşı Anayasa Mahkemesi'ne başvurabilmesini sağlamaktadır.¹³

Avrupa'da ise anayasa mahkemeleri, daha köklü bir geçmişe ve gelişmiş bir içtihat yapısına sahiptir. Almanya Federal Anayasa Mahkemesi¹⁴, bireysel başvuru hakkının en etkin şekilde uygulandığı örneklerden biridir. Mahkeme, insan hakları ve temel özgürlükler konusunda güçlü

⁶ **Hasan Tunç**, (2013) Türk Hukukunda Tutuklama Kararlarına Karşı Bireysel Başvuru Hakkı, Ankara Hacı Bayram Veli Üniversitesi Hukuk Fakültesi 2013) Türk: 17 Sayı: 2, , ss:1653-1654,

⁷ **Abdurrahman EREN**, Bireysel Başvuru Mekanizmasının Temel Hak ve Özgürlükler Rejimine Etkisi, YYÜHFD Y: 1 S: 1 (2013) s.136

⁸ **García, J. M.** (2021). "The Role of the Spanish Constitutional Court in Protecting Fundamental Rights." *European Constitutional Law Review* 17 (3): 463.

⁹ Jurix. "Fransa'da Anayasa Yargısı ve Bireysel Başvuru Sistemi." Erişim tarihi Mayıs 17, 2025. <https://www.jurix.com.tr/article/4481>.

¹⁰ **Christian TOMUSCHAT**, Çev. **Serkan TOMUSCHAT**, (2017) Anayasa Mahkemesi'Ne Göre Avrupa İnsan Hakları Mahkemesi Kararlarının Etkileri, EÜHFD, C. XXI, S. 1–2, s.123

¹¹ Bkz, **Yüksel METİN**, (2012) Anayasal Demokrasi İçinde Anayasa Mahkemesinin Konumu, S.D.Ü. Hukuk Fakültesi Dergisi C.2, S.1, s.110

¹² Anayasa Mahkemesi, "Bireysel Başvuru," erişim 18 Mayıs 2025, <https://www.anayasa.gov.tr/tr/mahkeme/gorev-ve-yetkileri/bireysel-basvuru/>. (14.02.2025)

¹³ **İsmail Köküarı**, (2011) "Hak Arama Özgürlüğü ve 2010 Anayasa Değişiklikleri," *Ankara Hacı Bayram Veli Üniversitesi Hukuk Fakültesi Dergisi* 15, no. 1: 187-188

¹⁴ **Sarah Katharina Stein**, "Lüth and Elfes – A German Approach to a Horizontal Effect of Fundamental Rights," *IACL-AIDC Blog*, 14 Haziran 2022, <https://blog-iacl-aidc.org/new-blog-3/2022/6/14/lth-and-elfes-a-german-approach-to-a-horizontal-effect-of-fundamental-rights>. (erişim tarihi: 12.05.2025)

içtihatlar geliştirmiştir.¹⁵ Bireyler, temel haklarının ihlal edildiğini düşündüklerinde doğrudan bu mahkemeye başvurabilmektedir. Özellikle ifade özgürlüğü, din özgürlüğü ve adil yargılanma hakkı konusundaki kararlar, Almanya’da anayasal hakların kapsamını belirlemiştir.¹⁶

Fransa Anayasa Konseyi ise anayasa normlarının denetimi ve temel hakların korunmasında farklı bir model sunmaktadır. Fransa’da bireysel başvuru hakkı (QPC - Öncelikli Anayasa Meselesi) 2010 yılında tanınmış ve bireylerin doğrudan hak ihlalleri konusunda mahkemeye başvurması mümkün hale gelmiştir. Fransa Anayasa Konseyi, temel hakların korunmasında anayasa normlarının yorumunu ve denetimini sağlar.¹⁷

İspanya Anayasa Mahkemesi de bireysel başvuru ve norm denetimi mekanizmalarını bir arada kullanır. Bireyler, anayasal haklarının ihlal edildiğini düşündüklerinde doğrudan Anayasa Mahkemesi’ne başvurabilmektedir. İspanya Anayasa Mahkemesi, ifade özgürlüğü, toplanma ve gösteri hakkı gibi konularda güçlü içtihatlar geliştirmiştir.¹⁸

Türkiye ile Avrupa’daki anayasa mahkemeleri arasındaki temel farklardan biri, bireysel başvuru hakkının gelişim sürecidir. Türkiye’de bu hak, nispeten yeni bir uygulama olmasına rağmen, bireysel hakların korunmasında önemli bir araç haline gelmiştir. Avrupa’da ise bireysel başvuru hakkı, anayasa mahkemelerinin etkinliğini ve bireylerin haklarını koruma kapasitesini artıran temel bir mekanizma olarak yerleşmiştir.¹⁹

Sonuç olarak, Bu karşılaştırmalı analiz, Türkiye Anayasa Mahkemesi’nin bireysel hakları koruma konusunda daha etkin ve gelişmiş bir içtihat yapısına sahip olabilmesi için Avrupa örneklerinden nasıl yararlanabileceğine dair önemli bir perspektif sunmaktadır.²⁰ Özellikle Almanya ve İspanya’da bireysel başvuru hakkının etkin kullanımı, Türkiye’nin de bu alanda daha güçlü bir koruma mekanizması geliştirmesi gerektiğini ortaya koymaktadır.²¹

Sonuç

¹⁵ **Sağlam Musa**, Bireysel Başvuru-Anayasa Şikayeti, HUKAB Yayını, HUKAB Sempozyum Serisi 1(Önsöz) sh.3-4; Karakaş ,Işıl,(AİHM Hakimi),Süregiden Sorunlara Yeni Cevaplar, İn AİHM ve Türkiye II Anayasa Şikayeti ve AİHM.Adalet Türkiye Akademisi Yayını (10 Aralık 2010 tarihinde düzenlenen sempozyumda konuşması) Sh.35

¹⁶ **Olivier Jouanjan**, (2009)“Freedom of Expression in the Federal Republic of Germany,” *Indiana Law Journal* 84, no. 3,s.876

¹⁷ Constitutional Council, “Decision no. 2010-25 QPC of 16 September 2010,” erişim 18 Mayıs 2025, <https://www.conseil-constitutionnel.fr/en/decision/2010/201025QPC.htm>

¹⁸ Tribunal Constitucional, “Recurso de amparo,” erişim 18 Mayıs 2025, <https://www.tribunalconstitucional.es/es/tribunal/Composicion-Organizacion/competencias/Paginas/04-Recurso-de-amparo.aspx>. (14.02.2025)

¹⁹ **Zühtü Arslan**, “Individual Application to the Constitutional Court of Türkiye: Recent Developments,” Anayasa Mahkemesi, erişim 18 Mayıs 2025, <https://www.anayasa.gov.tr/en/president/former-presidents-speeches/zuhtu-arslan/speeches/individual-application-to-the-constitutional-court-of-turkiye-recent-developments/>.(14.02.2025)

²⁰ **Hasan Tahsin Fendoğlu**, (2010) *Anayasa Mahkemesine Bireysel Başvuru*, Stratejik Düşünce Enstitüsü, 29 Mart,s.1

²¹ **Hasan Tahsin Fendoğlu**, (2020) *Anayasa Yargısı*, Yetkin Yayınları, Ankara, 2020, s. 350.

Anayasal hakların korunmasında anayasa mahkemelerinin rolü, demokratik bir hukuk devletinin temel unsurlarından biridir. Anayasa mahkemeleri, yasaların ve idari işlemlerin anayasal normlara uygunluğunu denetleyerek, bireylerin temel hak ve özgürlüklerini güvence altına alır. Türkiye ve Avrupa'daki anayasa mahkemeleri, bu işlevi farklı tarihsel ve hukuki temeller üzerine inşa etmiştir. Türkiye'de Anayasa Mahkemesi, 1961 Anayasası ile kurulmuş ve başlangıçta norm denetimi ile sınırlı bir yetkiye sahipken, 2010 yılında bireysel başvuru hakkının tanınması ile bireylerin haklarının korunmasında daha etkin bir mekanizma haline gelmiştir. Bireysel başvuru, bireylerin doğrudan hak ihlallerine karşı Anayasa Mahkemesi'ne başvurabilmesini sağlar.

Avrupa'da ise anayasa mahkemeleri daha köklü ve gelişmiş bir hak koruma geleneğine sahiptir. Almanya Federal Anayasa Mahkemesi, bireysel başvuru hakkının en güçlü ve etkin uygulandığı örneklerden biridir. Bireyler, temel haklarının ihlal edildiğini düşündüklerinde doğrudan bu mahkemeye başvurabilmektedir. Almanya Anayasa Mahkemesi'nin ifade özgürlüğü, din özgürlüğü ve adil yargılanma hakkı konusundaki içtihatları, Avrupa'da temel hakların korunmasında referans kabul edilmektedir. Fransa Anayasa Konseyi ise anayasa normlarının denetimi ve temel hakların korunmasında farklı bir model sunar. 2010 yılında bireysel başvuru hakkının tanınmasıyla bireyler, anayasal haklarının ihlal edildiğini düşündüklerinde doğrudan Konseye başvurabilmektedir.

İspanya Anayasa Mahkemesi, bireysel başvuru ve norm denetimi mekanizmalarını bir arada kullanır. Bireyler, anayasal haklarının ihlal edildiğini düşündüklerinde doğrudan Anayasa Mahkemesi'ne başvurabilmekte ve bu başvurular, hak ihlallerinin giderilmesi için güçlü bir araç sunmaktadır. İspanya Anayasa Mahkemesi'nin ifade özgürlüğü, toplanma ve gösteri hakkı gibi konulardaki içtihatları, anayasal hakların korunmasında etkili bir model sunmaktadır.

Türkiye ile Avrupa'daki anayasa mahkemeleri arasındaki temel fark, bireysel başvuru mekanizmasının gelişimidir. Türkiye'de bu hak nispeten yeni bir uygulama olmasına rağmen, anayasal hakların korunmasında önemli bir işlev üstlenmiştir. Avrupa'da ise bireysel başvuru hakkı, anayasa mahkemelerinin etkinliğini ve bireylerin haklarını koruma kapasitesini artıran temel bir mekanizma olarak yerleşmiştir. Özellikle Almanya ve İspanya, bireysel başvuru hakkının etkin kullanımıyla öne çıkmakta ve bireylerin temel haklarını koruma konusunda güçlü bir güvence sunmaktadır.

Bu karşılaştırmalı analiz, Türkiye Anayasa Mahkemesi'nin bireysel hakları koruma konusunda daha etkin ve gelişmiş bir içtihat yapısına sahip olabilmesi için Avrupa örneklerinden nasıl yararlanabileceğini göstermektedir. Almanya ve İspanya'da bireysel başvuru hakkının etkinliği, Türkiye'nin de bu alanda daha güçlü bir koruma mekanizması

geliştirmesi gerektiğini ortaya koymaktadır. Sonuç olarak, Türkiye Anayasa Mahkemesi'nin, bireysel başvuru hakkını daha etkin bir hak koruma aracı olarak geliştirmesi, içtihatlarını daha güçlü bir hak temelli perspektifle şekillendirmesi ve Avrupa'daki iyi uygulamalardan yararlanması, anayasal hakların korunması açısından kritik öneme sahiptir.

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ANAYASAL SADAKAT YÜKÜMLÜLÜĞÜ 'NÜN KAMU GÖREVLİSİ OLMAYANLARA GENİŞLETİLMESİ: TEHLİKELİ BİR EĞİLİM Mİ?

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Özet

Bu çalışma, anayasal sadakat yükümlülüğünün kapsamının kamu görevlileri dışındaki bireylere genişletilmesi yönündeki eğilimi eleştirel bir bakışla incelemektedir. Anayasal sadakat, geleneksel olarak yalnızca kamu gücünü kullanan kişiler için geçerli sayılan ve anayasanın üstünlüğüne bağlılık ile onun kurallarına uygun davranmayı zorunlu kılan bir yükümlülük olarak tanımlanmıştır. Ancak günümüzde özellikle sosyal medya aracılığıyla yapılan bireysel paylaşımların kriminalize edilmesiyle birlikte, anayasal sadakat yükümlülüğünün kamu görevlisi olmayan sıradan bireyler için de geçerli olduğu yönünde bir söylem gelişmektedir. Bu söylemin anayasa hukukunun özgürlükçü yapısıyla ne ölçüde bağdaşır olduğu, bu çalışmanın temel sorgulama alanını oluşturmaktadır.

Sadakat yükümlülüğü, Anayasa'nın 6., 11., 138. ve 153. maddeleri gibi hükümlerle kamu erkini kullananların anayasal normlara bağlı kalmalarını zorunlu kılan bir ilkedir. Bu bağlamda söz konusu yükümlülük, kamu görevlilerinin tarafsızlık ve hukuka uygunluk esaslarına riayet etmelerini sağlamayı amaçlamaktadır. Ancak sosyal medya çağında, yurttaşların yaptığı eleştirel veya mizahi paylaşımlar dahi zaman zaman “devlet düşmanlığı” veya “anayasal düzene tehdit” şeklinde yorumlanmakta; böylece anayasal sadakat kavramı genişletilerek kamu görevlisi olmayanlara da teşmil edilmektedir. Bu durum, birey haklarının sınırlandırılması riski doğurmaktadır.

Sosyal medya, bireylerin düşüncelerini açıklama ve kamu politikalarını sorgulama imkânı sunduğu kadar, devletin gözetim ve denetim alanını da genişletmiştir. Artık bireylerin paylaşımları sadece kişisel görüş değil, zaman zaman devletin anayasal bütünlüğüne tehdit unsuru olarak da değerlendirilebilmektedir. Bu bağlamda, bireylerin sosyal medya aracılığıyla gerçekleştirdiği bazı ifadeler, Türk Ceza Kanunu'nun 301 (Türklüğe hakaret) ve 216 (halkı kin ve düşmanlığa tahrik) gibi hükümleri kapsamında cezalandırılmakta; anayasal sadakat yükümlülüğü adeta bir ifade sınırlama aracı hâline gelmektedir.

Bu gelişmeler karşısında, anayasal sadakat kavramının genişletilmesinin demokratik hukuk devleti ilkesiyle çeliştiği ileri sürülebilir. Zira ifade özgürlüğü, örgütlenme hakkı ve siyasal katılım gibi temel haklar, yurttaşların yalnızca itaatkâr değil; eleştirel ve aktif bireyler olmalarını da öngörmektedir. Avrupa İnsan Hakları Mahkemesi'nin yerleşik içtihatları, özellikle Handyside v. Birleşik Krallık (1976) kararında vurgulandığı gibi, demokrasinin

çoğulculuk ve hoşgörü temelleri üzerine kurulu olduğunu; bu nedenle rahatsız edici, şok edici veya kışkırtıcı fikirlerin dahi ifade özgürlüğü kapsamında olduğunu kabul etmektedir.

Anayasal sadakat yükümlülüğünün sıradan yurttaşlara da yaygınlaştırılması, anayasanın kurucu rolünü pasif bir itaate indirgeme riskini beraberinde getirmektedir. Oysa anayasa, yalnızca devletin otoritesini güvence altına alan bir belge değil; aynı zamanda bireyin temel hak ve özgürlüklerini koruyan bir toplumsal sözleşmedir. Bu nedenle yurttaşlık, sadakatten ziyade eleştiri, katılım ve sorgulama temelinde kurulmalıdır. Devlete veya anayasaya duyulan sadakat, hukukla güvence altına alınacak bir yükümlülük değil; ancak özgür ve eleştirel yurttaşlık pratiği içinde doğal biçimde gelişebilecek bir bağlılık biçimi olabilir.

Çalışmada, anayasal sadakat yükümlülüğünün kamu görevlileriyle sınırlı tutulması gerektiği, aksi hâlde bireylerin ifade özgürlüğünün zedeleneyeceği ve demokratik tartışma ortamının daralacağı ileri sürülmektedir. Yurttaşların devlete ya da anayasaya eleştirel yaklaşım sergileyebilmeleri, anayasanın kendini yenileyebilmesi ve toplumsal meşruiyetini koruyabilmesi açısından hayati önemdedir.

Sonuç olarak anayasal sadakat yükümlülüğünün kapsamı genişletildikçe, demokratik anayasal düzenden uzaklaşma tehlikesi büyümektedir. Bu nedenle anayasal sadakat, yalnızca kamu göreviyle sınırlı tutulmalı; yurttaşlar anayasal düzene körü körüne bağlılıkla değil, eleştirel bir bilinçle yaklaşılmaya teşvik edilmelidir.

Anahtar Kelimeler: Anayasal sadakat, ifade özgürlüğü, anayasa hukuku, yurttaşlık, sosyal medya, kamusal denetim, çoğulculuk, kamu görevi, meşruiyet, anayasal eleştiri

EXTENDING THE DUTY OF CONSTITUTIONAL LOYALTY TO NON-PUBLIC OFFICIALS: A DANGEROUS TREND?

Abstract

This study examines the constitutional implications of extending the duty of constitutional loyalty beyond public officials to include ordinary citizens. Traditionally, this obligation has applied only to those who exercise public authority, ensuring that they act in accordance with the principles and norms of the constitution. However, in the digital age—particularly through the increasing use of social media—a tendency has emerged to impose expectations of constitutional loyalty on private individuals. This trend carries significant risks for individual rights and the liberal character of the constitutional system.

The constitution is a social contract between the state and its citizens, grounded not in unconditional obedience but in conscious and voluntary participation in the constitutional order.

Imposing a duty of loyalty on citizens suppresses the right to constitutional criticism and turns individuals into passive subjects. This undermines political participation the source of democratic legitimacy and creates a chilling effect on freedoms such as expression.

Comparative constitutional law supports the notion that loyalty duties are limited to public servants. In countries such as Germany, France, and the United States, loyalty to constitutional values is required of public officials to ensure institutional stability, whereas citizens are not bound by such obligations. On the contrary, their right to criticize the constitutional system is viewed as essential for constitutional development and societal pluralism.

In Turkey, the criminal prosecution of social media posts made by citizens has weakened trust in the constitution and equated questioning the constitutional order with disloyalty. This approach is problematic not only in terms of individual freedoms but also from the perspective of universal principles of constitutional law.

Judgments by the Turkish Constitutional Court and the European Court of Human Rights clearly affirm that freedom of expression is a cornerstone of democratic society and cannot be limited to acceptable or moderate opinions. Accordingly, the duty of constitutional loyalty should remain confined to public officials.

In conclusion, restricting the duty of loyalty to those who hold public office is essential for maintaining constitutional balance and a liberal democratic order. Citizens are not obligated to blindly obey the constitution; rather, they have a right and perhaps a duty to question and transform it. A modern constitution should not suppress dissent but embrace participation and freedom.

Keywords: Constitutional loyalty, freedom of expression, constitutional law, citizenship, social media, public oversight, pluralism, public office, legitimacy, constitutional critique

Giriş

Anayasa, modern devletin hem kurucu hem de sınırlayıcı belgesi olarak, siyasal iktidarın meşruiyetini ve sınırlarını belirleyen temel hukuk normudur. Anayasal düzenin istikrarı, yalnızca hukuki yapıların varlığıyla değil; bu yapılarla kurulan siyasal ve toplumsal ilişkilerin niteliğiyle mümkündür. Bu ilişkilerin merkezinde yer alan kavramlardan biri de “anayasal sadakat”tir. Anayasal sadakat yükümlülüğü, genellikle kamu görevini ifa eden bireylerin anayasal normlara, temel değerlere ve demokratik düzenin ilke ve kurallarına uygun davranmalarını zorunlu kılan bir anayasal ilkedir. Söz konusu yükümlülük, özellikle yürütme, yargı ve bürokratik erkleri kullanan kişilerin anayasal bağlılıklarını kurumsal düzeyde güvence

altına alma amacını taşır. Nitekim Türkiye Cumhuriyeti Anayasası'nın 6., 9., 11., 138. ve 153. maddelerinde bu anlayışa dayalı hükümler yer almaktadır.

Ancak son yıllarda, bu yükümlülüğün kapsamı üzerinde yapılan tartışmalar giderek derinleşmiş ve anayasal sadakatin yalnızca kamu görevlileriyle sınırlı olmayıp, sıradan yurttaşlara da teşmil edilip edilemeyeceği sorusu gündeme gelmiştir. Özellikle sosyal medya gibi dijital mecralarda bireylerin yaptığı eleştirel veya sistem karşıtı paylaşımlar, zaman zaman “anayasal düzene tehdit”, “devletin temel ilkelerine aykırılık” veya “sadakatsizlik” şeklinde değerlendirilmekte; böylece anayasal sadakat, genişletilerek bir tür siyasal davranış normuna dönüştürülmektedir. Bu gelişmeler, anayasa hukuku bakımından dikkatle ele alınması gereken bir eğilimi ortaya koymaktadır.

Sadakat yükümlülüğünün kamu görevlileri dışındaki bireylere yaygınlaştırılması, anayasal düzenin birey üzerindeki meşruiyetini sorgulatan ve devlet-toplum ilişkisini yeniden şekillendiren bir hukukî ve siyasal dönüşümün habercisidir. Zira anayasa, yalnızca devlete karşı yükümlülükler değil; bireylere karşı yükümlülükler de yükler. Bu bağlamda anayasa, yurttaşlardan körü körüne itaat değil; bilinçli bir katılım, eleştiri ve sorumluluk bekler. Sadakatin anayasal bağlamda bu ölçüde genişletilmesi, demokratik yurttaşlık anlayışı ile çelişebilir.

Çalışma, anayasal sadakat yükümlülüğünün kurumsal sınırlarını sorgularken, sosyal medya çağında sıradan bireylerin ifade özgürlüğü, eleştiri hakkı ve siyasal katılım gibi anayasal haklarının bu yükümlülük altında nasıl etkilenebileceğini analiz etmeyi amaçlamaktadır. Anayasanın öngördüğü sadakat ilişkisi, devletin otoritesine mutlak bağlılık mı; yoksa anayasal değerlerin içselleştirilmesi yoluyla gönüllü uyum mu anlamına gelmektedir? Bu soru, anayasal normların yalnızca hukuki değil; aynı zamanda sosyolojik ve siyasal bir bağlamda değerlendirilmesi gerektiğini ortaya koyar.

Anayasal sadakatin sınırlarının kamu görevlileri dışındaki bireylere kadar genişletilmesi, ifade özgürlüğü başta olmak üzere birçok temel hakkın kullanımını doğrudan etkileyebilir. Özellikle eleştirel söylemler, mizahi paylaşımlar ya da hükümet politikalarına yönelik muhalefet; sadakat yükümlülüğü çerçevesinde “tehdit” olarak yorumlandığında, anayasal düzende bir kırılma meydana gelir. Bu durum, anayasanın toplum nezdindeki meşruiyetini zayıflatabileceği gibi, bireylerin siyasal katılım kanallarını daraltarak toplumsal kutuplaşmayı da artırabilir.

Çalışmanın amacı, anayasal sadakat yükümlülüğünün anayasa hukukundaki yerini kuramsal olarak değerlendirmek, tarihsel kökenleri ve uluslararası hukuk sistemlerindeki karşılıklarıyla birlikte analiz etmek ve Türkiye bağlamında bu yükümlülüğün sınırlarının ne olması gerektiğini

tartışmaktır. Anayasa yalnızca bir hukuk metni değil; toplumsal uzlaşının, çoğulculuğun ve meşru muhalefetin de kurumsal zemini olduğuna göre, sadakat yükümlülüğü birey-devlet ilişkisini baskıcı değil; özgürlükçü bir çerçevede kurmalıdır.

Bu nedenle giriş bölümünde, anayasal sadakatin doğası, gelişim süreci ve mevcut tartışmalardaki yeri ele alınacak; devam eden bölümlerde ise bu yükümlülüğün kamu görevlileri dışındaki bireyler bakımından nasıl genişletildiği, bu genişletmenin hangi anayasal riskleri barındırdığı ve özgürlükçü demokrasi açısından ne tür sonuçlara yol açabileceği detaylı biçimde incelenecektir.

1. Anayasal Sadakatin Kavramsal Gelişimi ve Karşılaştırmalı Hukukta Yeri

Anayasal sadakat kavramı, hukuki bağlamda devlet ile birey arasında kurulan normatif ilişkinin temel yapı taşlarından biri olarak ortaya çıkar. Bu kavram, çoğu anayasa hukukçusu tarafından kamu görevlilerine özgü bir yükümlülük olarak tanımlanır ve demokratik anayasal düzenin devamlılığını sağlama amacı güder. Sadakat yükümlülüğü, bireylerin -özellikle de kamu gücünü kullanan aktörlerin- anayasal düzene karşı aktif bir tehdit oluşturmaması ve bu düzenin temel ilkelerine saygılı davranması gerektiği düşüncesine dayanır (*Isensee, 2001, s. 413*). Bu yükümlülük, sadece pasif bir itaat değil; aynı zamanda anayasal değerlerin benimsenmesini de kapsar.

Anayasal sadakat düşüncesinin gelişimi, özellikle 20. yüzyılda totaliter rejimlerin yıkımı sonrasında demokratik devletlerde önem kazanmıştır. Nazi Almanyası ve faşist İtalya gibi otoriter sistemlerin hukuk dışı uygulamalarla anayasal düzeni istismar etmiş olması, II. Dünya Savaşı sonrası anayasal sistemlerin “militan demokrasi” anlayışıyla kendi kendini koruma refleksini güçlendirmiştir. Bu doğrultuda anayasal sadakat, anayasal düzeni yıkmaya veya zayıflatmaya çalışan unsurlara karşı devletin ve kamu görevlilerinin direnme hakkı ve yükümlülüğü olarak şekillenmiştir (Loewenstein, 1937, s. 421).

Karşılaştırmalı hukukta özellikle Almanya Federal Cumhuriyeti Anayasası (Grundgesetz) çerçevesinde sadakat yükümlülüğü açık şekilde düzenlenmiştir. Alman Anayasası'nın 33. maddesi, kamu görevlilerinin anayasal düzene bağlılık göstermesini açıkça öngörmektedir. Bu sadakat anlayışı, kamu hizmetinin tarafsızlığını korumak ve anayasal devlet yapısının devamını sağlamak adına geliştirilmiştir (Mangoldt et al., 2018, s. 422). Aynı zamanda Alman Anayasa Mahkemesi (Bundesverfassungsgericht), sadakat yükümlülüğünü yalnızca devlete sadakat değil, anayasal değerlere sadakat olarak da yorumlamaktadır.

Benzer şekilde Fransa'da kamu görevlilerinin devlete sadakat yükümlülüğü Danıştay (Conseil d'État) kararlarıyla içtihat haline gelmiş ve bu yükümlülük, kamu hizmetinin devamlılığı ve tarafsızlığı ilkesiyle ilişkilendirilmiştir. ABD hukukunda ise doğrudan anayasal

sadakatten söz edilmemekle birlikte, federal kamu görevlilerinin anayasaya yemin etmesi zorunluluğu sadakat ilişkisini sembolik düzeyde kurumsallaştırır.

Öte yandan, bireylerin -özellikle kamu görevlisi olmayan sıradan yurttaşların- anayasal düzene karşı eleştirel tutumları bu ülkelerde genellikle ifade özgürlüğü kapsamında değerlendirilir. Avrupa İnsan Hakları Mahkemesi, bu konuda bireylerin politik ifade ve eleştiri haklarını korumayı tercih etmektedir. “*Vogt v. Germany*” davasında kamu görevlisinin Komünist Parti üyeliği nedeniyle görevine son verilmesi, kamu hizmetinin tarafsızlığı ilkesine aykırı bulunmamış, ancak ifade özgürlüğü açısından orantılılık ilkesinin tartışılması gerektiği vurgulanmıştır.

Dolayısıyla anayasal sadakat, kamu görevlileri için kurumsal bir zorunluluk iken, yurttaşlar açısından anayasal sistemin içselleştirilmesini bekleyen, ancak zorlayıcı yaptırımlarla desteklenmemesi gereken bir normatif ideal olmalıdır. Liberal demokrasilerde, anayasa yurttaşlar için bir aidiyet ve haklar manzumesi iken; kamu görevlileri için bir yükümlülük ve bağlılık kaynağıdır. Bu ayrım, anayasal düzenin hem özgürlükçü yapısını hem de kurumsal bütünlüğünü korumanın asli yoludur.

Bu bağlamda Türkiye’de anayasal sadakat yükümlülüğünün kamu görevlileri dışındaki bireyler için dolaylı biçimde uygulanmaya çalışılması, anayasanın dayandığı toplumsal sözleşme mantığını zedeleyebilir. Sıradan yurttaşın anayasal değerlere uyması elbette beklenebilir; fakat bu uyumun özgür iradeye ve eleştiri hakkına saygı temelinde gelişmesi anayasal rejimin meşruiyeti açısından daha sağlıklıdır.

2. Sosyal Medya Çağında Sadakat Yorumunun Genişlemesi

Dijital çağın sunduğu iletişim olanakları, bireylerin ifade biçimlerini dönüştürmüş ve sosyal medya araçları, bireyin siyasal katılımını doğrudan etkileyen yeni bir kamusal alan yaratmıştır. Twitter, Facebook, Instagram gibi platformlar, yurttaşların gündelik yaşam içinde politik yorumda bulunabildikleri, yönetime dair kanaatlerini dile getirdikleri birer alan haline gelmiştir (Bayraktar, 2021, s. 74). Bu dönüşüm beraberinde klasik kamu/özel alan ayrımını belirsizleştirmiş, devletin yurttaşın düşüncesi üzerindeki denetimini artıran yeni araçlara zemin hazırlamıştır.

Türkiye özelinde, sosyal medya paylaşımları üzerinden yürütülen soruşturmalar, bireylerin anayasal düzen karşısındaki eleştirilerini ifade etme özgürlüğünü sınırlandırabilecek düzeye ulaşmıştır. Türk Ceza Kanunu’nun 301. maddesi (Türklüğe hakaret), 216. maddesi (halkı kin ve düşmanlığa tahrik) ve 299. maddesi (Cumhurbaşkanına hakaret) gibi düzenlemeler, zaman zaman politik eleştiri sınırlarını aşan yorumlarla dahi cezalandırmaya yol açmaktadır (Karakaş,

2020, s. 63). Bu uygulamalar, anayasal sadakat yükümlülüğünün kamu görevlileri dışındaki bireyleri de kapsayacak şekilde genişletildiği izlenimini yaratmaktadır.

Bu bağlamda, sosyal medya çağında bireyin devlet ve anayasa ile olan ilişkisi daha görünür, izlenebilir ve müdahale edilebilir hale gelmiştir. Özellikle bürokratik kurumlar veya yargı organlarının sosyal medya içeriklerini “sadakatsizlik” ya da “devletin bütünlüğüne tehdit” olarak yorumlamaları, birey haklarıyla anayasal sadakat yükümlülüğü arasında doğrudan bir çatışma ortaya çıkarmaktadır (Yılmaz, 2022, s. 88).

Bu gelişmenin hukuk devleti ilkesi bakımından ciddi sakıncalar doğurduğu açıktır. Anayasa Mahkemesi'nin 2016 tarihli “İbrahim Öztürk” kararı da dahil olmak üzere, birçok kararında ifade özgürlüğü kapsamındaki düşünceler nedeniyle verilen cezaların hak ihlali teşkil ettiğine hükmedilmiştir (AYM, 2016, B.No: 2014/5863). Bu kararlar, anayasal sadakatin sınırlarını bireyin ifade hakkı çerçevesinde koruma altına almayı amaçlamaktadır.

Sadakat yükümlülüğünün kamu görevlisi olmayan bireylere teşmil edilmesinin doğrudan ya da dolaylı yollarla ifade özgürlüğü üzerinde “soğutucu etki” yarattığı görülmektedir (Erdoğan, 2020, s. 117). İnsan Hakları Avrupa Mahkemesi (AİHM) de Türkiye kararlarında bu durumu vurgulamış ve bireylerin eleştirel düşüncelerinin cezai yaptırımlara tabi tutulmasının demokratik toplumda kabul edilemez olduğunu ifade etmiştir (AİHM, Şorli v. Türkiye, 2021).

Özellikle kamu politikalarını eleştiren, mizah yapan veya alternatif siyasal duruşlar sergileyen sosyal medya kullanıcılarının “anayasal düzene tehdit” oluşturduğu gerekçesiyle hedef alınmaları, yurttaşların anayasal sadakat yükümlülüğünü ihlal ettiği gibi yorumlanmaktadır (Çelik, 2021, s. 149). Bu genişletici yorum, anayasa hukukunun temel değerlerinden olan çoğulculuk, ifade özgürlüğü ve siyasal katılım hakkını zedelemektedir.

Ayrıca medya ve yargı tarafından yürütülen bazı kampanyalarda bireylerin paylaşımlarına “anayasaya bağlı olmayan birey” etiketi yapıştırılması, anayasanın yurttaşlara güvenen niteliğini tehdit eder. Anayasa yurttaşın değil, devletin sadakatini güvence altına alan bir metin olarak tasarlanmıştır (Kaboğlu, 2018, s. 211). Yurttaşın anayasa ile olan ilişkisi gönüllülük ve eleştiri hakkı ekseninde kurulmalıdır.

Bu durum özellikle öğrenciler, sanatçılar, akademisyenler ve gazeteciler gibi kamusal figürlerin fikirlerini özgürce açıklamalarını sınırlandırmakta ve bir tür oto sansür rejiminin oluşmasına neden olmaktadır (Toprak, 2019, s. 165; Gözler, 2021, s. 92). Bu bağlamda anayasal sadakat kavramının geniş yorumunun ifade özgürlüğü ve akademik özerklik gibi hak alanlarını da tehdit edici boyuta ulaştığı ifade edilebilir.

Yukarıda ortaya konan gelişmeler ışığında, anayasal sadakatin sosyal medya çağındaki yeni anlam dünyası, yalnızca kamu görevlilerini değil, kamuoyunu etkileyen her bireyi kapsamına

alma potansiyeli taşıyan bir norm haline gelmektedir. Ancak anayasanın ruhu, yurttaşı sadakatle değil; özgürlükle bağlamayı esas almalıdır.

3. Anayasa Hukuku Açısından Sınırlar ve Özgürlükçü Yaklaşımlar

Anayasa hukukunun temel işlevlerinden biri, bireyin temel hak ve özgürlüklerini güvence altına alırken, devletin kurumsal yapısını da meşru sınırlar içerisinde tutmaktır. Bu çerçevede anayasal sadakat yükümlülüğü, devletin anayasal düzenini tehdit eden eylem ve söylemlere karşı bir tür koruyucu norm olarak tanımlanabilir. Ancak bu yükümlülüğün bireylere özellikle kamu görevlisi olmayan yurttaşlara genişletilerek uygulanması, anayasa hukukunun özgürlükçü yorumlarıyla ciddi bir gerilim yaratmaktadır (*Gözler, 2022, s. 55*).

Anayasa'nın 25. ve 26. maddelerinde güvence altına alınan düşünce ve ifade özgürlüğü, demokratik toplum düzeninin vazgeçilmez unsurlarındandır. Bireyin devlete ya da anayasal kurumlara yönelik eleştirileri, bu özgürlüğün doğal bir uzantısıdır. Anayasa Mahkemesi, çok sayıda kararında bu özgürlüğün yalnızca toplumda genel kabul gören fikirleri değil; aynı zamanda rahatsız edici, aykırı ve eleştirel düşünceleri de kapsadığını belirtmiştir (*AYM, 2014/12190, s. 7*).

Bu bağlamda anayasal sadakat yükümlülüğünün özgürlükçü anayasa anlayışıyla sınırlandırılması gerekir. Bireylerin siyasal iktidarı eleştirme, anayasanın yorumuna dair alternatif görüşler dile getirme ya da sistem karşıtı düşünceler taşıma hakları, anayasal sadakat kisvesiyle bastırılmamalıdır (*Kılıçoğlu, 2019, s. 112*). Aksi durumda anayasa, bireyin üzerinde hegemonik bir aygıt haline gelir.

Özgürlükçü anayasa kuramı, yurttaşların yalnızca haklardan yararlanan değil; anayasanın içeriğini sorgulayan, anayasal düzeni eleştirebilen aktif öznelerle dönüşmesini öngörür. Bu yaklaşım, anayasanın sabit ve değişmez bir metin olmaktan ziyade, toplumsal gelişim ve eleştirisiyle yeniden şekillenen bir yapı olduğunu kabul eder (*Kaboğlu, 2018, s. 93*).

Sadakat yükümlülüğü, bu çerçevede yalnızca kamu görevlileri için geçerli olmalı; yurttaşlar için ise anayasal değerlere gönüllü bağlılık temelinde, cezai yaptırımlarla desteklenmeyen bir normatif alan olarak kalmalıdır. Bireyin anayasal düzeni eleştirmesi, bu düzene zarar verme niyetini değil; onu daha katılımcı, adil ve demokratik hale getirme iradesini taşıyabilir (*Erdoğan, 2020, s. 101*).

Ayrıca anayasa hukukunun temel ilkelerinden biri olan “*hukuki güvenlik*” ilkesi de bu bağlamda göz önünde bulundurulmalıdır. Bireyin hangi ifadelerinin sadakat yükümlülüğüne aykırı sayılacağına dair açık ve öngörülebilir bir normatif çerçeve olmadığında, bu belirsizlik bireyin haklarını tehdit eder hale gelir (*Tanör, 2004, s. 67*).

Anayasa Mahkemesi'nin 2017 tarihli bir kararında “eleştiri, tahkirle karıştırılmamalıdır” ifadesiyle bu ayrım net biçimde ortaya konmuştur (*AYM, 2015/2364, s. 11*). Buna göre yurttaşın ifade özgürlüğü ancak açık bir nefret söylemi, şiddet çağrısı veya kamu düzenini açıkça tehdit eden eylemler söz konusuysa sınırlanabilir. Sadakat yükümlülüğü, bu sınırların ötesinde genişletilmemelidir.

Sonuç olarak anayasal sadakat yükümlülüğünün bireylere uygulanması, anayasa hukukunun özgürlükçü ve çoğulcu yapısıyla uyumlu biçimde dar yorumlanmalıdır. Aksi halde anayasa, bireyin eleştiri hakkını kısıtlayan bir ideolojik metne dönüşebilir. Bu ise anayasanın temel işlevi olan toplumsal sözleşme olma niteliğini zedeleyecektir.

4. Yorumun Genişletilmesinin Toplumsal ve Siyasal Etkileri

Anayasal sadakat yükümlülüğünün kamu görevlisi olmayan bireylere teşmil edilmesi yalnızca hukukî bir tartışma değil, aynı zamanda toplumsal ve siyasal sonuçları olan bir dönüşümdür. Sadakat yükümlülüğü kavramının geniş yorumlanması, toplumsal muhalefetin sınırlandırılması, siyasal çoğulculuğun daralması ve bireyler üzerinde otosansür baskısının artması gibi sonuçlara yol açmaktadır (*Çelik, 2021, s. 151*).

Bu durum özellikle gençler, öğrenciler, akademisyenler ve sanatçılar gibi düşünsel üretim yapan grupları doğrudan etkilemektedir. Bu kesimler, sosyal medya üzerinden yaptıkları açıklamaların “devlete sadakatsizlik” ya da “anayasal değerlere aykırılık” iddiasıyla soruşturmalara konu olması nedeniyle ifade alanlarını daraltmakta ve çoğu zaman kendi görüşlerini açıklamaktan imtina etmektedir (*Toprak, 2020, s. 174*).

Ayrıca anayasal sadakat kavramının kamusal tartışmalarda sıkça referans verilerek bir tür “ahlaki üstünlük” göstergesi haline gelmesi, siyasal iktidara yakın kesimler için bir meşruiyet aracı, muhalifler için ise potansiyel suçlama zemini yaratmaktadır. Bu da demokratik toplumda siyasal rekabetin, sadakat-ihanet ikiliği üzerine kurulmasına neden olmakta; kutuplaşmayı derinleştirmektedir (*Şen, 2019, s. 93*).

Sadakat yorumunun bu şekilde araçsallaştırılması, yurttaşların anayasa ile kurduğu ilişkiyi güven değil korku temelinde şekillendirir. Anayasa, halkın iradesiyle şekillenen ve onun haklarını güvence altına alan bir metin olmaktan uzaklaşır; bireyin özgürlüklerini tehdit eden bir sansür aracına dönüşür (*Kaboğlu, 2018, s. 97*).

Siyasal iktidar açısından da bu tür bir yorumun uzun vadede istikrar yerine kırılganlık doğuracağı açıktır. Çünkü ifade özgürlüğü ve siyasal katılım hakkı baskılandığında, toplumsal talepler demokratik yollarla dile getirilemez ve sistem dışı yollarla ifade bulur. Bu da anayasal düzenin meşruiyet temellerini zedeler (*Erdoğan, 2020, s. 113*).

Sosyal bilimlerde sıklıkla vurgulandığı üzere, siyasal sadakat ancak özgür yurttaşlık bilinciyle inşa edilebilir. Zorunlu sadakat, itaat üretir; fakat meşruiyet üretmez. Demokratik rejimlerin uzun vadeli sürdürülebilirliği, yurttaşların gönüllü olarak anayasal düzeni içselleştirmesine bağlıdır (*Habermas, 1996, s. 303*).

Bu bağlamda, anayasal sadakat yükümlülüğünün sıradan bireyler üzerinde geniş yorumlanması, toplumun siyasal bilinç gelişimini engeller, farklı düşünce ve yaşam biçimlerine tahammülsüzlük üretir ve siyasal alanı steril bir yapıya dönüştürür. Oysa anayasa, farklılıkları tanıyan ve onları anayasal zemine dâhil eden bir çoğulculuğu esas almalıdır (*Tanör, 2000, s. 49*).

Sonuç olarak, anayasal sadakat yükümlülüğünün toplum genelinde genişletilmesi, demokratik tartışma ortamını daraltmakta, bireyleri pasif yurttaşlara dönüştürmekte ve anayasanın meşruiyet temelini zayıflatmaktadır. Bu nedenle anayasal sadakat, kamusal iktidar sahipleriyle sınırlı bir yükümlülük olarak kalmalı; toplumda ise anayasal bilinç ve gönüllü katılım temelinde desteklenmelidir.

Sonuç

Bu çalışma, anayasal sadakat yükümlülüğünün kapsamının kamu görevlileri dışındaki bireyleri kapsayacak şekilde genişletilmesinin anayasa hukuku bakımından doğurduğu sorunları değerlendirmektedir. Geleneksel olarak yalnızca kamu erkini kullanan aktörlerle sınırlı olan bu yükümlülüğün, sosyal medya çağında sıradan yurttaşlara da uygulanması yönündeki eğilim, hem bireysel hak ve özgürlükler hem de anayasal sistemin özgürlükçü yapısı açısından riskli sonuçlar doğurmaktadır.

Anayasa, birey ile devlet arasında kurulan bir toplumsal sözleşmedir. Bu sözleşmenin ruhu, yurttaşın devlete koşulsuz sadakati değil, anayasal düzene bilinçli ve özgür iradeyle katılımını esas alır. Sadakat yükümlülüğünün bireylere teşmil edilmesi, anayasal eleştiri hakkını bastırmakta ve yurttaşları suskun, pasif birer özneye dönüştürmektedir. Bu durum, demokratik meşruiyetin kaynağı olan siyasal katılımı zayıflatmakta ve ifade özgürlüğü gibi temel haklar üzerinde caydırıcı bir etki yaratmaktadır.

Karşılaştırmalı anayasa hukukunda da görüldüğü üzere, sadakat yükümlülüğü yalnızca kamu görevlileriyle sınırlıdır. Almanya, Fransa ve ABD gibi örneklerde, kamu görevlilerinin anayasal değerlere bağlılığı kurumsal güvenliğin gereği olarak görülürken, yurttaşlar için böyle bir bağlayıcılık aranmamaktadır. Aksine, bireylerin anayasal düzeni eleştirebilmesi, anayasal gelişim ve toplumsal çoğulculuğun bir gereği olarak kabul edilmektedir.

Türkiye özelinde, sosyal medya çağında bireylerin yaptığı paylaşımların cezai yaptırımlarla karşılaşması, anayasanın birey üzerindeki güven inşa edici niteliğini zayıflatmakta ve anayasal

düzeni sorgulamanın “sadakatsizlik” ile özdeşleştirilmesine yol açmaktadır. Bu eğilim, yalnızca bireysel özgürlükler açısından değil, anayasa hukukunun evrensel ilkeleri açısından da tartışmalıdır.

Anayasa Mahkemesi ve Avrupa İnsan Hakları Mahkemesi kararları, ifade özgürlüğünün demokratik toplumun temelini oluşturduğunu ve bu özgürlüğün yalnızca makul ve kabul edilebilir düşüncelerle sınırlı olamayacağını açıkça ortaya koymaktadır. Bu bağlamda anayasal sadakat, bireyin değil; kamu erkini kullananların sorumluluğu olarak sınırlandırılmalıdır.

Sonuç olarak, anayasal sadakat yükümlülüğünün kamu görevlileriyle sınırlı kalması hem anayasal denge hem de özgürlükçü demokrasi anlayışı bakımından zorunludur. Yurttaşlar, anayasaya körü körüne sadakat göstermekle değil, onu sorgulamak ve dönüştürmekle yükümlüdür. Anayasa, kendisine eleştirel yaklaşan yurttaşı değil; yalnızca anayasal düzeni bozmaya yönelik şiddet içeren eylemleri tehdit olarak görmelidir. Bu yönüyle anayasa, sadakat üzerinden değil; özgürlük ve katılım üzerinden yeniden düşünülmelidir.

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FEASIBILITY OF ESTABLISHING INTEGRATED URBAN MANAGEMENT AND ITS ESTABLISHMENT REQUIREMENTS IN METROPOLITAN CITIES (CASE STUDY: ISFAHAN)

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Abstract

As an approach, integrated urban management implies adopting a holistic approach and designing mechanisms to incorporate the said approach into urban management. Thus, it is crucial to identify the factors affecting integrity and the lack of which in urban management to help realize integrated urban management. In so doing, the study emphasized how it would be best to specialize in management developments by initially defining relative concepts and making the conceptual space more transparent, and secondly, examining integrated urban management. The study was then concerned with transforming organizational structures and the interrelationship between relevant elements, modifying urban management rules and regulations, including the physical, social, and economic structures of cities, and strengthening the finances of municipalities to meet integrated urban management. The study finally offered some suggestions to improve urban management using an integrated approach. Integrated urban management is essentially taking on an active and dynamic role in management development and coordinating resources to achieve urban developmental goals. In this connection, this study aimed to investigate components of integrated urban management in the Iranian city of Isfahan. A review of various definitions of integrated urban management and the literature on the subject has led to the identification and selection of the most important indicators in integrated urban management. These indicators collected in this study amounted to 40 indicators, which were used by experts for evaluation. A questionnaire instrument was used to examine these indicators in the city of Isfahan, and then data analysis was performed. Results showed that a groundwork was laid in the city to implement and meet integrated management among executive organizations.

Keywords: City, integrated urban management, management, Isfahan City

Introduction

Today, urban management is being transformed worldwide. Cities are managed to meet the welfare and comfort of their residents. Modern urban management nowadays encompasses wide-ranging structures, playing a critical role in advancing different types of urban development plans, meeting population demands, and tackling traffic issues while promoting public welfare, housing, land uses, entertainment, culture, economy, infrastructure, etc. Urban management has transformed in the wake of advancements in the science of Management.

Elected by various groups of people across cities, urban councils are seen advocating equal urban living conditions. They are also working to make cities flourish, deal with public demands, and expand the growth and excellence of cities. Members of city councils represent various groups of people and serve to maintain and promote the values of the city and its people while trying to advance urban affairs in a way desired. Municipality authorities and city council members are also responsible for deciding what is bad and what is harmful for the city and its people, as well as their future. Concerning urban policy-making, governments are, in the meantime, playing a guidance role and are concerned with funding municipal divisions to meet public welfare in cities. Concerning decisions made about cities, however, municipalities seek to advance urban affairs under their respective structures. It is well understood that urban management has been around since the mid-20th century, as it has applied a scientific approach to deal with social affairs (Nallathiga, 2008).

Meanwhile, the type of a governance system, and consequently the systems employed by each government to handle urban affairs, as well as the scope of powers and relations of an urban government with other levels of the government could significantly contribute to the formation of a system of relationship between elements of management and urban planning. In more centralized systems, the extent of trust in urban governments is at the low end, with power delegation to urban governments involving only partial and insignificant activities, and urban planning policies usually fall under the powers of the central government. In the meantime, in decentralized systems, urban planning is adopted as a local activity and is entrusted to urban governments (Babaei & Ebrahimi, 2016).

Today, municipalities are suffering from complex, variable, and uncertain management structures worldwide, facing an unprecedented rise in public demands. The public, in the meantime, is calling for a kind of urban planning management institution that would be accessible and meet their needs. However, finances and other funding available to municipalities are being tightened up, presenting numerous challenges to applying innovative technologies in municipal functions. On the other hand, urban social and physical woes have become complicated, thereby increasing the need for more harmony and coordination in urban planning. Also, the growing pace of urbanism across the world, particularly in the developing world, on the one hand, and the failure of cities to meet their residents' needs, on the other hand, require a greater focus on the potentials of integrated urban management to deal with urban woes. The integration of urban management processes has been a major concern of scholars since the late 70s (Ghaffari-Gilandeh et al., 2016). The world community is now recognizing that the major problems of urban management are not financial crunch, modern technologies,

or skilled manpower; rather, urban management is primarily struggling with how it should handle and administer these factors. Moving beyond organizational structures, urban management refers to a range of respective stakeholder organizations involved with handling urban affairs and how these elements are interrelated (Ebrahimzadeh & Asadian, 2011).

Integrated urban management, in the meantime, is seen as one of the critical components of urban management systems. Since urban affairs are systematically interrelated, they should be managed under the authority of a specific organization, namely an integrated urban management system that will, in collaboration with other respective organizations, help establish an integrated form of management to regularly advance specific plans and save time and cost while properly administering relevant plans (Kazemian & Mirabedini, 2012).

An overview of the Iranian urban management situation implies that urban management is under the control of the government due to centralized and exogenous structures, as well as rent-based and oil-dependent economic policies. The Iranian urban management has thus come a long way from integrated and systematic management, struggling in an eddy of sectoral and cellular management and being deprived of urbanism processes due to the growing top-to-bottom approaches (Ramezani, 2015).

Integrated urban management systems in Iran are lagging behind modern developments and struggling with numerous problems. The most notorious problems facing Iranian urban management systems, especially in Isfahan, are as follows:

1. A lack of integrated management
2. A shortage of efficient and expert manpower
3. A lack of managerial communication among managers
4. A multitude of decision-making centers
5. Disintegrated organizational tasks and responsibilities across urban offices

Due to its centralized political-managerial structure, the Iranian urban management system has a one-way and linearly vertical relationship with superior systems and regional and national systems, making the system lean towards a passive management system. Meanwhile, incoherent systematic interactions with domestic and inferior levels have turned it into a system with a non-integrated and inconsistent management establishment. From an environmental perspective, the Iranian urban management system is operating under an adverse working environment due to poor political, social, financial, and legal features, which have discouraged social actors from engaging in urban affairs (Parhizgar & Firouzbakht, 2011). Since the early 90s, when the idea of autonomous municipalities was raised, the unity of urban management

has become increasingly popular. Since then, however, serious discussions have concerned the ambiguity of municipalities and urban councils contributing to urban management, as well as the role of governance and government organizations in cities. One source of ambiguity pertained to the position and role of local management in urban planning systems and providing urban development plans (Kazemian & Mir Abedini, 2011).

It is now widely agreed that the integrated urban management model serves as an efficient model applied by policy-makers, planners, legislators, and urban managers. Failing to be practically implemented across Iran, this model is still recognized as an ideal model and is taken into account as a favorable integrated urban management framework. While the urban management system in Iran is governed by some 25 organizations, urban structures appear to be inappropriate, and urban woes are getting complicated every day. Each organization views urban issues through the lens of its operations and amenities, and for this, an inclusive approach to urban issues is lacking. The organizations do not communicate well together and do not consult each other in policy-making processes. As a key member of the urban management system, the municipality is one of the key players to assume the leadership of cities because they are more involved with public affairs than other organizations. Thus, establishing a central office in the municipality to coordinate civil, economic, and social programs could help eliminate urban deficiencies (Mohammadi) in the city of Isfahan. In sum, integrated urban management can overcome many program and operational irregularities. This study, as stated above, aimed to investigate the organizations influencing Isfahan's urban management and whether it was feasible to establish an integrated urban management system.

Theoretical Foundations

Urban Management Tasks in Major Global Cities

Organizations worldwide involve a range of diverse tasks and responsibilities aimed at meeting social needs. For example, the Department of Education is tasked with training and transferring scientific experiences and findings to the new generation; the military is responsible for defending borders and countering aggression, while urban management has its specific tasks. Since their inception, urban management systems have been tasked with meeting public requirements such as supplying drinking water, lighting, and monitoring the environment. These basic tasks led to the formation of municipalities. Earlier, municipalities were formed to perform such services as providing route safety, supplying drinking water, creating soup kitchens, and orphanages. In the contemporary era, however, other tasks such as supplying electricity, gas, setting up libraries, trade and art exhibitions, as well as cultural facilities, were added to the operations of municipalities. However, urban management is now diversifying its

scope of responsibilities, with municipalities, once founded to clean up cities and provide food, are now working to meet public welfare and living standards. In the meantime, the scope of these tasks and responsibilities in municipalities may vary from one city to another or from one country to another. To know more about the diversity of tasks entrusted to municipalities (Esmaeilzadeh & Hemmati, 2012), Table 1 below elaborates on 12 major municipalities in the world:

Table 1: Global experiences of urban management

City	Country	Description of Tasks
Amsterdam	The Netherlands	Supplying electricity, cold and hot water, TV antennas, radio antennas, public transportation (buses, trams, express trains), cleaning up the city, administering economic affairs (parts of Ministry of Economy affairs), works of public interest, public and Traffic Police, military conscription, birth and death registration, employment, the elderly affairs, sports and entertainment, municipal affairs (local governments), installations, associations, financial municipal matters, budgets, auto technical check-ups, counseling and information, collecting vagabonds, construction, issuing driving permits, issuing passports, constructing slaughterhouses, correction facilities, graveyards, restaurants, nursing homes, welcoming foreigners, controlling food stuffs, endowments, issuing birth certificates, fire department, public insurance, hospitals, education, services and financial aids, internal urban contracts, domestic port facilities, housing, state-sponsored apartments, Youth affairs and Youth Centers, art and culture, libraries, films and video archives, city history, expos, museums, theaters and concerns, zoos, population statistics, symphonic orchestrate, festival affairs, etc.
Stockholm	Sweden	Urban planning, the environment, leisure, school units affairs, social affairs units, financial units, personnel units, premises and buildings, passageways and traffic, industrial affairs, transport, traffic, (e.g., bus-driving systems, large-scale and modern underground metro stations, inter-state/inner-city railway stations, and surrounding areas), school management, library affairs committees, archive affairs committees, foreign affairs committees, slaughterhouses, shops, National Defense Committees, orphan custodianship, fire and defense, housing, etc.
Berlin	Germany	Education, traffic, transportation, regional transport system, housing affairs, monitoring and regulation over state institutions involved in planning and policy-making, development, and prosperity, cultural affairs, schools and sports facilities, construction and demolition, urban services, such as utilities, water, wastewater, graveyards, waste, garbage, laboratories, treatment and social care services, etc.
Prague	The Czech Republic	Supplying gas, water, electricity, and developing kindergartens, maintaining and protecting sports facilities, expanding central shops and chain shops, etc.
Beijing	China	Healthcare, culture, sports, census, kindergartens, alley beautification, developing local streets, etc.
Toronto	Canada	Public health, planning, leisure, parks and green spaces, housing, urbanism legislation, civil development, fire departments, the healthy recreation
Tokyo	Japan	Social welfare, public education, public healthcare, urban planning, environmental protection, cultural affairs, the University of Tokyo, the elderly, economic affairs and jobs, ports and wharves
Kuala Lumpur	Malaysia	The mayor is delegated numerous powers to manage all service affairs.
London	England	Housing, local parks, local planning, supplying gas, electricity, schools, transportation, public health, leisure planning, medicine, housing, and construction, etc.
Los Angeles	The U.S.	Urban security, housing and urban protection, transportation, leisure, education and culture, human resources, economic prosperity, social development
Moscow	Russia	Urban economic development, educational destinations, health, and retirement

Source: Urban management in some major cities across the globe, listed by the Tehran Bureau of Urban Planning Studies

Area Under Study

Located in the central Iranian plateau, the Isfahan Plain represents astonishing ground features. The plain's location in central Iran has given Isfahan a unique situation, providing security and easy access to different parts of the country. In the meantime, proximity to the desert and the Zayandeh Roud River water represents a special ecosystem for the area (Province of Isfahan's Statistical Yearbook, 2010).

Spanning 179.106 square kilometers, Isfahan Province covers around 25.6% of the entire area of Iran, making it the fifth province after the provinces of Khorasan, Kerman, Sistan and Baluchistan, and Fars. This province shares borders with eight other provinces, bound in the north by provinces of Qom, Markazi, and Semnan, in the south by Fars and Kohgiluyeh and Boyer Ahmad, in the east by Yazd, and in the west by Lorestan and Chahar Mahal and Bakhtiari (Province of Isfahan's Statistical Yearbook, 2010).

Isfahan's Municipality performs its tasks and duties by a staff headquarters composed of mayoral administration (mayoral office, Public Relations and International Affairs, Inspection and Response to Legal Complaints, and relevant eight Secretariats and Security Departments) involved in policy-making, planning, and strategic regulation in various areas, as well as 15 regional municipality offices and 15 organizations in charge of executive affairs and realizing policies and decisions (Fig. 1).



Figure 1: Isfahan's 15 regions

Methodology

The study's methodology fell under descriptive-analytical (survey) research. The statistical population of the study consisted of all organizations that exert influence over executive procedures of urban affairs, though the organizations may not wield the same powers in terms of types and levels of influence. The most important of these organizations include: the Water and Wastewater Company, the Electricity Company, the Telecommunications Company, the Gas Company, the Municipality, and the Provincial Office, which are all involved in urban affairs. The sample under study was selected from among directors and deputies of these

companies and organizations who were familiar with inter-organizational relations and integrated urban management. The statistical population led to the selection of a 70-person sample size, and questionnaires were designed and distributed among experts and professionals. Data were collected using library and field survey methods. In the field survey method, an interview instrument was used. Data collected from the questionnaires were analyzed by the descriptive analytical method using descriptive statistics.

To measure the content and face validity of the study's questionnaires, the most recent articles on the subject, in addition to the views of esteemed supervisor and advisor professors and experts, were used, all confirming the validity of the questionnaires.

To measure the reliability of the questionnaires, an initial sample consisting of 30 questionnaires was pretested, and then, the resulting data were analyzed using the statistical SPSS software via Cronbach's alpha. Table 2 below gives Cronbach's alpha coefficients.

Table 2: Cronbach's alpha results

Total Questionnaire Reliability	
Number of items	Alpha values
40	0.744

Results

1.Descriptive Results of the Subjects:

Out of the 70 questionnaires analyzed, 10 people (14.3%) were women and 60 people (85.7%) were men.

The results showed that the 30-40-year-old age group (57.1%) and the 50+ age group (1.4%) held the highest and the lowest frequencies at 40 and 1 people, respectively.

Concerning education and literacy, 3 people (4.3%) held a Diploma, 8 (11.4%) an Associate's, 39 (55.7%) a B.A., and 20 (28.6%) an M.A.

Fifteen people (21%) held education degrees related to architecture and urban planning, while 79% held irrelevant education degrees.

2.Feasibility Results

This section concerns the questionnaires filled out by urban affairs experts. The first category of the items analyzes the urban management situation in Isfahan by evaluating integrated urban management indicators.

Table 3: First questionnaire item results Accessibility of information status

	Frequency	Percentage
Very low	21	30
Low	17	24.2
Medium	23	32.9
High	9	12.9
Very high	0	0
Total	70	100

Informational infrastructure status

	Frequency	Percentage
Very low	7	10
Low	40	57.1
Medium	18	25.7
High	5	7.1
Very high	0	0
Total	70	100

Human resources

	Frequency	Percentage
Very low	23	32.9
Low	22	31.4
Medium	13	18.6
High	12	17.1
Very high	0	0
Total	70	100

Relationship between the municipality and architecture and civil urban planning departments

	Frequency	Percentage
Very low	1	1.4
Low	9	12.7
Medium	14	20
High	7	10
Very high	39	55.7
Total	70	100

Employees' participation in decision-making processes

	Frequency	Percentage
Very low	17	24.3
Low	10	14.3
Medium	16	22.9
High	23	32.9
Very high	4	5.7
Total	70	100

Defining long-term and introvert programs for the city

	Frequency	Percentage
Very low	6	8.6
Low	34	48.6
Medium	28	40
High	2	2.8
Very high	0	0
Total	70	100

Financial plans and statements for citizens

	Frequency	Percentage
Very low	23	32.9
Low	12	17.1
Medium	28	40
High	6	8.6
Very high	1	1.4
Total	70	100

Citizen participation in handling urban affairs

	Frequency	Percentage
Very low	18	25.7
Low	39	55.8
Medium	11	15.7
High	1	1.4
Very high	1	1.4
Total	70	100

Directors' responsibility and accountability

	Frequency	Percentage
Very low	4	5.7
Low	47	67.2
Medium	5	7.1
High	14	20
Very high	0	0
Total	70	100

Collaboration between the private and public sectors in urban affairs

	Frequency	Percentage
Very low	2	2.9
Low	46	65.7
Medium	13	18.6
High	5	7.1
Very high	4	5.7
Total	70	100

Cooperation among organizations in charge of urban affairs

	Frequency	Percentage
Very low	15	21.4
Low	23	32.9
Medium	31	44.3
High	1	1.4
Very high	0	0
Total	70	100

Requirements for a trans-organizational center for managing urban affairs

	Frequency	Percentage
Very low	4	5.7
Low	39	55.7
Medium	9	12.9
High	3	4.3
Very high	15	21.4
Total	70	100

Organizational cooperation (solidarity)

	Frequency	Percentage
Very low	2	2.9
Low	19	27.1
Medium	38	54.3
High	10	14.3
Very high	1	1.4
Total	70	100

Holistic approach to complicated problems

	Frequency	Percentage
Very low	8	11.4
Low	21	30
Medium	31	44.3
High	7	10
Very high	3	4.3
Total	70	100

Increasing the expertise of managers and familiarity with urban affairs

	Frequency	Percentage
Very low	1	1.4
Low	9	12.9
Medium	25	35.7
High	25	35.7
Very high	10	14.3
Total	70	100

Feasibility of eliminating structural and establishment problems

	Frequency	Percentage
Very low	1	1.4
Low	15	21.4
Medium	20	28.6
High	32	45.7
Very high	2	2.9
Total	70	100

Significance of executing rules and regulations in decision-making processes

	Frequency	Percentage
Very low	1	1.4
Low	35	50
Medium	29	41.4
High	5	7.1
Very high	0	0
Total	70	100

Monitoring over-executing regulations

	Frequency	Percentage
Very low	6	8.6
Low	24	34.3
Medium	28	40
High	10	14.3
Very high	2	2.9
Total	70	100

The second category of the items concerns the integrated urban management indicators in Isfahan and the views of experts about their agreement over the options provided.

Table 4: The second questionnaire's item results

Agreement with the mayor as the most influential authority in decision-making

	Frequency	Percentage
Very low	1	1.4
Low	11	15.7
Medium	14	20
High	33	47.2
Very high	11	15.7
Total	70	100

The city council as the main authority in urban management

	Frequency	Percentage
Very low	8	11.4
Low	32	45.7
Medium	16	22.9
High	6	8.6
Very high	8	11.4
Total	70	100

Transferring infrastructure affairs to the municipality

	Frequency	Percentage
Very low	0	0
Low	27	38.6
Medium	9	12.9
High	32	45.7
Very high	2	2.8
Total	70	100

Increasing social justice via outsourcing

	Frequency	Percentage
Very low	14	20
Low	0	0
Medium	25	35.7
High	30	42.9
Very high	1	1.4
Total	70	100

Direct participation of citizens in urban affairs

	Frequency	Percentage
Very low	0	0
Low	11	15.7
Medium	20	28.6
High	29	41.4
Very high	10	14.3
Total	70	100

City council's accountability for urban problems

	Frequency	Percentage
Very low	1	1.4
Low 2	2	2.9
Medium	21	30
High	17	24.3
Very high	29	41.4
Total	70	100

Focus by management organizations in a region.

	Frequency	Percentage
Very low	1	1.4
Low	5	7.1
Medium	12	17.1
High	24	34.3
Very high	28	40
Total	70	100

A building independent from the municipality for the city council

	Frequency	Percentage
Very low	0	0
Low	10	14.3
Medium	8	11.4
High	25	35.7
Very high	27	38.6
Total	70	100

Availability of council members for the public

	Frequency	Percentage
Very low	0	0
Low	0	0
Medium	8	11.4
High	22	31.4
Very high	40	57.1
Total	70	100

Mere council's monitoring over the municipality's performance

	Frequency	Percentage
Very low	1	1.4
Low	4	5.7
Medium	11	15.7
High	44	62.9
Very high	10	14.3
Total	70	100

Referring urban crimes to the municipality

	Frequency	Percentage
Very low	15	21.4
Low	10	14.3
Medium	14	20
High	21	30
Very high	10	14.3
Total	70	100

Independent council's performance

	Frequency	Percentage
Very low	0	0
Low	1	1.4
Medium	27	38.6
High	19	27.1
Very high	23	32.9
Total	70	100

Availability of the mayor to promote performance

	Frequency	Percentage
Very low	1	1.4
Low	1	1.4
Medium	39	55.7
High	9	12.9
Very high	20	28.6
Total	70	100

Mayor's presence in the city's council meetings

	Frequency	Percentage
Very low	0	0
Low	12	17.1
Medium	6	8.6
High	27	38.6
Very high	25	35.7
Total	70	100

The council's accountability for eliminating shortages

	Frequency	Percentage
Very low	0	0
Low	5	7.1
Medium	2	2.9
High	17	24.3
Very high	46	65.7
Total	70	100

Conclusion

As indicated by directors of various organizations involved with Isfahan affairs, the information available to decision-makers is at an average level, the informational infrastructure status is weak, and expert and professional human resources in municipalities and relevant organizations are lacking. In the meantime, the municipality enjoys a great level of communication with architectural and urban planning, as well as civil departments, with its employees effectively participating and engaging in organizational decision-making processes. However, the quality of defining long-term urban plans, citizen participation in urban affairs, director responsibility and accountability for decisions, as well as collaboration between private and public sectors in

urban affairs, are low; as well, citizen availability, organizational goals, and financial statements are at their low ends. On the other hand, there is an average level of collaboration among the organizations in charge of urban affairs, organizational cooperation among directors of the organizations involved with executive affairs, the effects of urban manager expertise to resolve organizational issues, long-term goals shared by the above-sated organizations, and elaborate monitoring and oversight over regulations and directives. This has led to fewer requirements for decision-making centers and trans-organizational planning policies. On the other hand, organizations attach less significance to executing rules and regulations in policy-making processes. However, directors and professionals maintained that it was highly possible to establish effective interactions with citizens and remove structural issues in the municipality offices.

The findings of the study showed that Isfahan's urban management may not be integrated. It was found that directors and managers at various organizations largely agreed with the most influential decision-making authority of the city, i.e., the mayor, transferring infrastructure affairs to the municipality, outsourcing affairs to the municipality to help promote social justice, directly engaging citizens in decision-making processes, focusing functions of all urban management bodies on one single domain, making the council oversee the municipality's performance, promoting urban management performance by making members of the council available, ceding government responsibilities in one area of the city to urban management, establishing easy and ongoing communication between municipal officials with people, and engaging the mayor in urban council sessions. Consensus was also made about providing more responsibility to the urban council to eliminate shortages, making available members of the city council to the public, and providing a building independent of the municipality. There was, however, less agreement by professionals over mere oversight of the municipality's employees. As well, less consensus was made over the city council taking the main role in urban management. In sum, an average level of agreement was given to the ideas of the council working independently from the mayor, the effects of improving municipality performance by making the mayor accessible, and also referring complaints about the municipality's performance to the city council.

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INHERITANCE RIGHTS IN THE CAREGIVING RELATIONSHIP BETWEEN STEPPARENTS AND STEPCHILDREN UNDER THE VIETNAMESE CIVIL CODE

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ABSTRACT

Civil law in general, and inheritance relations in particular, have existed since the early stages of human society as an objective social phenomenon. They arose from practical life needs and emerged as an inevitable issue in the history of mankind. At a certain point, every person must face death—which marks the end of their activities and property ownership. In any society with social strata or classes, the issue of inheritance arises, leading to the development of inheritance law as part of civil law. This legal framework ensures that a deceased person's assets are transferred to surviving individuals to meet ongoing living needs. Among these provisions, the regulation of inheritance in the caregiving relationship between stepfathers or stepmothers and the biological children of their spouses is a special case. However, in reality, inheritance disputes are becoming increasingly complex, and resolving disputes involving such relationships still faces many obstacles and inadequacies in practice. Therefore, effective solutions are needed to address these issues and to enhance the implementation of the law as well as the judicial work of the courts.

Keywords: Inheritance; stepfather, stepmother, and sstepchil; legal inadequacies; complete solutions.

YEZIDI DIASPORA IN GERMANY: OPPORTUNITIES, CHALLENGES, AND DEBATES ON OFFICIAL RECOGNITION

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Abstract

The study explores questions such as "How and through what means is the Yezidi religious community part of the German society and engaging in dialogue with the State(s) of Germany?" and "At what level did the policies of the integration of the German States shape the Yezidi community?"

Yezidis, a religious minority from Middle Eastern cultural basins, have partly integrated into German society since the 2000s. The Yezidi society is based on tribal structures (Omarkhali, 2021) that encounter social and cultural challenges in their German diaspora. The oral tradition and memory that form the Yezidi society undergo new social interactions in the diaspora. Yezidis have been actively involved in public institutions across Germany, with individuals holding prominent roles in various professions, including doctors, lawyers, and judges. These Yezidis are seen by previous generations as a means of preserving traditional Yezidism against the pressures of 'assimilation' while also striving to gain official religious recognition in Germany. To overcome discourses of political security and cultural "otherness," Yezidis came across challenges in Germany. Their current advocacy is contributing to a shift in Germany's societal discourse on religious groups. In this context, Jürgen Habermas' concept of 'communicative rationality' offers a theoretical framework for understanding the potential role of religion in societal transformation. According to Habermas, modern, communicative reason alone is insufficient for achieving social integration; religious sources can provide the cohesion necessary for society (Habermas, 1992). Furthermore, he suggests that religion should not be confined to the private sphere; instead, it can help individuals develop their moral intuitions by engaging with the broader public discourse and the traditions of society (Habermas, 1996). The Yezidi diaspora in Germany is analyzed in this work.

Keywords: Yezidi, Germany, Diaspora, official recognition

ORAL WILLS UNDER CURRENT VIETNAMESE CIVIL LAW

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ABSTRACT

Wills are unilateral legal acts expressing an individual's disposition of their estate after death. Currently, under Vietnamese civil law, wills can be made in two forms: written wills and oral wills. Because a will only takes effect from the moment the testator (the person making the will) dies, its form is the only remaining evidence expressing the testator's intent. Therefore, if a will violates formal requirements, it will lead to the invalidation of the transaction. Currently, Vietnamese legal provisions regarding oral wills are not entirely clear. Furthermore, the conditions for oral wills are excessively strict, leading to difficulties in legal enforcement. At the same time, disputes over inherited assets bequeathed by oral wills are quite common. Within the scope of this article, the author will examine the concept and characteristics of an oral will and the conditions for making one. From there, the article will analyze the shortcomings of the current law and propose solutions to improve the effectiveness of Vietnamese law on oral wills..

Keywords: Wills, oral wills, testators, inheritance, inheritance under wills, legal requirements for an oral will.

FILING OF CRIMINAL CHARGES AS PER THE CRIME VICTIM'S PETITIONS ACCORDING TO VIETNAMESE CRIMINAL PROCEDURE LAW

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1. Introduction and Objectives: Filing of criminal charges as per the crime victim's petitions is a special case of initiating a criminal case. Accordingly, the competent authority and person conduct the proceedings on the basis of receiving and handling information about crimes that have signs of crime on the basis of the provisions of criminal law and criminal procedure. Although initiating a criminal case plays an important role in protecting the rights and interests of the State and society, it causes additional mental damage to the subject directly affected by the crime, the victim. Therefore, the criminal procedure law gives the victim in criminal proceedings the right to decide whether or not to initiate a criminal case in order to ensure the rights and interests of the victim, and not to cause them to suffer other mental damage due to the initiation of the case, the handling of the crime, and the offender.

The article focuses on analyzing cases where criminal cases can only be initiated when the victim's petitions and the legal consequences of withdrawing the request for prosecution. The group of authors aims to propose a number of recommendations to perfect the provisions of criminal procedure law and improve the effectiveness of applying the provisions filing of criminal charges as per the crime victim's petitions in Vietnamese criminal procedure law.

2. Research Methods: To complete this research paper, during the research process, the group of authors used analytical, synthetic, and statistical methods.

3. Main findings: Main findings: Through the process of researching the article, the group of authors analyzed the provisions of the 2015 Criminal Procedure Code (amended and supplemented in 2021) on the initiation of criminal cases at the request of the victim: (i) On the subject having the right to request the initiation of criminal cases at the request of the victim; (ii) On the scope of crimes prosecuted at the request of the victim; (iii) On the content, form, and legal consequences of the victim's request to initiate a criminal case; (iv) Proposals to improve the criminal procedure law on the initiation of criminal cases at the request of the victim.

4. Conclusions: Based on research and analysis filing criminal charges as per the crime victim's petitions, the group of authors proposes legal solutions, specifically perfecting Article 155 of the 2015 Vietnamese Criminal Procedure Code (amended and supplemented in 2021)

Keywords: Request of crime victim, representative, withdraw the request

PREPARATION AND CHARACTERIZATION OF MICROEMULSION FORMULATIONS

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ABSTRACT

Microemulsions are thermodynamically stable, optically clear, isotropic mixtures stabilized by surfactants. Today, they are defined as systems with an average droplet diameter ranging from 4 to 150 nm, which form spontaneously through the thermodynamic equilibrium of formulation components (aqueous phase, oil phase, nonionic or ionic amphiphilic molecules, and an optimal amount of co-solvent).

In microemulsions, surfactants are positioned at the oil-water interface, sharply separating the phases. These surfactants possess a polar head and a nonpolar tail, enabling them to disperse the internal phase into spherical droplets. Microemulsions may contain three or more phases in equilibrium. Depending on the composition and molecular concentration, the continuous phase may be aqueous, oily, or biphasic.

Due to their droplet size being significantly smaller than the wavelength of visible light, microemulsions appear transparent and their structures cannot be observed using optical microscopy. They exhibit Newtonian flow behavior, and biphasic microemulsions tend to be less viscous than those containing nano-sized droplets. These systems can serve as liquid membrane carriers for transporting lipophilic substances in aqueous media or hydrophilic substances through lipid media. Once prepared, microemulsions are characterized using various physical techniques, such as conductivity measurements, light scattering, ultracentrifugation, nuclear magnetic resonance (NMR), infrared spectroscopy (IR), small-angle X-ray scattering (SAXS), electron microscopy, and photon correlation spectroscopy.

Keywords: Characterization, microemulsions, preparation, surfactant

MİKROEMÜLSİYON FORMÜLASYONLARININ HAZIRLANMASI VE KARAKTERİZASYONU

ÖZET

Mikroemülsiyonlar, yüzey aktif maddelerle stabilize edilmiş, termodinamik olarak kararlı, optik olarak berrak ve izotropik karışımlardır. Günümüzde mikroemülsiyonlar; formülasyon bileşenlerinin (sulu faz, yağ fazı, anyonik veya iyonik amfifilik moleküller ve optimum miktarda yardımcı çözücü) termodinamik dengesiyle kendiliğinden oluşan, ortalama damlacık çapı 4 ila 150 nm arasında değişen sistemler olarak tanımlanmaktadır.

Mikroemülsiyonlarda yüzey aktif maddeler yağ ve su fazları arasındaki arayüze yerleşerek fazları keskin bir şekilde birbirinden ayırır. Bu yüzey aktif maddeler polar bir baş gruba ve apolar bir kuyruk bölgesine sahip olduklarından, iç fazı küresel damlacıklar halinde dağıtmalarını sağlar. Mikroemülsiyonlar birbiriyle dengede olan üç veya daha fazla faz içerebilir. Formülasyonun içeriğine ve moleküllerin konsantrasyonuna bağlı olarak sürekli faz; sulu, yağ bazlı veya iki fazlı olabilir.

Damlacık boyutları görünür ışığın dalga boyundan çok daha küçük olduğundan mikroemülsiyonlar şeffaftır ve yapıları optik mikroskopla gözlemlenemez. Newtonyen akış davranışı sergilerler ve iki fazlı mikroemülsiyonlar, nano boyutlu damlacık içerenlere kıyasla daha düşük viskoziteye sahiptir. Bu sistemler; lipofilik maddelerin sulu ortamda, hidrofilik maddelerin ise lipid ortamda taşınmasında sıvı membran taşıyıcıları olarak kullanılabilir. Mikroemülsiyonlar hazırlandıktan sonra; iletkenlik ölçümleri, ışık saçılımı, ultrasestrifügasyon, nükleer manyetik rezonans (NMR), infrared spektroskopisi (IR), küçük açılı X-ışını saçılımı (SAXS), elektron mikroskobu ve foton korelasyon spektroskopisi gibi çeşitli fiziksel karakterizasyon teknikleriyle değerlendirilir.

Anahtar kelimeler: Hazırlanma, karakterizasyon, mikroemülsiyonlar, yüzey aktif madde

PHYTOCHEMICAL ANALYSIS AND QUALITY CONTROL OF HERBAL MEDICINES USING CHROMATOGRAPHIC AND SPECTROSCOPIC TECHNIQUES

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Abstract

Phytochemical analysis plays a critical role in the quality control, safety, and efficacy of herbal medicines. With the growing global consumption of plant-based products, the need for standardized methods to evaluate their chemical composition and bioactive properties has become increasingly important. This paper provides an in-depth overview of the regulatory requirements and standardization efforts that govern the phytochemical analysis of herbal medicines. It explores the challenges posed by the natural variability of plant materials, as well as the complex nature of herbal preparations that contain multiple bioactive compounds. Various national and international regulatory frameworks, such as the U.S. FDA's Dietary Supplement Health and Education Act (DSHEA) and the European Medicines Agency's Traditional Herbal Medicinal Products Directive (THMPD), have been implemented to ensure product safety and consistency. Additionally, the World Health Organization (WHO) has developed guidelines to assist countries in regulating herbal medicines. Standardization methods such as Good Manufacturing Practices (GMP), Good Agricultural Practices (GAP), and advanced analytical techniques like chromatography, spectrometry, and DNA barcoding are integral to ensuring that herbal products meet quality and safety standards. Despite progress in these areas, challenges remain, including the lack of universal global standards and issues of adulteration. A continued focus on international collaboration, harmonized standards, and advanced testing techniques will be essential for improving the global regulation and quality control of herbal medicines.

Keywords: Phytochemical analysis, herbal medicines, regulation, standardization, quality control, Good Manufacturing Practices.

Introduction to Phytochemical Analysis: Overview of phytochemicals, their importance, and challenges in analysis.

Phytochemical analysis is a field of study that has garnered increasing attention in recent years due to the vital role that plant-derived compounds, known as phytochemicals, play in various aspects of human health, agriculture, and the environment. Phytochemicals are naturally

occurring, bioactive compounds produced by plants that are not directly involved in the plant's primary metabolic processes such as growth, reproduction, or energy production. Instead, they are secondary metabolites that serve a variety of purposes for the plants, including defense against herbivores, pathogens, and environmental stressors. The importance of phytochemicals extends beyond their ecological role; they have significant therapeutic, nutritional, and industrial applications. The analysis of these compounds provides insight into their structure, bioactivity, and potential uses, especially in medicine and pharmacology. Despite their growing importance, however, the analysis of phytochemicals is fraught with numerous challenges. This essay explores the overview of phytochemicals, their significance, and the difficulties researchers encounter when attempting to analyze these compounds. Phytochemicals can be classified into several broad categories based on their chemical structure, biological activity, and the physiological roles they play within plants. One of the most well-known classes of phytochemicals is alkaloids. These nitrogen-containing compounds have long been studied for their potent pharmacological effects on humans and animals. Alkaloids include a wide range of compounds such as morphine, quinine, caffeine, and nicotine, all of which have established medical applications. For example, morphine is a powerful pain reliever derived from the opium poppy, and quinine, derived from the bark of the cinchona tree, has been historically used to treat malaria. Alkaloids are often of particular interest to pharmaceutical research because of their strong effects on the human nervous system, immune system, and cardiovascular system. Another important class of phytochemicals is flavonoids. Flavonoids are polyphenolic compounds that are widespread in the plant kingdom and are known for their antioxidant, anti-inflammatory, and anticancer properties. They are commonly found in fruits, vegetables, grains, and beverages like tea and wine. Flavonoids, such as quercetin, catechins, and anthocyanins, contribute to the color and flavor of these plants and are believed to have numerous health benefits. Flavonoids have been linked to the prevention of chronic diseases like heart disease, diabetes, and cancer, primarily due to their ability to neutralize free radicals and reduce oxidative stress. The antioxidant activity of flavonoids is thought to protect cells and tissues from the damage caused by reactive oxygen species, which play a central role in aging and the development of several diseases. Terpenoids, another major group of phytochemicals, are compounds that contain isoprene units and are known for their aromatic properties. Terpenoids include essential oils like limonene, menthol, and camphor, which are widely used in aromatherapy and the cosmetic industry due to their fragrant properties. In addition to their aromatic qualities, terpenoids also have antimicrobial, anti-inflammatory, and anticancer activities. For example, limonene, a terpene found in citrus fruits, has been shown to have

anticancer properties, particularly in lung and breast cancer cells. Furthermore, terpenoids are precursors to important biomolecules such as steroids and carotenoids, the latter being essential for vision and immune function.

Phenolic compounds represent another class of phytochemicals that are of great interest due to their potential health benefits. These compounds contain phenol rings, which have strong antioxidant properties. Phenolic compounds, such as tannins, lignans, and stilbenes, are widely distributed in plants and are primarily responsible for the antioxidant activity of plant-based foods. These compounds help to mitigate oxidative damage in the body, potentially reducing the risk of chronic diseases such as cardiovascular disease, diabetes, and cancer. Moreover, phenolic compounds have been shown to have antimicrobial, anti-inflammatory, and anticancer properties, making them an important focus of research in the field of plant-based medicine. In addition to these major classes, phytochemicals can also include glycosides, which are compounds that consist of a sugar molecule bound to a non-sugar component such as a phenolic compound or a terpenoid. Glycosides are found in a variety of plant species and have diverse biological activities. For instance, cardiac glycosides such as digoxin, derived from the foxglove plant, are used to treat heart conditions by increasing the strength of heart contractions. Other glycosides, such as saponins, possess antimicrobial and anticancer activities. The bioactivity of glycosides is closely tied to the ability of the sugar moiety to enhance the solubility and absorption of the non-sugar component in the body. Essential oils are another significant group of phytochemicals. These oils, which are concentrated extracts of plant material, are responsible for the characteristic aroma of many plants and have various therapeutic applications. Essential oils are used in a wide range of industries, including cosmetics, pharmaceuticals, and aromatherapy, where they are valued for their ability to promote relaxation, reduce stress, and improve mood. Essential oils like lavender, eucalyptus, and tea tree oil have been shown to possess antimicrobial, anti-inflammatory, and antioxidant properties, making them useful in the treatment of conditions such as skin infections, respiratory ailments, and anxiety. The importance of phytochemicals is immense, particularly in the fields of human health, nutrition, and medicine. Many of the pharmacologically active compounds derived from plants serve as the basis for modern pharmaceutical drugs. The rich diversity of phytochemicals found in plants provides an invaluable resource for drug discovery and development. Several drugs, including aspirin, quinine, and taxol, have been derived from plant sources and have revolutionized the treatment of various diseases. In fact, more than 25% of all modern medicines are derived from plants or plant-based compounds. Moreover, the bioactive properties of phytochemicals have led to the development of functional foods and dietary

supplements, which are designed to promote health and prevent disease. For instance, flavonoids, phenolic compounds, and other antioxidants found in fruits and vegetables have been linked to a reduced risk of chronic diseases like heart disease, cancer, and neurodegenerative disorders. Beyond human health, phytochemicals play critical roles in plant defense and survival. Many phytochemicals serve as natural pesticides, repellents, or antimicrobial agents, protecting plants from herbivores, pathogens, and environmental stress. For instance, alkaloids like nicotine and caffeine deter herbivores, while terpenoids and phenolic compounds have antimicrobial and antifungal properties. The ecological significance of phytochemicals is further demonstrated by their role in pollination and seed dispersal. Some plants produce specific volatile compounds to attract pollinators, while others use their secondary metabolites to deter herbivores or inhibit the growth of competing plants. Despite their importance, the analysis of phytochemicals presents numerous challenges. The complexity of plant material poses a significant hurdle in phytochemical analysis. Plants contain a wide variety of compounds, including water-soluble molecules, lipids, proteins, and sugars, in addition to the desired phytochemicals. This complexity makes it difficult to selectively extract and identify specific compounds of interest. In many cases, the target phytochemicals may be present in very low concentrations, making their isolation and analysis even more challenging. Another challenge lies in the vast diversity of phytochemicals. Each plant species contains a unique combination of phytochemicals, and even within a single plant species, different parts of the plant (e.g., leaves, roots, flowers, seeds) may contain varying levels of these compounds. Environmental factors such as soil type, climate, and cultivation practices can also affect the concentration and profile of phytochemicals in plants. This variability makes it difficult to develop standardized methods for the analysis of phytochemicals across different species or growing conditions. Moreover, the chemical structure of many phytochemicals is highly complex, and some compounds share similar molecular characteristics, making it challenging to distinguish between them using conventional analytical techniques. The extraction and purification of these compounds often require sophisticated methods such as chromatography (e.g., high-performance liquid chromatography [HPLC], gas chromatography [GC]) and mass spectrometry (MS), which can be time-consuming, expensive, and require specialized expertise. Additionally, the development of reliable and reproducible methods for the quantification of phytochemicals remains a significant challenge, as the methods must account for the potential presence of interfering substances in the plant material. Standardization of analytical protocols is another issue in phytochemical analysis. Although several techniques are used for the identification and quantification of phytochemicals, there is no universally accepted

standard for their analysis. This lack of uniformity in analytical methods can lead to inconsistent results and difficulties in comparing findings across different studies. Furthermore, the identification of phytochemicals requires advanced instrumentation and knowledge of chemical structures, which can be a barrier to widespread research and application. In conclusion, phytochemicals are a diverse and invaluable class of compounds that hold tremendous promise for human health, agriculture, and industry. Their therapeutic properties, particularly in the treatment of chronic diseases, as well as their ecological functions in plants, underscore their importance in both natural and applied sciences. However, the analysis of phytochemicals remains a complex and challenging endeavor, due to the diversity of compounds, the complexity of plant matrices, and the lack of standardized analytical methods. Overcoming these challenges will require continued innovation in analytical techniques, as well as interdisciplinary collaboration among researchers in chemistry, biology, pharmacology, and agriculture.

Chromatographic Techniques for Phytochemical Analysis: Discussion of various chromatographic methods, such as HPLC, GC, and TLC.

Chromatographic techniques are widely employed in the analysis of phytochemicals due to their ability to separate, identify, and quantify the complex array of compounds found in plant materials. These techniques are fundamental tools in the field of phytochemical research, as they provide an effective way to study plant-derived compounds, many of which are bioactive and have medicinal, nutritional, and ecological significance. Chromatography encompasses a variety of methods, with high-performance liquid chromatography (HPLC), gas chromatography (GC), and thin-layer chromatography (TLC) being among the most commonly used techniques for phytochemical analysis. Each of these chromatographic methods offers distinct advantages and challenges, making them suitable for different applications depending on the nature of the phytochemicals being studied, the sample matrix, and the desired resolution of the analysis. High-performance liquid chromatography (HPLC) is one of the most widely used techniques in phytochemical analysis due to its versatility, high resolution, and ability to analyze compounds that are not volatile or thermally stable, which are common characteristics of many phytochemicals. HPLC involves the separation of compounds in a liquid sample based on their interaction with a stationary phase, typically a solid or semi-solid material packed into a column, and a mobile phase, usually a liquid solvent or a mixture of solvents that flows through the column. The compounds in the sample are separated based on differences in their solubility, size, polarity, and other chemical properties, and they are detected as they elute from the column. Detection is often achieved using UV-Vis spectrophotometry, fluorescence, or

mass spectrometry, depending on the nature of the compounds and the sensitivity required for the analysis. One of the primary advantages of HPLC in phytochemical analysis is its ability to separate complex mixtures of compounds, even when they are present in low concentrations. This is particularly useful when analyzing plant extracts that contain a wide range of phytochemicals, including alkaloids, flavonoids, terpenoids, phenolic compounds, and glycosides. HPLC is also highly reproducible, making it an ideal method for quality control and standardization of plant-based products. Furthermore, the method allows for both qualitative and quantitative analysis, meaning that it can be used not only to identify the compounds present in a sample but also to determine their concentrations. HPLC is also well-suited for the analysis of compounds that are sensitive to heat or degradation, which would be problematic in other chromatographic methods such as gas chromatography. The ability to separate non-volatile and thermally labile compounds makes HPLC a preferred technique for analyzing a wide variety of phytochemicals, particularly those found in medicinal plants. However, one of the limitations of HPLC is the relatively high cost of the equipment and the need for specialized training to operate the system. Additionally, while HPLC offers high resolution and sensitivity, it may require significant time and effort to optimize the method for each individual phytochemical, as different compounds often require different mobile phase compositions and flow rates for optimal separation.

Gas chromatography (GC) is another powerful chromatographic technique commonly used in the analysis of volatile and semi-volatile phytochemicals, such as essential oils, terpenoids, and alkaloids. GC separates compounds based on their volatility and interaction with a stationary phase, typically a capillary column coated with a film of liquid or solid material. The sample is vaporized and injected into the chromatograph, where it is carried through the column by an inert carrier gas, such as helium or nitrogen. As the sample moves through the column, the individual components are separated based on their volatility and affinity for the stationary phase. As with HPLC, detection of the separated compounds is often achieved using a variety of detectors, including flame ionization detectors (FID) or mass spectrometers (MS), which provide highly sensitive and selective detection of compounds. One of the key advantages of GC in phytochemical analysis is its high efficiency and resolution, allowing for the rapid separation of volatile compounds, even those present in trace amounts. GC is particularly effective for analyzing essential oils and other highly volatile substances, as well as for identifying terpenoids and other compounds with low molecular weights. The technique is widely used in the fragrance, flavor, and cosmetic industries, where essential oils and other volatile plant compounds are frequently analyzed. GC is also relatively fast, with some analyses

being completed in just a few minutes, making it suitable for high-throughput screening of plant samples. However, GC is limited to the analysis of compounds that can be vaporized without decomposition, which excludes many non-volatile phytochemicals, such as large molecules like glycosides, proteins, and certain alkaloids. Additionally, while GC offers excellent resolution for volatile compounds, it does not provide the same level of sensitivity or resolution for non-volatile compounds as HPLC. Sample preparation for GC can also be more complex, as it often requires derivatization of the sample to improve volatility or detectability. Despite these limitations, GC remains an invaluable tool for the analysis of volatile phytochemicals, particularly in the study of essential oils and other plant-based fragrances.

Thin-layer chromatography (TLC) is a simpler, more cost-effective chromatographic technique that is widely used for the preliminary analysis of phytochemicals. TLC is based on the separation of compounds on a flat surface, typically a glass or plastic plate coated with a thin layer of adsorbent material, such as silica gel or alumina. The sample is applied as a small spot on the plate, and the plate is then placed in a developing chamber with a solvent or solvent mixture as the mobile phase. The solvent moves up the plate by capillary action, and the individual compounds in the sample are separated based on their differential migration rates, which depend on their interactions with the stationary phase and the solvent. TLC is often used as a screening method to quickly assess the composition of a plant extract or to confirm the presence of specific phytochemicals. The technique is relatively simple to perform, requiring minimal equipment and preparation, and it can be completed in a short amount of time. In many cases, TLC can be used to identify individual phytochemicals by comparing the migration of spots to known standards or by using detection methods such as UV light or chemical reagents that produce color changes in the presence of specific compounds. TLC is particularly useful for qualitative analysis and is commonly employed in the pharmaceutical, food, and herbal medicine industries to confirm the presence of key phytochemicals in raw materials and finished products. Despite its advantages, TLC has several limitations compared to HPLC and GC. The resolution of TLC is lower, meaning that it may not be as effective for separating complex mixtures of compounds, particularly those that are present in trace amounts. Additionally, TLC is less quantitative than HPLC or GC, and it is more challenging to achieve reproducible results without careful optimization of the experimental conditions. Furthermore, TLC is limited by the availability of detection methods, as it often requires additional steps, such as spraying with reagents or visualization under UV light, to identify compounds. Nonetheless, TLC remains an important tool in the preliminary analysis of phytochemicals and is often used as a complementary technique alongside more advanced methods such as HPLC

and GC. While HPLC, GC, and TLC are the most commonly used chromatographic techniques for phytochemical analysis, other specialized methods, such as supercritical fluid chromatography (SFC) and high-performance thin-layer chromatography (HPTLC), are also employed in certain applications. Supercritical fluid chromatography, for example, uses supercritical carbon dioxide as a mobile phase, offering advantages such as faster analysis times, lower solvent usage, and the ability to analyze non-volatile compounds. High-performance thin-layer chromatography (HPTLC) improves the resolution and sensitivity of traditional TLC by using high-pressure pumps to apply the sample to the plate and more refined development techniques, making it more suitable for quantitative analysis. In conclusion, chromatographic techniques such as HPLC, GC, and TLC are essential tools in the analysis of phytochemicals, providing researchers with the ability to separate, identify, and quantify the complex mixtures of compounds found in plants. HPLC is a highly versatile and powerful method that is suitable for analyzing a wide range of non-volatile and thermally labile compounds, while GC excels in the analysis of volatile substances like essential oils and terpenoids. TLC, though less sophisticated, remains a valuable tool for preliminary screening and qualitative analysis due to its simplicity and low cost. Each of these chromatographic methods has its own strengths and limitations, and the choice of technique depends on the specific nature of the phytochemicals being studied and the goals of the analysis. As phytochemical research continues to evolve, advances in chromatography and related techniques will further enhance our understanding of the complex world of plant-derived compounds and their applications in health, industry, and agriculture.

Spectroscopic Techniques for Phytochemical Analysis: Explanation of spectroscopic methods, including NMR, IR, and MS.

Spectroscopic techniques are indispensable tools in the analysis of phytochemicals, providing detailed information about the chemical structure, functional groups, molecular composition, and interaction of compounds found in plant materials. These techniques are widely utilized in the identification, quantification, and structural elucidation of bioactive compounds, which is essential for understanding their biological properties, potential therapeutic applications, and roles in the plant's metabolism. Among the various spectroscopic methods, Nuclear Magnetic Resonance (NMR) spectroscopy, Infrared (IR) spectroscopy, and Mass Spectrometry (MS) are some of the most commonly used techniques in phytochemical analysis. Each of these techniques offers unique insights into the molecular characteristics of phytochemicals and, when used together, they provide a comprehensive approach to studying plant-derived compounds. Despite their distinct principles and capabilities, these methods are often

complementary, allowing researchers to gain a more complete understanding of complex plant matrices and their constituent compounds. Nuclear Magnetic Resonance (NMR) spectroscopy is one of the most powerful and informative techniques for the structural elucidation of phytochemicals. NMR spectroscopy works on the principle of nuclear spins and their interaction with an applied magnetic field. Certain atomic nuclei, such as hydrogen (^1H) and carbon (^{13}C), possess a magnetic moment that can be aligned with an external magnetic field. When subjected to a radiofrequency pulse, these nuclei absorb energy and transition between different energy states, producing signals that can be detected and analyzed. In phytochemical analysis, the most commonly used types of NMR are proton (^1H) NMR and carbon-13 (^{13}C) NMR, although two-dimensional (2D) and three-dimensional (3D) NMR techniques, such as COSY (Correlation Spectroscopy), HSQC (Heteronuclear Single Quantum Coherence), and HMBC (Heteronuclear Multiple Bond Correlation), are also employed to provide further structural detail. The ^1H NMR spectrum provides information about the hydrogen atoms in a molecule and their chemical environment. By analyzing the chemical shifts, coupling constants, and integration of the peaks, researchers can determine the number and type of protons present, as well as their spatial relationships. This information is crucial for identifying functional groups, such as alcohols, phenols, alkyl groups, and aromatic rings, which are common in phytochemicals. In addition to providing detailed information about the hydrogen atoms in a compound, ^1H NMR can also offer insight into the compound's overall molecular structure, allowing the determination of its stereochemistry and conformation. Similarly, ^{13}C NMR spectroscopy provides valuable information about the carbon backbone of a molecule, including the types of carbon atoms present (e.g., quaternary, tertiary, secondary, or primary carbons) and their respective chemical environments. Carbon atoms attached to electronegative elements like oxygen or nitrogen, or part of unsaturated systems such as double bonds or aromatic rings, will resonate at different frequencies, allowing researchers to distinguish between different carbon environments. This can be extremely helpful in determining the overall molecular structure and confirming the presence of specific functional groups or structural motifs. When analyzing complex plant extracts, NMR spectroscopy can be particularly useful because it provides high-resolution, non-destructive analysis and requires only small amounts of sample material. Furthermore, NMR can be applied to both volatile and non-volatile compounds, making it suitable for a wide variety of phytochemical investigations. However, NMR has certain limitations. It generally requires more sample material than other techniques, and due to the complexity of plant extracts, the spectra can be challenging to interpret, especially for mixtures containing a large number of compounds. Moreover, NMR is

not as sensitive as some other spectroscopic techniques, which can make it less suitable for detecting compounds present in trace amounts. Infrared (IR) spectroscopy is another widely used spectroscopic technique that is particularly valuable for identifying functional groups within a compound. The fundamental principle of IR spectroscopy is based on the absorption of infrared radiation by a molecule, which leads to vibrational transitions within the bonds of the molecule. Different bonds absorb infrared radiation at characteristic frequencies depending on the mass and type of atoms involved, as well as the strength and nature of the bond. As a result, the IR spectrum provides a unique fingerprint for functional groups such as hydroxyl groups (-OH), carbonyl groups (C=O), amines (-NH_2), and aromatic rings, which are commonly found in phytochemicals. The IR spectrum is typically divided into two regions: the functional group region ($4000\text{--}1300\text{ cm}^{-1}$) and the fingerprint region ($1300\text{--}400\text{ cm}^{-1}$). The functional group region contains peaks that correspond to the stretching vibrations of key functional groups, while the fingerprint region contains more complex absorptions related to bending vibrations and other structural features unique to the compound. The analysis of the IR spectrum can therefore provide critical information about the presence of specific functional groups and offer insights into the molecular structure of phytochemicals. One of the main advantages of IR spectroscopy is its ability to analyze compounds with minimal sample preparation and the speed at which results can be obtained. IR spectroscopy is also non-destructive, allowing for the analysis of valuable or limited sample material. It is often used in combination with other spectroscopic methods like NMR and MS to confirm structural details. However, IR spectroscopy has its limitations. It does not provide information about the overall molecular structure of a compound or the exact arrangement of atoms within the molecule. Additionally, because many phytochemicals share similar functional groups, distinguishing between structurally similar compounds based solely on their IR spectra can be challenging. Despite these challenges, IR spectroscopy remains an essential tool for quickly identifying functional groups and verifying the presence of key structural features in phytochemical analysis. Mass Spectrometry (MS) is another powerful and highly sensitive technique that is extensively used in the identification and structural characterization of phytochemicals. Unlike NMR and IR spectroscopy, which provide information about the molecular structure through the analysis of molecular vibrations and nuclear spins, MS relies on the measurement of the mass-to-charge ratio (m/z) of ions produced by a sample. In a typical MS experiment, the sample is ionized (often using techniques such as electron ionization or electrospray ionization), and the resulting ions are separated based on their mass-to-charge ratio in a mass analyzer. The separated ions are then detected and recorded, generating a mass spectrum that provides

information about the molecular weight and fragmentation pattern of the sample. MS is highly sensitive and capable of detecting compounds at low concentrations, making it ideal for the analysis of trace compounds in complex plant matrices. The mass spectrum generated from MS analysis provides crucial information about the molecular weight of a compound, which can be used to identify its molecular formula. The fragmentation pattern in the spectrum offers insights into the structure of the compound, as different bonds break in characteristic ways during ionization. By analyzing the mass spectrum and comparing it to known spectra in databases, researchers can often identify the compound or its fragments and make inferences about its structure. One of the significant advantages of MS is its ability to provide both qualitative and quantitative data. Coupled with chromatographic techniques like HPLC or GC, MS can be used to identify and quantify phytochemicals in complex plant extracts. For example, GC-MS is a powerful technique for analyzing volatile compounds like essential oils, while LC-MS (liquid chromatography-mass spectrometry) is widely used for the analysis of non-volatile compounds. Moreover, the high sensitivity of MS makes it suitable for analyzing low-abundance compounds in plant extracts, which would be challenging to detect using NMR or IR spectroscopy. However, while MS is highly sensitive and provides detailed molecular information, it requires sophisticated instrumentation and expertise in interpreting mass spectra, especially in complex samples like plant extracts. The ionization process can sometimes lead to the loss of important structural information, particularly for larger, more complex molecules, and the fragmentation patterns may be difficult to interpret. Furthermore, because MS identifies compounds based on their mass-to-charge ratios, the technique may not always provide definitive information about the exact structure of the compound without complementary data from other spectroscopic methods. In conclusion, spectroscopic techniques such as NMR, IR, and MS are fundamental in the analysis of phytochemicals, providing essential insights into the molecular structure, functional groups, and overall composition of plant-derived compounds. NMR spectroscopy is particularly powerful for detailed structural elucidation and is invaluable for identifying complex molecules in plant extracts. IR spectroscopy offers quick and reliable information about functional groups and is useful for confirming the presence of specific structural features. MS, with its high sensitivity and ability to identify compounds at low concentrations, is essential for both qualitative and quantitative analysis, particularly when coupled with chromatography. Together, these techniques form a comprehensive toolkit for the study of phytochemicals, helping to unlock the chemical diversity of plants and advance our understanding of their therapeutic, nutritional, and ecological roles.

Extraction and Isolation of Phytochemicals: Description of methods for extracting and isolating phytochemicals from herbal materials.

The extraction and isolation of phytochemicals from herbal materials are fundamental processes in the field of phytochemistry and natural product research. These methods are essential for obtaining plant-based compounds that have potential therapeutic properties, as well as for identifying new bioactive substances that can be used in pharmaceuticals, nutraceuticals, and cosmetics. Plants are rich sources of a diverse array of secondary metabolites, such as alkaloids, flavonoids, terpenoids, phenolic acids, glycosides, and essential oils. These compounds often have potent biological activities, making them the focus of intense scientific interest. The methods used for the extraction and isolation of phytochemicals are varied, each with its own advantages, limitations, and suitability for different types of compounds. They typically involve the use of solvents to selectively extract phytochemicals from plant tissues, followed by techniques to purify and isolate individual compounds. The process of extraction begins with the selection and preparation of plant material. The choice of plant part (e.g., leaves, roots, bark, seeds, flowers, or stems) largely depends on the type of phytochemicals being targeted, as different plant parts often contain different concentrations of bioactive compounds. For example, essential oils are typically extracted from the flowers, leaves, or seeds of plants, while alkaloids may be more concentrated in the roots or stems. Once the plant material is selected, it is generally dried to remove moisture, as this helps to prevent the degradation of phytochemicals and ensures more efficient extraction. Drying also makes the plant material easier to handle and grind into a fine powder, which increases the surface area available for solvent extraction. The extraction process itself involves using a solvent to dissolve the desired phytochemicals from the plant material. The choice of solvent is crucial, as it determines which types of compounds are extracted. Solvents can be classified as polar or non-polar, and the solvent used is selected based on the polarity of the target phytochemicals. Polar solvents, such as water, methanol, ethanol, and acetone, are often used to extract water-soluble compounds like flavonoids, glycosides, and alkaloids. Non-polar solvents, such as hexane, chloroform, or ethyl acetate, are better suited for extracting non-polar compounds like essential oils, lipids, and terpenoids. The polarity of the solvent is important because phytochemicals with similar polarity to the solvent are more likely to be dissolved and extracted. There are several common methods of extraction, each suited to different types of phytochemicals and plant materials. One of the simplest and most widely used methods is maceration, where the plant material is soaked in a solvent at room temperature for a period of time, often several hours or overnight. During this time, the solvent dissolves the phytochemicals, and the mixture is periodically agitated to

enhance extraction. After the extraction period, the solvent is separated from the plant material by filtration or decantation. Maceration is a relatively straightforward and low-cost method, but it is often time-consuming and may not be as efficient as other methods for extracting certain compounds. A more efficient and faster method of extraction is Soxhlet extraction, which involves the continuous extraction of phytochemicals using a solvent. In this method, a solvent is heated in a flask and vaporized. The vapor travels through a condenser, where it is cooled and condensed back into liquid form. The condensed liquid is then cycled through the plant material in a thimble, where it dissolves the phytochemicals. After passing through the plant material, the solvent is collected in the flask, heated again, and the cycle repeats. Soxhlet extraction allows for the continuous extraction of phytochemicals, which increases the efficiency of the process. It is especially effective for extracting lipophilic compounds like essential oils and fatty acids, although it can also be used for other types of compounds. Ultrasonic-assisted extraction is another method that uses high-frequency sound waves to facilitate the extraction of phytochemicals from plant material. In this technique, plant material is immersed in a solvent, and ultrasonic waves are applied to the mixture. The high-frequency sound waves create microscopic bubbles in the solvent, and when these bubbles collapse, they generate intense localized heat and pressure. This phenomenon, known as cavitation, helps to break down the plant cell walls, allowing the solvent to penetrate more easily and extract the phytochemicals. Ultrasonic-assisted extraction is relatively fast, efficient, and uses lower temperatures than traditional methods like Soxhlet extraction, making it particularly suitable for heat-sensitive compounds. Another advanced method is supercritical fluid extraction (SFE), which uses a supercritical fluid, typically carbon dioxide (CO₂), as the solvent. A supercritical fluid is a substance that is held at a temperature and pressure above its critical point, where it exhibits properties of both liquids and gases. Supercritical CO₂ is particularly useful for extracting non-polar compounds, such as essential oils and terpenes, as it can selectively dissolve these compounds while leaving behind polar substances. The advantage of SFE is that it is highly efficient, uses no toxic solvents, and operates at relatively low temperatures, which is beneficial for preserving the bioactivity of heat-sensitive compounds. However, the equipment required for supercritical fluid extraction can be expensive, which limits its widespread use to specialized laboratories. Once the phytochemicals have been extracted, the next step is often to isolate individual compounds for further analysis or use. Isolation involves separating specific phytochemicals from the complex mixture obtained through extraction. This step is crucial for identifying and studying the properties of individual compounds, especially when working with mixtures of bioactive substances that may

have synergistic or antagonistic effects. Several techniques are employed for the isolation of phytochemicals, including chromatography, crystallization, and liquid-liquid extraction. Chromatography is one of the most common and effective methods for isolating phytochemicals. Chromatographic techniques, such as column chromatography, thin-layer chromatography (TLC), and high-performance liquid chromatography (HPLC), rely on the differential movement of compounds in a mixture based on their interaction with a stationary phase and a mobile phase. In column chromatography, a mixture is passed through a column filled with a stationary phase (often silica gel or alumina), and the different components of the mixture are separated as they move through the column at different rates. The solvent (mobile phase) can be adjusted to improve the separation of compounds. Once separated, the individual compounds can be collected and further purified. Thin-layer chromatography (TLC) is a simpler and less expensive technique that is commonly used for monitoring the progress of extraction or separation. In TLC, a small amount of the extract is spotted onto a thin layer of stationary phase material (such as silica gel) on a plate. The plate is then placed in a solvent, which moves up the plate by capillary action. The compounds in the extract separate based on their interaction with the stationary phase and the solvent, and can be visualized under UV light or by applying chemical reagents. TLC is particularly useful for the rapid screening of phytochemicals but does not offer the high resolution and capacity for isolation that column chromatography or HPLC can provide. High-performance liquid chromatography (HPLC) is a powerful and highly efficient technique for isolating individual phytochemicals from complex mixtures. HPLC separates compounds based on their affinity for the stationary phase and their solubility in the mobile phase. The compounds in the extract are passed through a column packed with a stationary phase, and the solvent is pumped through the column at high pressure. The compounds are separated as they interact differently with the stationary phase and elute at different times. HPLC offers high resolution and is capable of isolating very pure compounds, which makes it ideal for pharmaceutical applications where purity is essential. Crystallization is another method used for the isolation of pure compounds. This technique takes advantage of the fact that many phytochemicals can form crystals when dissolved in a solvent and then allowed to slowly evaporate. The compound crystallizes as the solvent evaporates, and the crystals can be collected and further purified. While crystallization is not as commonly used as chromatography for the isolation of phytochemicals, it is particularly effective for compounds that form large, pure crystals, such as alkaloids or flavonoids. Liquid-liquid extraction is also frequently used for isolating phytochemicals, particularly when dealing with mixtures of compounds that differ in polarity. In this method, the extract is partitioned between two

immiscible solvents, such as water and an organic solvent (e.g., hexane, chloroform, or ethyl acetate). The phytochemicals in the extract partition between the two solvents based on their polarity, allowing for the separation of polar and non-polar compounds. Liquid-liquid extraction is often used as a preliminary step before further purification by chromatography. In conclusion, the extraction and isolation of phytochemicals from herbal materials are critical steps in the discovery and development of plant-based compounds with potential therapeutic or commercial value. The choice of extraction method depends on the type of compound being targeted, the characteristics of the plant material, and the scale of the extraction. Techniques such as maceration, Soxhlet extraction, ultrasonic-assisted extraction, and supercritical fluid extraction offer various advantages in terms of efficiency, selectivity, and environmental sustainability. After extraction, isolation techniques like chromatography, crystallization, and liquid-liquid extraction play key roles in purifying individual phytochemicals for further study. Together, these methods provide researchers with the tools needed to explore the vast chemical diversity of plants and unlock their potential for various applications.

Quantification and Identification of Phytochemicals: Discussion of techniques for quantifying and identifying phytochemicals using chromatographic and spectroscopic methods.

The quantification and identification of phytochemicals are fundamental components of phytochemical analysis, playing a vital role in the discovery and development of bioactive compounds derived from plants. These processes allow researchers to determine the presence, concentration, and chemical structure of various phytochemicals, which are often explored for their medicinal, nutritional, and industrial value. The accurate identification and quantification of phytochemicals can aid in determining their therapeutic potential, ensure the quality of herbal products, and assist in the standardization of plant-based drugs and supplements. Various techniques, especially chromatographic and spectroscopic methods, have been developed to facilitate the identification and quantification of phytochemicals. These techniques are frequently used in combination to provide complementary information and ensure the robustness of analytical results. Chromatographic techniques, such as high-performance liquid chromatography (HPLC), gas chromatography (GC), and thin-layer chromatography (TLC), are widely used for the separation, quantification, and identification of phytochemicals. These methods leverage the differential partitioning of compounds between a stationary phase and a mobile phase to separate individual components from a complex mixture. Each chromatographic technique has its own set of applications, advantages, and limitations, and the choice of technique is often determined by the physicochemical properties of the

phytochemicals being analyzed, such as volatility, polarity, and molecular weight. High-performance liquid chromatography (HPLC) is one of the most powerful and widely used techniques for the analysis of phytochemicals. HPLC is particularly well-suited for the analysis of non-volatile, thermally labile, and polar compounds, such as alkaloids, flavonoids, phenolic acids, and glycosides, which are commonly found in plant materials. In HPLC, a sample is injected into a column that is packed with a stationary phase, typically silica gel or other materials with specific surface properties. A solvent, or mobile phase, is pumped through the column at high pressure, causing the different components in the sample to separate as they interact with the stationary phase to different extents. The separated components are then detected, usually by UV-Vis absorbance, fluorescence, or refractive index detectors. The quantification of phytochemicals using HPLC is typically achieved by comparing the peak area or peak height of the compound of interest to a calibration curve generated from known standards. The sensitivity and specificity of HPLC allow for the accurate quantification of phytochemicals in plant extracts and herbal formulations. Moreover, when combined with mass spectrometry (MS), HPLC-MS provides enhanced sensitivity and the ability to confirm the molecular structure of the separated compounds. This combination is highly effective for identifying unknown compounds and quantifying them with high accuracy. HPLC can also be coupled with diode-array detectors (DAD) for additional spectral information, which helps confirm the identity of compounds based on their unique absorbance spectra. Gas chromatography (GC) is another powerful chromatographic technique used for the identification and quantification of volatile compounds, such as essential oils, terpenes, and other volatile phytochemicals. GC relies on the differential partitioning of compounds between a stationary phase, typically a column coated with a liquid or solid adsorbent, and a mobile phase, usually an inert gas like helium or nitrogen. The sample is vaporized and injected into the column, where compounds separate based on their boiling points, vapor pressures, and interactions with the stationary phase. As the separated compounds elute from the column, they are detected by detectors such as flame ionization detectors (FID) or mass spectrometers (GC-MS), which measure the quantity and provide structural information. GC is particularly suitable for the analysis of volatile and thermally stable compounds, and it offers high resolution and sensitivity, making it ideal for identifying and quantifying trace amounts of volatile phytochemicals in plant extracts. GC-MS is a powerful tool for both qualitative and quantitative analysis, as it can provide structural information about the compounds through mass spectrometry while quantifying their concentration based on peak area or peak height in the chromatogram. One of the advantages of GC is its ability to provide rapid and accurate analysis,

especially for essential oils and other volatile natural products, but its application is limited to compounds that can be vaporized without decomposition, making it less suitable for non-volatile or thermally unstable compounds. Thin-layer chromatography (TLC) is a simpler and more cost-effective chromatographic technique that is often used for the preliminary identification and semi-quantification of phytochemicals. In TLC, a sample is applied to a thin layer of stationary phase material, usually silica gel or alumina, on a flat plate. The plate is then immersed in a solvent or solvent mixture, which moves up the plate by capillary action, carrying the sample along with it. The components of the sample separate as they move at different rates, depending on their affinity for the stationary phase and the solvent. After the separation, the components are visualized under UV light or by using chemical reagents to stain the compounds. While TLC is not as precise or sensitive as HPLC or GC, it remains a useful tool for screening plant extracts and monitoring the progress of extractions or separations. For quantification, TLC can be coupled with densitometry, where the intensity of the spots is measured using a scanner, and the intensity is correlated with the amount of phytochemical present. However, TLC is generally used for qualitative analysis, as the resolution is lower compared to HPLC and GC, and it may not provide the high sensitivity needed for quantification in complex mixtures. In addition to chromatographic methods, spectroscopic techniques are essential for the identification and quantification of phytochemicals. These methods rely on the interaction of molecules with various forms of electromagnetic radiation to provide information about their chemical structure, functional groups, and concentration. The most commonly used spectroscopic techniques for phytochemical analysis include nuclear magnetic resonance (NMR) spectroscopy, infrared (IR) spectroscopy, ultraviolet-visible (UV-Vis) spectroscopy, and mass spectrometry (MS). Nuclear magnetic resonance (NMR) spectroscopy is one of the most powerful tools for the identification and structural elucidation of phytochemicals. NMR spectroscopy provides detailed information about the atomic environment of hydrogen (^1H) and carbon (^{13}C) nuclei within a molecule. In the case of phytochemicals, NMR can provide insights into the molecular structure, including the arrangement of atoms, functional groups, and stereochemistry. Proton (^1H) NMR and carbon-13 (^{13}C) NMR are particularly useful for identifying complex compounds in plant extracts. One of the major advantages of NMR is its ability to identify compounds in mixtures without the need for prior separation, making it a non-destructive and informative technique for phytochemical identification. Quantification using NMR involves measuring the integration of the peaks in the spectrum, which is proportional to the number of protons or carbons in the compound. By comparing the peak areas to a known standard or a reference compound, the

concentration of phytochemicals can be determined with high accuracy. NMR is especially useful for quantifying compounds that are present in high concentrations, but it may not be as sensitive for detecting trace compounds, making it more suitable for qualitative analysis and the identification of complex mixtures. Infrared (IR) spectroscopy is another widely used spectroscopic technique for identifying functional groups and providing structural information about phytochemicals. IR spectroscopy measures the absorption of infrared radiation by the sample, causing molecular vibrations in chemical bonds. Different functional groups absorb at characteristic frequencies in the IR spectrum, making it possible to identify the presence of specific groups, such as hydroxyl ($-OH$), carbonyl ($C=O$), and amino ($-NH_2$) groups, which are common in phytochemicals. IR spectroscopy is particularly useful for confirming the presence of specific functional groups in compounds and providing information about their molecular structure. While IR spectroscopy is not typically used for quantification in the same way as NMR or chromatographic methods, it can still provide semi-quantitative data when used in conjunction with calibration curves. The intensity of the absorbance at specific wavelengths is proportional to the concentration of the compound, making IR a useful tool for monitoring changes in the concentration of phytochemicals during extraction or formulation. Ultraviolet-visible (UV-Vis) spectroscopy is another commonly used method for the identification and quantification of phytochemicals, especially those containing conjugated double bonds, such as flavonoids, phenolic acids, and alkaloids. UV-Vis spectroscopy measures the absorption of ultraviolet or visible light by the sample, and the resulting spectrum provides information about the electronic transitions in the molecule. The absorption maxima in the UV-Vis spectrum are characteristic of the functional groups and conjugated systems present in the compound, making it useful for the identification of certain classes of phytochemicals. Quantification using UV-Vis spectroscopy is based on Beer-Lambert's law, which states that the absorbance of light is directly proportional to the concentration of the absorbing species. By measuring the absorbance at specific wavelengths and comparing it to a calibration curve, the concentration of phytochemicals can be determined. UV-Vis spectroscopy is often used in routine analyses because it is fast, non-destructive, and relatively easy to perform, making it suitable for the quantification of common phytochemicals like flavonoids and phenolic compounds. Mass spectrometry (MS), particularly when coupled with chromatographic techniques like HPLC or GC, is invaluable for both the identification and quantification of phytochemicals. MS measures the mass-to-charge ratio of ions produced by the sample and can provide detailed information about the molecular weight, molecular formula, and fragmentation pattern of the compound. MS is highly sensitive, capable of detecting compounds at low concentrations, and can be used

to identify unknown compounds in complex mixtures. When coupled with chromatographic techniques, MS allows for precise identification and quantification of phytochemicals, providing complementary information about their molecular structure. In conclusion, the identification and quantification of phytochemicals are crucial for understanding the chemical composition and biological activity of plant-based compounds. Chromatographic methods, such as HPLC, GC, and TLC, provide effective separation and quantification of phytochemicals, with HPLC being the most commonly used technique for non-volatile and polar compounds. Spectroscopic methods, such as NMR, IR, UV-Vis, and MS, provide complementary information about the structure and concentration of phytochemicals, with each technique offering unique advantages. By combining these methods, researchers can obtain accurate and detailed information about the chemical properties of phytochemicals, facilitating their identification, quantification, and potential applications in various industries.

Quality Control of Herbal Medicines: Overview of quality control measures for herbal medicines, including authentication, purity, and potency assessment.

The quality control of herbal medicines is a critical aspect of their development, manufacturing, and clinical application. Herbal medicines have been used for centuries across cultures for their therapeutic benefits, and their increasing popularity in modern times, particularly in the form of dietary supplements, presents significant challenges in ensuring their safety, efficacy, and consistency. Unlike synthetic pharmaceuticals, herbal medicines are derived from natural sources, primarily plants, which are complex and contain a variety of bioactive compounds. Consequently, ensuring the quality of herbal medicines requires a multi-faceted approach, involving a series of measures to authenticate the raw material, assess purity, and evaluate potency. The goal of quality control in herbal medicines is to ensure that the final product is safe for consumers, contains the intended active ingredients at the correct concentrations, and is free from contaminants that could pose a risk to health. One of the first and most essential steps in quality control is the authentication of the plant material used to produce the herbal medicine. Plant material is often harvested from wild or cultivated sources and can undergo variations in composition due to differences in environmental factors, such as soil type, climate, and cultivation practices. For herbal medicines to be effective, it is crucial that the correct plant species is used, and that it is properly identified to avoid the potential use of adulterated or substituted plant materials. Authenticating plant material typically involves morphological, microscopic, and organoleptic (sensory) examination. Morphological analysis includes identifying key features such as leaf shape, flower structure, stem, and root characteristics. However, morphological identification alone can sometimes be insufficient, especially when

dealing with species that look similar or exhibit considerable variation within species. To further confirm the authenticity of the plant, microscopic examination is often conducted, particularly of the plant's cellular structure. Microscopic analysis allows the identification of specific anatomical features of the plant, such as trichomes (hair-like structures), vascular bundles, and other tissues that are characteristic of a particular plant species. Moreover, modern molecular techniques such as DNA barcoding and polymerase chain reaction (PCR) are increasingly being used to authenticate plant materials. DNA barcoding relies on the analysis of specific gene regions that are unique to particular species, providing a highly accurate method for species identification. This technique is particularly useful when plant material is fragmented or when there is a need to distinguish between closely related species that may have similar morphological characteristics. Once the plant material has been authenticated, ensuring the purity of the herbal medicine becomes a key aspect of quality control. Purity assessment refers to the evaluation of the raw material or final product to confirm that it is free from contaminants, adulterants, or other foreign substances. Contaminants can include harmful substances, such as heavy metals, pesticides, solvents, and microbiological agents, while adulterants may be intentional additions, such as other plants or synthetic substances, which may compromise the product's safety and efficacy. The assessment of purity often involves the use of analytical techniques such as high-performance liquid chromatography (HPLC), gas chromatography (GC), and mass spectrometry (MS). These techniques are capable of detecting even trace amounts of contaminants or adulterants in herbal medicines. For example, HPLC can be used to quantify the specific bioactive compounds in the herbal product, while MS can identify the molecular structure of any unknown or unexpected compounds present, which could indicate adulteration. Another critical aspect of purity testing is the assessment of microbial contamination. Herbal medicines can be prone to contamination by bacteria, fungi, and other microorganisms during harvesting, processing, or storage. Microbial contamination not only poses a risk to human health but can also affect the stability and potency of the herbal product. Therefore, microbiological testing is essential, and standard methods, such as total aerobic microbial count, yeast and mold count, and testing for specific pathogens like *Escherichia coli* or *Salmonella*, are employed to ensure the product is free from harmful microorganisms. In addition, herbal products should be assessed for the presence of mycotoxins, toxic secondary metabolites produced by molds, which could pose a significant health risk. In parallel to ensuring the purity of the herbal medicine, the potency of the final product must be assessed. Potency refers to the strength or concentration of the active ingredients in the herbal product and is directly related to the therapeutic efficacy of the medicine. The potency of herbal

medicines can be highly variable, influenced by factors such as the plant's genetic background, cultivation conditions, harvest time, and post-harvest processing. As such, consistent potency is a fundamental requirement for the reliable clinical application of herbal medicines. To assess potency, it is necessary to quantify the active constituents in the herbal preparation. Various methods are employed for the quantification of active compounds, including spectroscopic techniques, such as ultraviolet-visible (UV-Vis) spectroscopy, nuclear magnetic resonance (NMR) spectroscopy, and HPLC. UV-Vis spectroscopy, for example, can be used to determine the concentration of phenolic compounds, flavonoids, and other bioactive components by measuring their absorbance at specific wavelengths. HPLC is particularly useful for the quantification of a wide range of active ingredients in herbal medicines, such as alkaloids, terpenes, and glycosides, providing a high degree of specificity and sensitivity. Another approach to potency assessment is the use of bioassays, which measure the biological activity of the herbal medicine. Bioassays are typically used when it is difficult to identify or quantify specific active compounds, as is the case with many herbal preparations that contain a complex mixture of phytochemicals. Bioassays can be *in vitro*, involving the use of cultured cells or enzymes, or *in vivo*, involving animal models. These tests evaluate the effectiveness of the herbal medicine in producing a desired biological response, such as antimicrobial, anti-inflammatory, or antioxidant activity. The results of bioassays can help determine the therapeutic potential of the herbal product and guide dosage recommendations. For instance, a herbal preparation might be evaluated for its ability to inhibit the growth of bacteria or its effect on inflammatory markers in a cellular model. Stability testing is another important component of quality control for herbal medicines, as the active compounds in these products may degrade over time due to exposure to environmental factors such as light, temperature, and humidity. Stability testing involves subjecting the herbal medicine to conditions that simulate real-world storage and usage, and then evaluating changes in its potency, purity, and overall quality over time. This type of testing is critical to ensuring that herbal medicines maintain their efficacy and safety throughout their shelf life. Stability studies often involve accelerated stability testing, where products are stored under elevated temperature and humidity conditions to speed up the degradation process and predict the product's shelf life. The consistency and reliability of herbal medicines are of paramount importance in their clinical use, and standardization plays a vital role in achieving this goal. Standardization refers to the process of ensuring that each batch of herbal medicine contains a consistent concentration of active ingredients. This is essential to ensure that the herbal product is both safe and effective. Standardization is typically achieved by quantifying the key bioactive compounds in each batch using methods such as HPLC, and

ensuring that these compounds are present at the specified levels. In many cases, the potency of the active ingredients is correlated with their therapeutic efficacy, so standardizing the concentration of these compounds helps to guarantee that the product will have a consistent clinical effect. Good Manufacturing Practices (GMP) are also critical in ensuring the quality control of herbal medicines. GMP is a set of guidelines and standards that manufacturers must adhere to during the production of herbal medicines. These guidelines ensure that herbal medicines are consistently produced and controlled according to quality standards. GMP covers various aspects of production, including raw material sourcing, manufacturing processes, quality testing, packaging, labeling, and storage. By following GMP, manufacturers can ensure that their herbal medicines are free from contaminants, properly labeled, and consistently meet the required potency levels. In recent years, regulatory bodies such as the World Health Organization (WHO), the European Medicines Agency (EMA), and the U.S. Food and Drug Administration (FDA) have increasingly focused on the need for standardized quality control measures for herbal medicines. These organizations provide guidelines on the authentication, purity, potency, and stability testing of herbal products, and many countries have developed national regulations to ensure that herbal medicines meet quality standards. As the demand for herbal products continues to grow, the implementation of rigorous quality control measures will be essential to protect public health and ensure that herbal medicines are safe, effective, and consistent. In conclusion, the quality control of herbal medicines is a complex and multi-dimensional process that encompasses authentication, purity, and potency assessment. Given the variability of plant materials and the diversity of bioactive compounds they contain, it is essential to employ a range of techniques to assess the quality of herbal products. Authentication ensures that the correct plant species is used, while purity testing confirms that the product is free from contaminants and adulterants. Potency assessment involves quantifying the active ingredients to ensure the product's therapeutic efficacy. Additionally, stability testing, standardization, and adherence to Good Manufacturing Practices are critical for maintaining the consistency and reliability of herbal medicines. With rigorous quality control measures in place, consumers can have confidence in the safety and efficacy of herbal products.

Challenges and Limitations in Phytochemical Analysis: Discussion of challenges and limitations in phytochemical analysis, including complexity of herbal matrices and lack of standards.

Phytochemical analysis is a cornerstone of modern herbal medicine research and development, playing an essential role in understanding the chemical constituents of plants that are responsible for their biological effects. The importance of phytochemical analysis lies not only

in discovering new compounds with potential therapeutic benefits but also in ensuring the quality, consistency, and safety of herbal products. However, despite the advances in analytical techniques, phytochemical analysis remains a challenging field due to several inherent complexities. Among these challenges, the complexity of herbal matrices and the lack of standardized methods and reference materials are particularly significant hurdles that can hinder accurate and reproducible analysis. These challenges not only complicate the research and development of herbal medicines but also contribute to difficulties in their regulation and quality control. One of the primary challenges in phytochemical analysis is the complexity of herbal matrices. Unlike synthetic drugs, which consist of single compounds, herbal medicines are composed of complex mixtures of numerous bioactive and inactive constituents, including alkaloids, flavonoids, terpenoids, glycosides, phenolic compounds, and essential oils. These compounds are often present in varying concentrations depending on factors such as plant species, geographic origin, cultivation practices, seasonal variations, and methods of harvesting and processing. This inherent complexity makes it difficult to isolate and analyze the specific compounds responsible for a plant's medicinal properties, as they are often accompanied by other compounds that can interfere with the analysis. Herbal matrices typically include not only the bioactive phytochemicals but also other substances such as fibers, lipids, proteins, sugars, and minerals. These matrix components can have a substantial impact on the extraction efficiency, separation, and detection of the target compounds. The presence of matrix components may also cause interferences in chromatographic and spectroscopic measurements, making the analysis more complicated and requiring additional steps in sample preparation. For example, in the extraction process, the use of solvents, temperature, and time can all affect the quantity and quality of the extract, potentially altering the profile of active compounds. Furthermore, the presence of impurities or co-extracted substances can complicate the interpretation of analytical data and lead to inaccurate results. To address this issue, researchers often employ multiple extraction methods to optimize the yield of bioactive compounds. These methods can include maceration, Soxhlet extraction, ultrasonic-assisted extraction, or supercritical fluid extraction, each with its advantages and limitations. Even with these optimized extraction techniques, there is always the risk of incomplete extraction or the loss of certain compounds, particularly those that are sensitive to heat, light, or oxygen. This complexity of herbal matrices requires a combination of sophisticated analytical techniques to accurately quantify and identify the bioactive constituents and to account for possible interferences. The presence of complex mixtures also complicates the identification of individual compounds. Herbal medicines often contain hundreds, if not thousands, of different

substances in trace amounts, making it difficult to isolate and identify specific compounds of interest. While advanced chromatographic methods, such as high-performance liquid chromatography (HPLC) and gas chromatography (GC), can effectively separate compounds based on their physical properties, the analysis of complex mixtures may still require extensive fractionation and isolation. Techniques such as mass spectrometry (MS) and nuclear magnetic resonance (NMR) spectroscopy are valuable tools for identifying individual components, but the sheer number of compounds and the potential for isomers or closely related compounds further complicates the process. Another significant challenge in phytochemical analysis is the lack of standards and reference materials. The availability of authenticated reference standards is essential for ensuring the accuracy and reliability of analytical results, particularly for the quantification of bioactive compounds. However, unlike pharmaceutical products, for which purified compounds are available as standards, herbal products often lack such well-characterized reference standards. The absence of standardized compounds can result in variations in the quality of herbal medicines and inconsistencies in the quantification of active constituents across different batches or preparations. For many herbal medicines, the active compounds are complex natural products that have not been fully isolated or characterized. In some cases, the bioactive components may be present in low concentrations or in combinations that have not been fully understood. The lack of available reference standards means that researchers often have to rely on comparative methods, such as the use of known markers or the establishment of a fingerprint profile for the plant extract. While these methods can provide useful information, they are less precise than quantifying a specific compound with a reference standard. The absence of standards also complicates the standardization of herbal medicines. Standardization refers to the process of ensuring that each batch of an herbal product contains a consistent concentration of active ingredients, and it is a crucial aspect of ensuring the quality and safety of herbal medicines. However, without validated reference standards, it is challenging to establish reliable and reproducible methods for standardizing herbal products. In many cases, herbal products are standardized based on the concentration of one or more marker compounds, but this approach can be problematic if the marker compounds do not represent the full spectrum of bioactivity in the plant or if their concentration does not correlate with the therapeutic effects of the product. Another challenge in phytochemical analysis is the difficulty in detecting low-abundance compounds that are often responsible for the therapeutic effects of herbal medicines. Some bioactive compounds, such as certain alkaloids, flavonoids, and saponins, may be present in only trace amounts in the plant material, requiring highly sensitive and selective analytical techniques to detect and quantify them accurately. Although techniques

such as HPLC, GC, and MS offer excellent sensitivity, they still may not detect compounds that are present in extremely low concentrations or that are masked by matrix effects. This issue is particularly problematic when analyzing whole plant extracts, which may contain a wide variety of interfering substances, making it difficult to detect trace levels of specific active ingredients. Moreover, the chemical diversity of phytochemicals in herbal products presents a significant challenge in developing universal analytical methods. Each plant species contains a unique profile of phytochemicals, which can vary widely even within the same species due to factors such as environmental conditions and genetic diversity. For example, the concentration of a particular compound may be higher in one plant cultivar or region than in another, complicating efforts to develop standardized methods for all herbal medicines. This diversity also means that a single analytical method may not be suitable for all plant materials, requiring the development of specific methods tailored to individual herbs or plant families. As a result, phytochemical analysis often requires a range of complementary techniques to accurately identify and quantify the diverse array of compounds present in herbal products. In addition to these technical challenges, regulatory issues also play a significant role in the limitations of phytochemical analysis. In many countries, there are insufficient regulations or guidelines for the quality control of herbal medicines. This lack of regulatory oversight means that the quality of herbal products can vary widely between manufacturers, with inconsistent levels of active ingredients, contaminants, and adulterants. Although some regulatory bodies, such as the World Health Organization (WHO) and the U.S. Food and Drug Administration (FDA), have developed guidelines for the quality control of herbal medicines, these regulations are often general and may not address all the specific challenges associated with herbal analysis. The lack of harmonized standards across different regions further complicates the global trade of herbal medicines, leading to issues with product consistency and safety. The diversity of plant species, coupled with the complexity of herbal matrices, also makes the establishment of global phytochemical databases challenging. While databases of known phytochemicals exist, they often lack comprehensive data on the chemical profiles of all plant species, especially those that are less commonly used or are only found in specific regions. The absence of these comprehensive databases limits the ability of researchers to compare the phytochemical profiles of different plant species, further complicating efforts to identify new bioactive compounds. Another limitation in phytochemical analysis is the difficulty in correlating the chemical profile of a plant with its therapeutic effects. While many bioactive compounds have been identified in plants, it is often unclear how these compounds interact synergistically or antagonistically to produce the observed therapeutic effects. Herbal medicines contain complex

mixtures of compounds, and it is often the case that the therapeutic efficacy of a product depends not only on the presence of individual compounds but also on their interactions within the matrix. This complexity complicates the establishment of clear and reliable relationships between the chemical composition of a plant and its pharmacological activity. Moreover, the bioavailability of these compounds can be influenced by factors such as metabolism and the formulation of the product, which further complicates the analysis. Finally, the variability of raw materials, particularly in the case of wild-harvested plants, poses a challenge in ensuring consistent quality in phytochemical analysis. Unlike controlled agricultural products, wild plants can exhibit considerable variability in their chemical composition, depending on factors such as climate, soil quality, and harvest time. Even with cultivation practices aimed at reducing this variability, factors such as soil composition, water availability, and weather conditions can still lead to fluctuations in the concentration of bioactive compounds. As a result, even if a particular plant is identified and standardized, the chemical profile of the plant may differ from batch to batch, making it difficult to ensure consistent potency and quality in the final product. In conclusion, phytochemical analysis, while critical to the development and quality control of herbal medicines, is fraught with challenges and limitations. The complexity of herbal matrices, the lack of standardized methods and reference materials, the difficulty of detecting low-abundance compounds, and the variability in plant composition all pose significant hurdles to accurate and reproducible analysis. These challenges underscore the need for continued research and innovation in analytical techniques and the development of standardized protocols to address the unique complexities of herbal medicine. Furthermore, greater regulatory oversight and the establishment of harmonized global standards are essential to ensure the safety, efficacy, and quality of herbal medicines in the marketplace.

Advanced Techniques in Phytochemical Analysis: Introduction to advanced techniques, such as hyphenated techniques (e.g., LC-MS) and chemometric methods.

Phytochemical analysis is a critical aspect of herbal medicine research, focusing on the identification, quantification, and understanding of the bioactive compounds present in plants. As the field of phytochemistry continues to grow, so do the methods available for studying plant-derived compounds. While traditional techniques, such as thin-layer chromatography (TLC), gas chromatography (GC), and high-performance liquid chromatography (HPLC), have been extensively used for phytochemical analysis, more advanced techniques have emerged that provide enhanced sensitivity, resolution, and specificity. These advanced methods include hyphenated techniques like liquid chromatography-mass spectrometry (LC-MS) and gas chromatography-mass spectrometry (GC-MS), as well as chemometric methods that help in

data interpretation. These modern approaches offer significant improvements over conventional methods and are indispensable tools in the field of phytochemical analysis, helping to address many of the complexities posed by herbal matrices and the identification of multiple components in plant materials. One of the most powerful and widely used advanced techniques in phytochemical analysis is the combination of chromatography and mass spectrometry, often referred to as hyphenated techniques. The hyphenation of chromatography with mass spectrometry enhances the strengths of both techniques, providing complementary advantages. Chromatography serves as a separation technique, allowing for the isolation of individual components from complex mixtures. Mass spectrometry, on the other hand, provides detailed information about the molecular mass, structure, and fragmentation patterns of the compounds, making it an invaluable tool for identification and structural elucidation. The combination of these two techniques facilitates a much more precise and comprehensive analysis of phytochemicals, particularly in complex plant extracts that contain a large number of compounds. Liquid chromatography-mass spectrometry (LC-MS) is one of the most common hyphenated techniques used in phytochemical analysis. Liquid chromatography separates compounds based on their interactions with a stationary phase, allowing for the separation of compounds according to their polarity, size, and other physicochemical properties. After separation, the compounds are introduced into the mass spectrometer, where they are ionized, and the resulting ions are detected and analyzed. The advantages of LC-MS lie in its ability to provide high resolution, sensitivity, and speed, as well as its ability to analyze a wide range of compounds, including those that are thermally labile or polar. LC-MS is particularly useful for identifying low-abundance compounds, detecting complex mixtures, and providing structural information about phytochemicals, such as molecular mass, formula, and fragmentation patterns. One of the key applications of LC-MS in phytochemical analysis is the identification of bioactive compounds in complex plant extracts. Plants often contain a mixture of hundreds of different compounds, many of which can have overlapping chromatographic features. LC-MS provides a high degree of selectivity by allowing compounds to be identified based on their mass-to-charge (m/z) ratio and retention time, making it a powerful tool for untargeted profiling of plant extracts. Moreover, the ability to perform tandem mass spectrometry (MS/MS) enables the fragmentation of ions to provide additional structural information, further improving the accuracy of compound identification.

Gas chromatography-mass spectrometry (GC-MS) is another widely used hyphenated technique in phytochemical analysis. Unlike LC-MS, which is generally used for polar and thermally labile compounds, GC-MS is primarily used for volatile compounds and those that

can be vaporized without decomposition. GC separates compounds based on their volatility and interaction with the stationary phase of the column, while the mass spectrometer provides molecular-level information. GC-MS is particularly effective in analyzing essential oils, terpenes, and fatty acids, which are often found in herbal extracts and contribute to their aroma and biological activity. The combination of GC and MS enables the detection and identification of even trace amounts of volatile compounds, making it an essential tool in the characterization of aromatic and lipophilic constituents in plants. Both LC-MS and GC-MS have significantly advanced the field of phytochemical analysis by providing highly sensitive and specific methods for compound identification, quantification, and profiling. However, these techniques alone are often not sufficient to fully capture the complexity of plant-based materials. As a result, the integration of chemometric methods with chromatographic and spectroscopic data has become increasingly important in modern phytochemical analysis. Chemometrics refers to the use of statistical and mathematical methods to analyze and interpret complex data sets, often involving large amounts of multivariate data. In the context of phytochemical analysis, chemometric techniques help to extract meaningful information from complex chromatographic, spectroscopic, or even spectrometric data, making it easier to identify patterns, relationships, and trends in the data. By employing chemometric techniques such as principal component analysis (PCA), partial least squares (PLS) regression, and cluster analysis, researchers can gain deeper insights into the chemical composition of plant extracts and their variability across different samples or batches. One of the main challenges in phytochemical analysis is the high degree of variability found in plant materials, which can be influenced by factors such as geographic origin, seasonal variations, growth conditions, and harvesting methods. Chemometric methods help to account for this variability by providing a means of grouping samples with similar chemical profiles and identifying key components responsible for differences between groups. PCA, for example, is commonly used to reduce the dimensionality of complex data sets, identifying major sources of variation and grouping similar samples based on their chemical characteristics. PLS regression is often used in quantitative analysis to correlate the chemical composition of samples with their biological activity or other properties, allowing researchers to predict the concentration of specific compounds or the overall potency of an herbal preparation. Another important chemometric method in phytochemical analysis is cluster analysis, which groups samples based on their chemical similarity. This technique is often used in combination with chromatographic and spectroscopic techniques to identify patterns in complex plant extracts and to investigate the relationships between different plant species, cultivars, or processing methods. By clustering

samples with similar chemical profiles, researchers can identify characteristic compounds or markers that are responsible for specific biological activities or pharmacological effects. The integration of chemometric methods with hyphenated techniques such as LC-MS and GC-MS enhances the ability to analyze complex data from herbal extracts. These advanced methods enable researchers to process large data sets more efficiently and accurately, identifying subtle differences in chemical profiles that might otherwise go unnoticed. For example, by combining chromatographic data with chemometric analysis, researchers can more effectively identify markers for quality control, monitor batch-to-batch consistency, and investigate potential adulteration in herbal products. Additionally, chemometric methods can be used to study the interaction between multiple compounds in plant extracts, providing insights into synergistic or antagonistic effects that might contribute to the overall biological activity of the herbal preparation. In addition to LC-MS, GC-MS, and chemometric methods, other advanced techniques such as nuclear magnetic resonance (NMR) spectroscopy, high-resolution mass spectrometry (HRMS), and Fourier-transform infrared (FTIR) spectroscopy are also being used in phytochemical analysis. NMR spectroscopy, for instance, is a non-destructive technique that provides detailed structural information about compounds, making it a valuable tool for identifying complex natural products. HRMS offers higher resolution and accuracy in the mass determination of compounds, making it particularly useful for the analysis of low-abundance phytochemicals. FTIR spectroscopy, on the other hand, provides information about functional groups and molecular vibrations, allowing for the identification of specific chemical bonds within the phytochemicals. Another recent innovation in phytochemical analysis is the use of ultra-high-performance liquid chromatography (UHPLC), which offers increased resolution and faster separation times compared to traditional HPLC. UHPLC, when coupled with MS or other detection methods, provides highly efficient analysis of complex plant extracts, allowing for faster and more detailed profiling of phytochemicals. This technique has gained popularity in the analysis of herbal medicines and dietary supplements, where high throughput and rapid analysis are often required to meet regulatory standards and consumer demands. The development of high-throughput screening methods is also an important advancement in phytochemical analysis, particularly for the discovery of new bioactive compounds. High-throughput techniques enable the screening of large numbers of plant samples for specific biological activities, such as antimicrobial, anti-inflammatory, or antioxidant effects. These methods are often combined with advanced chromatographic and spectroscopic techniques to identify and isolate the compounds responsible for these effects. The integration of high-throughput screening with LC-MS or other analytical methods allows for the rapid

identification of promising phytochemicals, accelerating the process of drug discovery and the development of new herbal medicines. In conclusion, advanced techniques in phytochemical analysis, such as hyphenated techniques (LC-MS, GC-MS), chemometric methods, and high-throughput screening, have significantly enhanced the ability to identify, quantify, and understand the complex chemical compositions of plant materials. These methods offer superior sensitivity, resolution, and specificity compared to traditional approaches, providing researchers with powerful tools to unravel the complexities of plant-based medicines. By integrating multiple advanced techniques, researchers can gain deeper insights into the chemical diversity of plant extracts, improve the accuracy and reproducibility of analyses, and address challenges such as batch-to-batch variability, adulteration, and standardization. As the field of phytochemistry continues to evolve, these advanced methods will play a crucial role in ensuring the quality, safety, and efficacy of herbal medicines, driving further innovations in natural product research and drug development.

Regulatory Requirements and Standardization: Overview of regulatory requirements and standardization efforts for phytochemical analysis and quality control of herbal medicines.

Regulatory requirements and standardization efforts are central to ensuring the safety, efficacy, and quality of herbal medicines. With the increasing global consumption of plant-based products, there has been a growing recognition of the need to establish stringent frameworks for regulating herbal medicines. These efforts are not only crucial for safeguarding public health but also for promoting the credibility of herbal products in the global marketplace. Regulatory guidelines and standards provide a foundation for quality control processes, ensuring that herbal medicines meet specific safety thresholds and deliver consistent therapeutic outcomes. However, due to the complexity of plant materials and the diversity of phytochemicals, the process of regulatory standardization presents significant challenges. These challenges stem from issues such as the natural variability of plant-based ingredients, the lack of universally accepted methods for analysis, and the difficulty in ensuring reproducibility across different batches or geographical regions. As a result, a multifaceted approach involving various national and international bodies, scientific research, and collaborative efforts between industry stakeholders is necessary for the effective regulation and standardization of herbal medicines. One of the key challenges in regulating herbal medicines is the natural variation found in plant materials. Unlike synthetic pharmaceuticals, which consist of chemically defined compounds, herbal medicines are derived from complex biological matrices containing hundreds or thousands of different compounds. These compounds can vary not only between

species but also within the same species depending on environmental factors, such as geographic origin, climate, soil composition, and cultivation practices. This inherent variability makes it difficult to establish uniform quality standards for herbal products. Even when plants are cultivated under controlled conditions, their chemical composition may fluctuate due to factors such as growth stage, harvest time, and post-harvest processing. As a result, the regulatory process for herbal medicines must account for this natural variability and adopt flexible approaches to ensure that products meet safety and quality standards despite these fluctuations. To address these challenges, regulatory authorities around the world have developed specific frameworks and guidelines aimed at promoting the quality control and standardization of herbal medicines. These regulations generally focus on several key areas: product identification, safety, efficacy, quality control, and labeling. Regulatory agencies, such as the U.S. Food and Drug Administration (FDA), the European Medicines Agency (EMA), the World Health Organization (WHO), and national drug regulatory bodies, play a pivotal role in establishing these frameworks and ensuring compliance with quality standards. In many regions, herbal medicines are considered a form of dietary supplement or complementary medicine, which means they are subject to different regulatory standards than conventional pharmaceuticals. For example, in the United States, the FDA regulates herbal products under the Dietary Supplement Health and Education Act (DSHEA) of 1994. Under DSHEA, manufacturers are responsible for ensuring that their herbal products are safe, properly labeled, and free of contaminants. However, unlike pharmaceutical drugs, herbal supplements are not subject to pre-market approval, meaning that manufacturers do not need to demonstrate the safety or efficacy of their products before they are sold on the market. This regulatory framework has led to concerns about product quality, as there is no mandatory requirement for manufacturers to provide evidence of the consistency and potency of the active ingredients in their herbal formulations. In contrast, in the European Union, herbal medicines are more strictly regulated. The European Medicines Agency (EMA) has established a more comprehensive regulatory framework for herbal medicinal products, particularly through the European Union's Traditional Herbal Medicinal Products Directive (THMPD), which came into effect in 2004. The THMPD requires that herbal medicines, when marketed as medicines, must meet specific criteria for quality, safety, and efficacy. Herbal products marketed under the THMPD must provide evidence of their therapeutic use for at least 30 years, with at least 15 years of that usage occurring within the EU. The THMPD also mandates that herbal medicines undergo quality control testing to ensure consistency and that they are manufactured in compliance with good manufacturing practices (GMP). However, the directive does not require clinical trials for

traditional herbal medicines, recognizing the importance of historical evidence and traditional knowledge in evaluating the safety and efficacy of these products. In addition to regulatory frameworks for herbal medicines, international standardization efforts have been initiated by organizations such as the World Health Organization (WHO) and the International Organization for Standardization (ISO). The WHO, in particular, has taken a leading role in promoting the standardization and quality control of herbal medicines. Since 2004, the WHO has been working to develop guidelines on the quality control, safety, and efficacy of herbal medicines, which serve as a global reference for both national regulatory bodies and industry stakeholders. The WHO's "Monographs on Selected Medicinal Plants" and "Quality Control Methods for Medicinal Plant Materials" are key resources that provide detailed information on the identification, pharmacognostic features, and standardization of herbal materials. These monographs outline the necessary tests for identifying plant materials, assessing their chemical composition, and ensuring the presence of active compounds, as well as providing specifications for acceptable limits of contaminants such as heavy metals, pesticides, and microbial pathogens. The standardization of herbal medicines requires a careful balance between tradition and modern science. Many herbal medicines have been used for centuries, and their therapeutic properties are based on historical and anecdotal evidence rather than clinical trials. The regulatory frameworks for herbal medicines, particularly in the European Union and the WHO guidelines, acknowledge the importance of traditional knowledge but emphasize the need for modern analytical methods to ensure quality control. This has led to the development of various techniques for the analysis and standardization of herbal products. High-performance liquid chromatography (HPLC), gas chromatography (GC), mass spectrometry (MS), and nuclear magnetic resonance (NMR) spectroscopy are some of the advanced analytical techniques used for the identification and quantification of bioactive compounds in herbal medicines. These methods help ensure that the active ingredients in herbal products are present in consistent concentrations, thereby improving product reliability. Quality control in the herbal medicine industry also extends beyond the analysis of individual active compounds. Comprehensive quality control measures encompass the entire production process, from raw material sourcing to the final product formulation. Good Manufacturing Practices (GMP) are a set of standards that ensure the consistent production of high-quality herbal medicines. GMP guidelines focus on aspects such as plant cultivation, harvesting, drying, extraction, and processing, as well as ensuring that manufacturing facilities meet specific hygiene, safety, and documentation requirements. In some regions, herbal products are also subject to pharmacopoeial standards, which provide detailed specifications for the purity,

potency, and identity of raw materials and finished products. In addition to analytical methods, authentication of raw materials is a critical component of standardization. The process of authentication ensures that the herbal materials used in the production of herbal medicines are of the correct species and origin. Misidentification of plant species is a common problem in the herbal industry, which can lead to adulteration or contamination. Techniques such as DNA barcoding, which involves the analysis of specific genetic markers to verify plant identity, have become increasingly popular as tools for authentication. DNA barcoding offers a reliable and precise method of confirming the species identity of plant materials, particularly for plant species with similar morphological characteristics. Standardization also addresses the issue of contaminants, which can pose significant risks to consumer health. Herbal medicines can be contaminated by pesticides, heavy metals, mycotoxins, and microorganisms, which can result from poor agricultural practices, inadequate processing, or improper storage. Regulatory agencies often set limits for these contaminants and require herbal medicines to undergo testing to ensure they are within safe thresholds. The establishment of limits for contaminants is a critical aspect of ensuring the safety of herbal products. For example, the WHO provides guidelines for acceptable limits for pesticide residues in medicinal plant materials, and many countries have their own regulatory limits for heavy metals such as lead, arsenic, and cadmium. These efforts help protect consumers from potentially harmful substances that may be present in herbal products. Despite the progress made in regulatory frameworks and standardization efforts, several challenges remain in ensuring the quality and safety of herbal medicines. One major challenge is the lack of universal standards for the analysis and regulation of herbal products. The natural variation found in plant materials means that there is no one-size-fits-all approach to the standardization of herbal medicines. Different countries and regions may have varying requirements for the quality control and testing of herbal products, creating a fragmented regulatory landscape. Additionally, the rapid growth of the herbal market, coupled with the increasing popularity of online sales, has led to concerns about the authenticity and quality of herbal products. In some cases, herbal products may be adulterated with synthetic compounds, improperly labeled, or contaminated with harmful substances. The future of regulatory requirements and standardization for herbal medicines will likely involve greater international collaboration and harmonization of standards. The establishment of internationally recognized standards for the quality control, safety, and efficacy of herbal medicines will help promote the global trade of these products while ensuring consumer protection. Furthermore, advances in analytical technologies and improved quality control measures will enable more accurate and reliable testing of herbal products, facilitating better

regulatory oversight. In conclusion, the regulatory requirements and standardization efforts for phytochemical analysis and quality control of herbal medicines are crucial for ensuring that these products are safe, effective, and consistent. While significant progress has been made in establishing frameworks for the regulation of herbal medicines, challenges remain due to the inherent complexity and variability of plant-based materials. Ongoing collaboration between national regulatory agencies, international organizations, industry stakeholders, and researchers is essential to develop and implement comprehensive guidelines that promote the global standardization and quality assurance of herbal medicines.

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INTEGRATION OF METACOGNITION IN TEACHING AND LEARNING CHEMISTRY IN SECONDARY SCHOOL

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ABSTRACT

Cognitive activity is the ability to perform brain functions such as attention, memory, language, visual-spatial perception, and executive functions. Metacognition is the ability to think, or “think about thinking”: researchers have identified metacognition as essential to science education in general and to the development of scientific literacy in particular, as it is key to developing a deep conceptual understanding of scientific ideas, scientific practice, and self-regulated learning.

This study used a quasi-experimental approach with pre- and post-testing. The target audience of the study consisted of students of grades 8 and 9 of the Lyceum "Young Talents". At Baku State University. A purposive sampling procedure was used to select the sample for the study. Two chemistry teachers were selected to assist in the experiment.

The results of the conducted content analysis showed that the students place the main emphasis on the use of cognitive strategies (repetition, help from adults, and their own independent search). Revision sessions also play an important role in the learning activities of students. At the same time, only a small number of students are familiar with planning, defining goals, setting tasks) and time strategies (schedule, breaks).

The results of this study are consistent with the literature review.

Metacognitive tactics and metacognitive questions were used in the hopes that students would become more engaged in class discussions and contribute more to the learning environment. It was hoped that one of the metacognitive techniques would also increase student engagement. No published studies have examined student engagement in class discussions.

Keywords: metacognition, teaching science, chemistry education, education strategies

Cognitive activity is the ability to perform brain functions such as attention, memory, language, visual-spatial perception, and executive functions. Metacognition is the ability to think, or “think about thinking”: researchers have identified metacognition as essential to science education in general and to the development of scientific literacy in particular, as it is key to developing a deep conceptual understanding of scientific ideas, scientific practice, and self-regulated learning [1-2]. In short, metacognition allows students to think about their thinking, reflect on, and regulate their own learning.

Bandura's social cognitive theory [3,4] included the concept of self-regulated learning (SRL), which he applied to classroom learning (Figure 1).

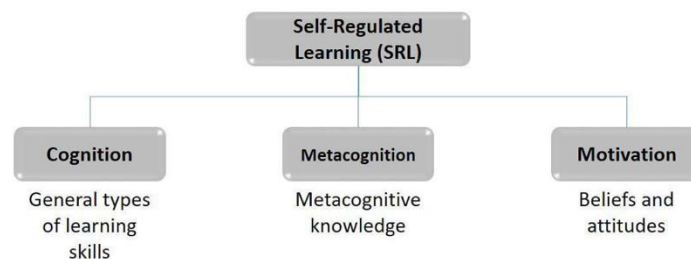


Figure 1. The relationships among the components of self-regulated learning

Metacognitive approaches are teaching methods and strategies that are purposefully aimed at developing and using students’ metacognitive abilities. These approaches are aimed at helping students understand and control their cognitive processes during the learning process. Metacognitive approaches may include teaching strategies for planning learning activities, the ability to monitor their progress and evaluate their knowledge and skills, and the ability to regulate their cognitive efforts depending on the tasks and goals set. These approaches help students become more independent, adaptive, and effective learners [5].

Learning involves self-regulatory processes such as planning, monitoring, regulating, and reflecting that help improve student learning and learning outcomes [6,7]. Consistently, self-regulated learning improves academic achievement and motivation [8-10]. Teachers can promote self-regulated learning by focusing on learning strategies or by creating learning environments that facilitate students’ organization of information and planning for learning [11,12]

Metacognitive teaching methods are teaching approaches that help learners develop and apply their metacognitive abilities. These methods include teaching learners strategies for planning, monitoring, and evaluating their own learning processes. They also help learners become aware of their strengths and weaknesses, helping them adapt and cope with different

learning tasks more effectively. Examples of metacognitive teaching methods include teaching self-testing strategies, using metacognitive questions to stimulate reflection, and modeling and practicing metacognitive strategies through collaborative learning and feedback. These methods help learners become more aware, self-regulated, and effective learners [13].

Metacognitive strategies are the ways and methods that people use to understand, control, and regulate their cognitive processes. These strategies help students effectively plan their learning activities, monitor their progress in the learning process, and evaluate their knowledge and skills. The use of metacognitive strategies allows students to adapt to different learning situations and increases their ability to self-regulate and self-monitor [14].

Theoretical framework

The difficulty of successfully teaching and applying theory in practice has a negative impact on the professional development of beginning teachers teaching subjects such as mathematics, physics, chemistry, and biology. Future teachers need to have a good understanding of teaching methods, approaches, and strategies [15].

Future general education teachers need perspectives on good teaching methods and how to apply theory in practice, in addition to clear ideas and knowledge.

The preparation of successful teachers is influenced by the pedagogical competence of future teachers. Teachers who teach chemistry often have sufficient teaching experience. A. K. Smith emphasizes the importance of subject expertise and pedagogical competence in classes where chemistry is taught, so that they can manage and organize their classes, create lesson plans, use effective teaching methods, identify students' prior knowledge, and involve students in scientific projects [16].

According to J. Santangelo [17], metacognitive teaching methods control students' cognitive behavior and systematically help to achieve cognitive goals. Students can learn more effectively and show higher results in the classroom if metacognitive approaches and metacognitive skills are included in the curriculum. Metacognitive skills help to create a favorable learning environment and stimulate thinking. Teachers tend to identify complex questions that students construct.

As a result, a learning environment is created and dialogue between learners and teachers is strengthened. Assessing metacognitive abilities, sequencing teaching and learning, and using appropriate metacognitive approaches to teaching to achieve learning goals may all be more familiar to metacognitively oriented teachers.

Despite the challenging curriculum and short time, it is still possible to teach chemistry using metacognitive teaching methods. The key to gaining deeper conceptual knowledge of scientific

concepts is metacognitive engagement, which is the main characteristic of science learning. Academic performance is enhanced by using metacognitive teaching tactics in the classroom. Metacognitive approaches and teaching methods are essential for developing students' metacognitive skills [18].

Self-regulation and effective management of the learning process are made possible by metacognitive methods. Academic achievement, improved cognition, and monitoring of cognitive processes are some of the benefits of using metacognitive teaching methods in the classroom.

Teaching processes that aim to actively control the cognitive processes involved in learning are known as metacognitive teaching techniques. They improve student performance and help students develop metacognitive skills. There are five approaches to teaching: evidence, concepts, processes, procedures, and principles [19].

By activating metacognitive processes of self-regulation, reflection, and error correction, they help learners solve problems. Through these aspects of learning, learners gain knowledge on how to use and integrate metacognition into the teaching and learning process. These educational initiatives develop specific scientific and metacognitive skills. These facts encourage research on the impact of metacognitive approaches and teaching methods. Metacognitive teaching methods have been found to improve learners' knowledge in physics. Metacognitive techniques increase the level of knowledge in chemistry subject areas.

However, metacognitive techniques have a significant impact on how well students learn chemistry. Therefore, metacognitive approaches and teaching methods can be used in chemistry lessons. Scientific knowledge and metacognitive skills are related to each other. By strengthening their metacognitive skills, beginning teachers improve their pedagogy. Similarly, G. Schraw notes that there is no single, comprehensive theoretical model of metacognition in the literature that facilitates conceptual explanation [20].

Metacognition and academic success are linked. More research is needed on the knowledge and application of metacognitive learning among future teachers. This will allow us to better understand how these future teachers understand and apply metacognitive methods in their practice, and what factors may influence the success of their use in the educational process.

Such research can shed light on possible barriers or potential ways to improve the effectiveness of metacognitive learning in the school environment. In addition, it can also help to develop recommendations for educational institutions and teacher training programs on the implementation of metacognitive teaching methods in the educational process. In addition, it is important to consider that people acquire information, learn and develop metacognitive skills

not only in formal learning situations but also in everyday life. For example, in the process of solving problems at school, interacting with the environment, making decisions in everyday situations, etc.

Academic success is closely related to metacognitive skills. To manage and regulate the learning process, it is necessary to use metacognitive abilities. The decision to achieve academic goals is made with the help of metacognitive abilities. Students who have developed metacognitive abilities are more successful in learning activities. According to R. Maor [19], metacognitive abilities lead to metacognitive awareness. Metacognitive abilities provide conscious participation, stimulate cognitive processes, provide reflective learning, increase the adequacy of thinking, support lifelong learning and equip students with deep information. Metacognitive abilities are important for self-control, which is a good indicator of academic success, motivating and setting the ability to perform, helping to solve problems, the importance of metacognitive abilities for lifelong learning is recognized [21].

The key to creating a learning environment that promotes cognitive enhancement is to strengthen learners' metacognitive skills. Future teachers who possess metacognitive abilities and skills can apply techniques and methods that are appropriate for classroom teaching. Therefore, training in metacognitive approaches and skills should be strengthened.

Several types of metacognitive abilities have been described in the literature, including metacognitive knowledge, metacognitive monitoring, metacognitive regulation, metacognitive awareness, and metacognitive experience.

Cognitive approach is the use of appropriate cognitive methods to solve a specific scenario in the teaching and learning process, the level of selection and the use of specific and appropriate teaching techniques. Cognitive methods guide the learning process and help learners solve problems effectively. Cognitive strategies accelerate the learning process, enhance self-esteem and increase learners' participation in academic activities. They are also associated with conceptual growth. Using cognitive strategies helps learners achieve their academic goals and expand their knowledge. Using the right method will help you achieve the learning outcomes of a particular unit or topic. When the set learning objectives are achieved, knowledge in the area of knowledge is considered to be acquired. Using cognitive methods improves understanding, cognition and overall performance.

Avargil et al.[1] presented a summary of studies of metacognitive interventions in science education, which showed that most of these studies included elements that could be classified as sub-dimensions related to the regulation of cognition rather than knowledge of cognition.

Zohar and Barzilai [22] found in their review of papers on metacognition in science education that the most common metacognitive intervention tools were metacognitive cues. Similarly, in our review of papers on metacognition in chemistry education, metacognitive cues were included in several papers and were expressed through reflective writing when considering planning, monitoring, and evaluating the learning process, questions, or guidelines that were given to students during various activities. These activities include problem solving, experimentation, research studies, reading scientific texts, writing reports and reflecting on or discussing scientific topics [23,24].

To successfully complete cognitive activities, learners use cognitive methods. Since they promote engagement in the learning process, the use of an effective cognitive approach improves learners' academic performance. The use of cognitive strategies increases the value of knowledge. It helps learners to participate more actively in classes and promotes task completion, emotion regulation, and problem-oriented learning.

Considering all the above, the aim of this study is to identify the key features and elements that are needed in metacognitive teaching in teacher training programs in chemistry education and provide chemistry teachers with practical and implementable recommendations so that they can improve their students' metacognitive knowledge and skills.

Materials and methods

This study used a quasi-experimental approach with pre- and post-testing. The target audience of the study consisted of students of grades 8 and 9 of the Lyceum "Young Talents". At Baku State University. A purposive sampling procedure was used to select the sample for the study. Two chemistry teachers were selected to assist in the experiment. Each chemistry teacher had 24 students in their class (Table 1).

Table 1. Statistical data of respondents

school	8th grade			9th grade		
	woman	man	total	woman	man	total
"Young talents" of BSU – class 8a (1st category)	14	10	24	12	12	24
"Young talents" of BSU – class 8a (2nd category)	12	10	24	8	16	24
Total participants: 96						

The following methods were used in the study:

- questionnaire
- interview.

Learning strategies are considered as a key element of self-regulation in the learning process and are defined as a set of educational methods and techniques that are purposefully applied with awareness to achieve long-term learning goals.

The selected teachers were assigned to read the chemistry subject material for a month in the manner they were accustomed to, with a pre-designed test added at the end of each week. The result compiled for that month was designated as the preliminary test.

After that, the teachers were given the following recommendations according to the experimental stage to implement metacognitive strategies in their lessons and during the next month with the addition of a pre-designed test at the end of each month. The compiled result of the second month was designated as the post-test. The pre-designed tests before and after were based on measuring the students' self-regulation skills, the students' cognitive self-awareness skills and the students' learning skills through the integration of metacognitive teaching strategies.

The collected data were analyzed using statistical procedures including descriptive and inferential analysis. In this regard, descriptive statistics were measured to describe the characteristics of the participating 8th-9th grade students and their responses.

Results and discussion

The interviews included 10 questions aimed at identifying the methods used by teachers to develop universal learning strategies and motivation in schoolchildren. One of the important conditions of this interview format was the active participation of each group member in the discussion. As a result, the interviews with the school teachers were divided into two categories depending on the degree of attention paid to the motivation of students and the development of their learning strategies.

The first category are teachers who are only superficially familiar with the concept of learning strategies and have not applied methods that promote their development, even at an intuitive level.

And the second category is teachers who have a clear understanding of learning and motivation strategies and are actively working on their development.

Within the framework of the current study, 5 significant evaluation criteria were identified: 1 - value strategies, 2 - expectations, 3 - affective strategies, 4 - cognitive and metacognitive strategies, 5 - resource management strategies.

When discussing methods for developing universal educational meta-skills, teachers limited themselves to the aspect of working with educational material, which, of course, is one of the main components of the development of cognitive learning strategies: repetition, clarification, organization.

This includes, for example, interaction between students both in class and outside of school: asking the teacher for additional help, searching for additional materials on the Internet or in textbooks, creating diagrams, tables, charts for deeper assimilation of information, and so on.

However, when it comes to developing teaching strategies, the range of methods used by teachers is much broader.

Contrary to the teachers' ideas, the majority of schoolchildren (almost 60%) were able to clearly identify what strategies they use in the learning process (Figure 1).

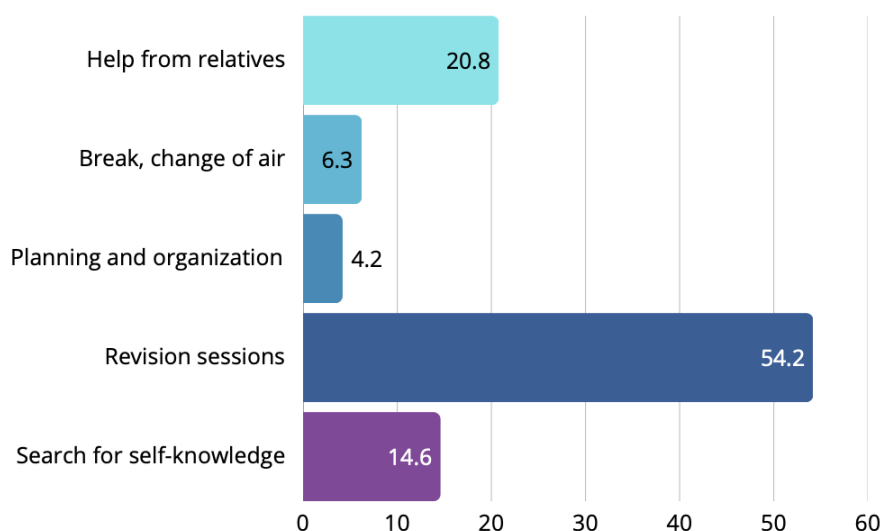


Figure 1. Metacognitive strategies used by learners (in per cent, %)

The results of the conducted content analysis showed that the students place the main emphasis on the use of cognitive strategies (repetition, help from adults, and their own independent search). Revision sessions also play an important role in the learning activities of students. At the same time, only a small number of students are familiar with planning, defining goals, setting tasks) and time strategies (schedule, breaks).

The results of this study are consistent with the literature review. For example, the present study found a significant impact of using metacognitive strategies on self-regulation and study skills of middle school chemistry students.

Metacognitive intervention has been shown to help students understand complex concepts in chemistry, and metacognitive assessment can help teachers and teacher educators better

understand their students' learning processes [2,24]. We believe that students' ability to monitor and evaluate their learning process is key to developing their conceptual understanding of science and making connections between different phenomena. Reviewing the articles on metacognition, we see that the aspect of regulating cognition is central to this field and that the intervention phase is usually separated from the assessment phase. Our aim in this section is to recommend and present the key features and elements that are needed in metacognitive teaching in or about teacher training programs in chemistry education and to provide chemistry teachers with practical and implementable guidelines so that they can improve their students' metacognitive knowledge and skills. We will now present the general principles that we propose to include in metacognition teaching and present a proposed task on the topic of energy in chemistry.

Conclusions

Metacognitive tactics and metacognitive questions were used in the hopes that students would become more engaged in class discussions and contribute more to the learning environment. It was hoped that one of the metacognitive techniques would also increase student engagement. No published studies have examined student engagement in class discussions.

However, when teachers used metacognitive strategies that encouraged students to reflect on their understanding of scientific topics, students engaged in meaningful and in-depth discussions. Using metacognitive questions to write in their notebooks and then sharing the information from the notes with students in class demonstrated a tendency to engage in deeper discussions. Students in the group who were asked metacognitive questions shared their thoughts on the topics and how they felt when they asked the questions. When students were asked metacognitive questions, some of them with their comments not to the teacher, but to their comrades who, as it seemed to them, were experiencing difficulties in studying the material.

Learners are more likely to use a variety of metacognitive strategies to evaluate their work when they are in groups rather than working alone.

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ENZYMES AND POULTRY FEED INDUSTRY**Prof. Dr. Muhammad TAYYAB**Institute of Biochemistry and Biotechnology, University of Veterinary and Animal Sciences, Lahore,
Pakistan**Abstract**

Poultry sector is one of the major established industries of Pakistan that is committed to provide valuable meat to our community. Phytases, cellulases, xylanases and proteases are the main enzymes being added in the poultry feed. The addition of these enzymes is important because their addition in feed put a positive impact on the growth of poultry bird. Phytases are responsible for the availability of free phosphorus while the xylanases and cellulases are responsible for the availability of monomeric absorbable sugars for the growth of bird whereas proteases also involve for the improvement of digestion of proteins. In the absence of these enzymes the phytate, cellulose and xylan are not being digested by the poultry bird and these components of feed simply pass through the digestive track and are removed from the body with manure and contribute in environmental pollution.

In the current study the phytase, cellulase and xylanase genes from hyper-thermophilic bacterium were amplified by using the PCR and ligated into the cloning vector pTZ57R/T. These vectors were transferred in the E.coli DH5 α cells. The expression of phytase, cellulase and xylanase genes were analyzed in E.coli BL21CodonPlus cells with the help of pET expression system. Recombinant proteins were purified through different chromatographic techniques and their molecular masses were determined through SDS-PAGE. Recombinant proteins were characterized. The locally produced recombinant enzymes were utilized for supplementation of poultry feed to examine their effect on the growth of poultry birds. The supplementation of poultry feed with locally produced enzymes showed significant growth enhancing effect on poultry birds and improved the feed uptake and feed conversion ratio.

Key Words: Poultry enzymes, Recombinant proteins, hyper-thermophilic bacterium

EFFECT OF ANTENATAL USE OF HIGH ENERGY NUTRITIONAL SUPPLEMENTS ON CARDIO METABOLIC RISK MARKERS IN UNDERWEIGHT PRIMI GRAVIDAS; A RANDOMIZED CONTROLLED TRIAL

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Abstract

Objective: To investigate the effect of high energy nutritional supplements on cardio metabolic risk markers in underweight primigravidas.

Methodology: A single blinded randomized controlled trial was conducted from April 2018-August 2019 among the Pakistani tertiary care facilities of Khyber Pakhtunkhwa. A total of thirty six participants were randomized into two groups receiving either high energy nutritional supplement or Placebo. They were instructed to take Placebo/Supplement alongside to their regular prenatal care and food from their first antenatal visit till a week postnatally. Anthropometric measurements and blood samples were taken at baseline visit, between 16-20 weeks gestation and a post natal visit.

Results: The two-way repeated measures ANOVA showed that there was a highly significant time effect on participant's Insulin level ($F(1.8, 53.6) = 10.64, P < 0.000, \eta^2 = 0.269$). A highly significant time effect on participant's insulin resistance ($F(2, 68) = 8.116, P < 0.001, \eta^2 = 0.193$) was also observed. There was a highly significant time effect on participant's LDL level as well ($F(2, 68) = 11.82, P < 0.000, \eta^2 = 0.258$).

Conclusion: Supplementation with high energy nutritional supplements may improve insulin levels and insulin sensitivity in underweight primigravidas.

Trial registry: <https://www.ClinicalTrials.gov> Identifier: ISRCTN 10088578. Registered on 27

March 2018. <https://www.isrctn.com/ISRCTN10088578>.

Keywords: High energy nutritional supplements, Primigravida, Insulin resistance, Cardio metabolic risk factors

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CRISPR AND GENE EDITING TECHNOLOGIES, REVOLUTIONIZING GENOMIC MEDICINE

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Abstract: The development of CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) has transformed the field of genome editing, offering an efficient, precise, and cost-effective tool for modifying DNA. Since its adaptation from a bacterial immune defense system, CRISPR-Cas systems have been harnessed for diverse applications including gene therapy, functional genomics, and diagnostics. Recent advances, such as base editing, prime editing, and epigenome editing, have expanded the precision and versatility of these technologies. This article reviews the molecular mechanisms of CRISPR, emerging variants of Cas proteins, and the ethical considerations surrounding their use in clinical and research contexts.

Introduction

Gene editing technologies have long promised the ability to correct genetic mutations, enhance crop resistance, and treat inherited diseases. Among the various tools developed—zinc finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs), and CRISPR-Cas systems—CRISPR has emerged as the most widely adopted due to its programmability and efficiency [1]. CRISPR-Cas9, the most common variant, enables targeted DNA cleavage using guide RNA (gRNA) that directs the Cas9 endonuclease to specific genomic loci.

Mechanism of CRISPR-Cas9

CRISPR-Cas9 editing relies on a short RNA molecule that guides the Cas9 protein to a complementary DNA sequence adjacent to a protospacer adjacent motif (PAM) site. Cas9 introduces a double-strand break (DSB), which is subsequently repaired by either non-homologous end joining (NHEJ) or homology-directed repair (HDR) [2]. NHEJ often introduces insertions or deletions (indels), while HDR allows for precise edits using a donor template.

Advances in CRISPR Technology

Base Editing. Base editors chemically convert one base pair into another without inducing a DSB. Cytosine base editors (CBEs) convert C•G to T•A, while adenine base editors (ABEs)

convert A•T to G•C. These tools are ideal for correcting point mutations associated with monogenic diseases [3].

Prime Editing. Prime editing expands CRISPR's potential by combining Cas9 nickase with a reverse transcriptase, guided by a prime editing gRNA (pegRNA). This method allows insertions, deletions, and all 12 base-to-base conversions without requiring DSBs or donor templates [4].

Epigenome Editing. Modified Cas proteins fused to epigenetic modifiers can regulate gene expression without altering DNA sequence. For instance, dCas9 fused with KRAB (a transcriptional repressor) enables precise gene silencing, whereas dCas9-p300 promotes gene activation via histone acetylation [5].

Clinical Applications. CRISPR-based therapies have entered clinical trials for conditions such as β -thalassemia, sickle cell disease, and Leber congenital amaurosis. In 2020, the first CRISPR-edited cells were infused into patients as part of in vivo human trials [6]. Moreover, ex vivo editing of hematopoietic stem cells has shown promise for treating hemoglobinopathies.

Limitations and Ethical Considerations

Despite its promise, CRISPR poses risks such as off-target effects, immune responses, and incomplete editing. Germline editing, particularly in embryos, has raised profound ethical concerns. The case of He Jiankui, who edited the CCR5 gene in human embryos, underscored the need for global regulatory frameworks and ethical consensus [7].

Future Directions

The next generation of CRISPR tools includes engineered Cas variants with higher fidelity (e.g., SpCas9-HF1, eCas9), CRISPR systems from diverse species (e.g., Cas12, Cas13), and CRISPR-based diagnostic platforms such as SHERLOCK and DETECTR. Integrating CRISPR with AI and single-cell technologies may enhance target prediction and personalized therapies.

Conclusion

CRISPR has revolutionized molecular biology and genomics, enabling precise and accessible genome editing. Ongoing advancements continue to refine its accuracy, efficiency, and safety. However, careful consideration of ethical implications is essential as the technology moves toward widespread clinical use.

Keywords: CRISPR, Gene Editing Technologies, Genomic Medicine

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TARGETING METABOLIC REPROGRAMMING IN CANCER**Dr., Assistant Professor, Samira BAGHIROVA**

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Abstract

Metabolic reprogramming is now recognized as a hallmark of cancer, representing a fundamental shift in how tumor cells acquire and utilize energy. This article reviews recent advances in the biochemistry of cancer metabolism, focusing on alterations in glycolysis, glutaminolysis, and lipid metabolism. Emphasis is placed on the potential of targeting these pathways for therapeutic purposes, with reference to key biochemical mechanisms and novel clinical strategies.

Introduction

The transformation of normal cells into cancer cells involves profound changes in metabolic pathways. First described by Otto Warburg in the 1920s, cancer cells exhibit increased glucose uptake and preferentially ferment glucose to lactate even in the presence of oxygen—a phenomenon known as the Warburg effect [6]. This reprogramming allows cancer cells to meet the demands of rapid proliferation, evade apoptosis, and survive under stress conditions [2]. In recent years, advances in metabolomics and systems biology have provided deeper insights into the molecular regulation of cancer metabolism, prompting the development of targeted biochemical therapies.

Metabolic Hallmarks of Cancer**Aerobic Glycolysis and the Warburg Effect**

Cancer cells exhibit enhanced glycolysis despite the availability of oxygen, a feature that supports biosynthetic processes and generates ATP rapidly [5]. Key enzymes such as hexokinase 2 (HK2), pyruvate kinase M2 (PKM2), and lactate dehydrogenase A (LDHA) are often upregulated. Therapeutic strategies targeting glycolytic enzymes are under investigation, with LDHA inhibitors showing promise in preclinical models [7].

Glutaminolysis

Glutamine metabolism supports cancer cell growth by fueling the tricarboxylic acid (TCA) cycle, producing NADPH, and supplying nitrogen for nucleotide synthesis. The enzyme glutaminase (GLS) converts glutamine to glutamate, which is then used in various biosynthetic pathways. Inhibitors of GLS, such as CB-839, have entered clinical trials for several malignancies [1].

Altered Lipid Metabolism

Cancer cells upregulate de novo lipid synthesis pathways to produce phospholipids and cholesterol for membrane biosynthesis. Fatty acid synthase (FASN) and sterol regulatory element-binding proteins (SREBPs) are central regulators of lipid metabolism in tumors. Targeting lipid biosynthesis, for instance with FASN inhibitors, is a growing area of interest in biochemical oncology [3].

Therapeutic Implications

Biochemical insights into metabolic reprogramming have led to new therapeutic targets. Agents such as 2-deoxy-D-glucose (2-DG), which inhibits glycolysis, and CB-839, a glutaminase inhibitor, have shown potential in early-phase trials. Furthermore, metabolic vulnerabilities can enhance the efficacy of conventional therapies such as chemotherapy and radiotherapy [4].

Challenges and Future Directions

Despite promising advances, several challenges remain. Metabolic pathways are often redundant, and tumor heterogeneity can result in variable responses. Moreover, normal proliferative tissues may also rely on similar metabolic pathways, raising concerns about toxicity. Ongoing research aims to develop selective inhibitors, identify predictive biomarkers, and combine metabolic therapies with immune checkpoint blockade.

Conclusion

Metabolic reprogramming is a defining feature of cancer and provides novel biochemical targets for therapy. A deeper understanding of the metabolic dependencies of tumors will pave the way for the development of more effective and selective cancer treatments. Biochemistry continues to play a central role in uncovering the molecular mechanisms underlying cancer and designing rational interventions.

Keywords: cancer, glycolysis, glutaminolysis, lipid metabolism.

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STUDY OF THE EFFECT OF REPEATED USE OF CYCLOPHOSPHAMIDE AND DOXORUBICIN ON THE CONCENTRATION OF SEX HORMONES IN THE BLOOD OF FEMALE WHITE RATS

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Relevance. The normal activity of the female body is regulated by neuro-endocrine regulation. The center of the neuroendocrine system is the hypothalamus. There, hormones-release factors are synthesized in nerve cells, the main function of which is to regulate the activity of the pituitary gland. Due to the normal activity of the pituitary gland, the required amount of female sex hormones FSH, LH, estradiol and prolactin is synthesized in the female body, which can lead to the maturation of egg cells in the ovaries, fertilization and pregnancy. The ratio of FSH and LH also plays an important role in the occurrence of this process. In addition to regulating the activity of the sex glands, LH also regulates the synthesis of the female sex hormone progesterone and the male sex hormone testosterone. The amount of this hormone varies in different stages of the ovulatory-menstrual cycle.

In the female body, FSH is absolutely necessary for the maturation of the egg cell in the follicles. This hormone is synthesized in the anterior lobe of the pituitary gland in women and is secreted into the blood at intervals of 3-4 hours. This hormone regulates the synthesis of estrogen hormones in the ovaries. The ratio of FSH and LH changes in different phases of the ovulatory-menstrual cycle. Thus, FSH is synthesized in the first half of the cycle, and lactotropin and LH are synthesized in excess in the second half. If the amount of FSH and LH in the body is normal, then the follicles and the corpus luteum develop normally. If FSH and LH are not synthesized in the female body in the required amount, then masculinization of the mammary glands and underdevelopment of the genital organs are observed in women. At this time, depression, decreased libido, mood swings, polycystic ovary syndrome, and infertility can develop in women.

It has been proven that testosterone receptors are present in many tissues of the female body, in the mammary glands, heart, blood vessels, gastrointestinal system, lungs, brain and spinal cord, peripheral nerves, bladder, urethra, uterus, ovaries, vagina, skin, bone tissue, bone marrow, synovial membrane, muscle and adipose tissue. Therefore, testosterone deficiency in the female body manifests itself not only with sexual disorders, but also with other pathological symptoms such as tension, arousal, depression, decreased muscle and bone mass, memory impairment, chronic pain, urinary disorders, including urinary incontinence, and reproductive disorders. Thus, female sex hormones - estrogens - participate in the development of the genitals

and secondary sexual characteristics of women and mammals, the ability to reproduce, and in protein, fat and carbohydrate metabolism. The main physiological function of progesterone is to play a role in preparing the female mammalian body for pregnancy, fertilization, and the regulation of pregnancy, childbirth, and lactation. Progesterone reduces the contractility of the uterus and its sensitivity to oxytocin (a hormone of the posterior pituitary gland). Progesterone is of great importance in maintaining pregnancy. Progesterone changes the functional state of the central nervous system, and in large doses has a narcotic effect.

In our modern era, the widespread spread of oncological diseases, especially among young people, is considered one of the most important issues facing practical oncology when treating these diseases without compromising the reproductive capacity of these young people.

Materials and methods of the study. The studies were conducted on 66 female white rats, weighing 175-200 g, bred in the vivarium of the Scientific Research Center of Azerbaijan Medical University. The animals were divided into 7 groups. 6 female rats were used in the control group, and 10 female rats in each group in the experimental groups. The first experimental group received 10 mg/kg cyclophosphamide, the second group received 20 mg/kg (Russian Federation), the third group received 2.5 mg/kg, the fourth group received 5 mg/kg doxorubicin (Germany) the fifth group received 10 mg/kg cyclophosphamide and 2.5 mg/kg doxorubicin, and the sixth group received 20 mg/kg doxorubicin and 5 mg/kg doxorubicin intraperitoneally for 1 week.

After 1 week of treatment with cytostatics, the levels of reproductive hormones total testosterone (Tü), free testosterone (Ts), follicle-stimulating hormone (FSH), luteinizing hormone (LH), prolactin (PL), progesterone (PG), estriol (ER), estradiol (ED) were determined in the blood of female rats in all groups.

During the scientific research, the regulations of the European Parliament and the European Union regarding the protection of animals were followed.

Student's t-test and non-parametric Wilcoxon-Mann-Whitney U-test were used to calculate the experimental data. The results were processed using the Microsoft Excel (Office-2010) statistical program.

Results and discussion. Initially, we injected 10 mg/kg cyclophosphamide intraperitoneally into female white rats for 5 days, and then compared the concentrations of reproductive hormones Tü, Ts, FSH, LH, PL, PG, ER and ED in the blood taken from the tail vein with the indicators of the control group.

We initially conducted our studies against the background of the determination of a dose of 10 mg/kg cyclophosphamine. It turned out that cyclophosphamide caused a sharp decrease in

the amount of Tü compared to the indicators of the control group. Thus, while the amount of Tü in the blood of the control group animals was 0.23 ± 0.02 nmol/l, against the background of repeated use of cyclophosphamide at a dose of 10 mg/kg, this indicator decreased by 47.8% to 0.11 ± 0.01 nmol/l $P < 0.05$. Determination of the amount of Ts showed that the amount in the control group decreased by 46.9% from 0.81 ± 0.04 pg/ml to 0.38 ± 0.02 pg/ml. When determining the amount of FSH, it was found that this indicator in the blood of the animals of the control group was 1.60 ± 0.10 ME/ml, but after repeated administration of cyclophosphamide at a dose of 10 mg/kg, it decreased by 48.7% to 0.78 ± 0.02 ME/ml. Determination of the amount of LH showed that this indicator in the blood of the animals of the control group was 1.74 ± 0.03 ME/ml, but after repeated administration of cyclophosphamide at a dose of 10 mg/kg, the amount of LH decreased by 32.2% to 0.56 ± 0.05 ME/ml, $p < 0.001$. Continuing our experiments and determining the amount of PL in the blood of the control group of animals, it turned out that the amount of this hormone was 242.6 ± 6.4 ME/ml. In the group administered cyclophosphamide at a dose of 10 mg/kg, this indicator decreased by 57.8% and was 140.2 ± 3.1 ME/ml. The same decrease was observed in the amount of PG. Thus, while in the blood of the female animals of the control group this indicator was 15.1 ± 0.05 nmol/l, under the influence of cyclophosphamide at a dose of 10 mg/kg, this indicator decreased by 33.9% and was 5.12 ± 0.73 nmol/l. When studying the amount of ER, it was found that the amount of this hormone in the blood of the control group of animals was 1.86 ± 0.07 ng/l, while under the influence of cyclophosphamide at a dose of 10 mg/kg, it decreased by 25.8% to 0.48 ± 0.01 ng/l, statistically significant. When determining the concentration of ED, it was found that in the blood of the control group of animals this indicator was 14.41 ± 1.06 pg/ml. In this group, which received a repeated dose of cyclophosphamide at a dose of 10 mg/kg, the concentration of ED decreased by 20.7% to 2.98 ± 0.005 pg/ml.

We continued our studies against the background of repeated use of a dose of cyclophosphamide at a dose of 20 mg/kg. It turned out that a dose of cyclophosphamide at a dose of 20 mg/kg causes more serious hormonal disorders. Thus, against the background of the administration of a dose of 20 mg/kg of cyclophosphamide, there was a sharp decrease in the amount of the hormone Tu compared to the indicators of the control group. While the amount of Tu in the blood of the animals of the control group was 0.23 ± 0.02 nmol/l, against the background of repeated use of cyclophosphamide at a dose of 20 mg/kg, this indicator decreased by 69.6% to 0.07 ± 0.001 nmol/l, $P < 0.05$.

Determination of the amount of Ts hormone showed that in the control group this indicator was 0.81 ± 0.04 pg/ml, while its amount decreased by 70.4% to 0.24 ± 0.01 pg/ml. When

determining the amount of FSH, it was found that this indicator in the blood of the animals of the control group was $1.60 \pm 0.10 \text{ ME/ml}$, but against the background of repeated administration of cyclophosphamide at a dose of 20 mg/kg, it decreased by 61.25% to $0.62 \pm 0.01 \text{ ME/ml}$. Determination of the amount of LH showed that in the blood of the animals of the control group, this indicator was $1.74 \pm 0.03 \text{ ME/ml}$, but against the background of repeated administration of cyclophosphamide at a dose of 20 mg/kg, the amount of LH decreased by 81.5% to $0.34 \pm 0.02 \text{ ME/ml}$, $p < 0.001$. Continuing our experiments and determining the amount of PL in the blood of the control group of animals, it turned out that the amount of this hormone was $242.6 \pm 6.4 \text{ ME/ml}$.

In the group administered cyclophosphamide at a dose of 20 mg/kg, this indicator decreased by 50% and was $121.32 \pm 2.7 \text{ ME/ml}$. The same decrease was observed in the amount of PG. Thus, while this indicator was $15.1 \pm 0.05 \text{ nmol/l}$ in the blood of the female animals of the control group, this indicator decreased by 79.4% and was $3.12 \pm 0.09 \text{ nmol/l}$ due to the repeated administration of cyclophosphamide at a dose of 20 mg/kg. When studying the amount of ER, it was found that the amount of this hormone in the blood of the control group of animals was $1.86 \pm 0.07 \text{ ng/l}$, but under the influence of cyclophosphamide at a dose of 20 mg/kg, it decreased by 82.8% statistically to $0.32 \pm 0.01 \text{ ng/l}$. When determining the concentration of ED, it was found that this indicator in the blood of the control group of animals was $14.41 \pm 1.06 \text{ pg/ml}$. In the group that received a repeated dose of cyclophosphamide at a dose of 20 mg/kg, this indicator decreased by 86% statistically to $2.02 \pm 0.002 \text{ pg/ml}$.

In the next stage of our research, we determined the concentration of reproductive hormones in the blood of female white rats against the background of a repeated dose of doxorubicin at a dose of 2.5 mg/kg. The results of our studies showed that repeated administration of doxorubicin at a dose of 2.5 mg/kg caused a sharp decrease in the amount of Tü compared to the control group. Thus, while the amount of Tü in the blood of animals in the control group was $0.23 \pm 0.02 \text{ nmol/l}$, this indicator decreased by 56.5% to $0.13 \pm 0.01 \text{ nmol/l}$ against repeated administration of doxorubicin at a dose of 2.5 mg/kg, $P < 0.05$. Determination of the amount of Ts showed that while this indicator was $0.81 \pm 0.04 \text{ pg/ml}$ in the control group, it decreased by 50.6% to $0.41 \pm 0.01 \text{ pg/ml}$ against repeated administration of doxorubicin at a dose of 2.5 mg/kg. When determining the amount of FSH, it was found that this indicator was $1.60 \pm 0.10 \text{ ME/ml}$ in the blood of the control group of animals, but decreased by 50.6% to $0.81 \pm 0.02 \text{ ME/ml}$ against the background of repeated administration of doxorubicin at a dose of 2.5 mg/kg. Determination of the amount of LH showed that while this indicator was $1.74 \pm 0.03 \text{ ME/ml}$ in the blood of the control group of animals, this amount decreased by 35.05% to $0.61 \pm 0.04 \text{ ME/ml}$ against the

background of repeated administration of doxorubicin at a dose of 2.5 mg/kg, $p < 0.001$. Continuing our experiments and determining the amount of PL in the blood of the control group of animals, it was found that the amount of this hormone was 242.6 ± 6.4 ME/ml. In the group administered doxorubicin at a dose of 2.5 mg/kg, this indicator decreased by 59.4% to 144.3 ± 2.9 ME/ml. The same decrease was observed in the amount of PG. Thus, while in the blood of female animals of the control group this indicator was 15.1 ± 0.05 nmol/l, under the influence of doxorubicin at a dose of 2.5 mg/kg, this indicator decreased by 38.3% to 5.79 ± 0.68 nmol/l. When studying the amount of ER, it was found that while in the blood of animals of the control group it was 1.86 ± 0.07 ng/l, under the influence of doxorubicin at a dose of 2.5 mg/kg, the amount of this hormone decreased by 27.4% to 0.51 ± 0.01 ng/l, statistically significant. When determining the concentration of ED, it was found that in the blood of animals of the control group this indicator was 14.41 ± 1.06 pg/ml. In this group, which received a repeated dose of 2.5 mg/kg of doxorubicin, the concentration of ED decreased by 20.9%, reaching a statistically significant decrease of 3.02 ± 0.005 pg/ml.

We continued our studies against the background of repeated use of a dose of 5 mg/kg of doxorubicin. It turned out that a dose of 5 mg/kg of doxorubicin causes a more serious hormonal disorder. Thus, against the background of the determination of a dose of 5 mg/kg of doxorubicin, a sharp decrease in the amount of the hormone Tu occurred compared to the indicators of the control group. While the amount of Tu in the blood of animals of the control group was 0.23 ± 0.02 nmol/l, against the background of repeated use of doxorubicin at a dose of 5 mg/kg, this indicator decreased by 60.9% to 0.09 ± 0.001 nmol/l $P < 0.05$. Determination of the amount of the hormone Ts showed that while in the control group this indicator was 0.81 ± 0.04 pg/ml, its amount decreased by 64.2% to 0.29 ± 0.02 pg/ml. When determining the amount of FSH, it was found that this indicator was 1.60 ± 0.10 ME/ml in the blood of the control group of animals, but after repeated administration of doxorubicin at a dose of 5 mg/kg, it decreased by 55.7% to 0.71 ± 0.01 ME/ml. Determination of the amount of LH showed that while this indicator was 1.74 ± 0.03 ME/ml in the blood of the control group of animals, after repeated administration of doxorubicin at a dose of 5 mg/kg, the amount of LH decreased by 76.5% to 0.41 ± 0.02 ME/ml, $p < 0.001$. Continuing our experiments, when determining the amount of PL in the blood of the control group of animals, it was found that the amount of this hormone was 242.6 ± 6.4 ME/ml. In the group administered doxorubicin at a dose of 5 mg/kg, this indicator decreased by 53.3% to 129.4 ± 2.4 ME/ml. The same trend was observed in the amount of PG. Thus, while this indicator in the blood of female animals of the control group was 15.1 ± 0.05 nmol/l, this indicator decreased by 85.6% to 3.69 ± 0.07 nmol/l due to the repeated

administration of doxorubicin at a dose of 5 mg/kg. When studying the amount of ER, it was found that the amount of this hormone in the blood of animals of the control group was $1.86 \pm 0.07 \text{ ng/l}$, it decreased by 77.5% statistically significantly to $0.42 \pm 0.02 \text{ ng/l}$ due to the effect of doxorubicin at a dose of 5 mg/kg. When determining the concentration of ED, it was found that this indicator in the blood of animals of the control group was $14.41 \pm 1.06 \text{ pg/ml}$. In the group that received a repeated dose of doxorubicin at a dose of 5 mg/kg, this indicator decreased by 79.2% statistically significantly to $3.01 \pm 0.001 \text{ pg/ml}$.

In the next stage of our studies, since combined chemotherapy is used to achieve a high cytostatic effect in chemotherapy, we also prescribed a dose of cyclophosphamide 10 mg/kg together with a dose of doxorubicin 2.5 mg/kg to female white rats. It turned out that the combined use of cyclophosphamide and doxorubicin caused a more pronounced decrease in the amount of Tu compared to the indicators of the control group. Thus, while the amount of Tu in the blood of the control group animals was $0.23 \pm 0.02 \text{ nmol/l}$, against the background of repeated use of a dose of cyclophosphamide 10 mg/kg and a dose of doxorubicin 2.5 mg/kg, this indicator was 73.02% $0.06 \pm 0.001 \text{ nmol/l}$ $P < 0.05$. Determination of the amount of Ts showed that, while the amount of this hormone in the control group was $0.81 \pm 0.04 \text{ pg/ml}$, in the blood of animals re-administered with cyclophosphamide at a dose of 10 mg/kg and doxorubicin at a dose of 2.5 mg/kg, this amount decreased by 72.9% to $0.22 \pm 0.01 \text{ pg/ml}$. When determining the amount of FSH, it was found that, while this indicator was $1.60 \pm 0.10 \text{ ME/ml}$ in the blood of animals in the control group, it decreased by 66.3% to $0.54 \pm 0.02 \text{ ME/ml}$ against the background of re-administration of cyclophosphamide at a dose of 10 mg/kg and doxorubicin at a dose of 2.5 mg/kg. Determination of the amount of LH showed that in the blood of the control group of animals, this indicator was $1.74 \pm 0.03 \text{ ME/ml}$, while against the background of repeated administration of cyclophosphamide at a dose of 10 mg/kg and doxorubicin at a dose of 2.5 mg/kg, the amount of LH decreased by 75.9% to $0.42 \pm 0.03 \text{ ME/ml}$, $p < 0.001$. Continuing our experiments and determining the amount of PL in the blood of the control group of animals, it turned out that the amount of this hormone was $242.6 \pm 6.4 \text{ ME/ml}$. In the group administered cyclophosphamide at a dose of 10 mg/kg and doxorubicin at a dose of 2.5 mg/kg, this indicator decreased by 54.4% to $132.0 \pm 2.7 \text{ ME/ml}$. The same decrease was observed in the amount of PG. Thus, while this indicator in the blood of female animals of the control group was $15.1 \pm 0.05 \text{ nmol/l}$, this indicator decreased by 73.3% to $4.01 \pm 0.54 \text{ nmol/l}$ due to the combined administration of cyclophosphamide at a dose of 10 mg/kg and doxorubicin at a dose of 2.5 mg/kg. When studying the amount of ER, it was found that the amount of this hormone in the blood of animals of the control group was $1.86 \pm 0.07 \text{ ng/l}$, while it was

statistically significantly decreased by 80.2% to $0.37 \pm 0.01 \text{ ng/l}$ due to the combined administration of cyclophosphamide at a dose of 10 mg/kg and doxorubicin at a dose of 2.5 mg/kg. When determining the concentration of ED, it was found that this indicator in the blood of animals of the control group was $14.41 \pm 1.06 \text{ pg/ml}$. In this group, which received a repeated dose of cyclophosphamide 10 mg/kg with a dose of doxorubicin 2.5 mg/kg, the concentration of ED decreased by 83.9% to $2.04 \pm 0.002 \text{ pg/ml}$. In the next stage of our studies, since combined chemotherapy is used to achieve a high cytostatic effect in chemotherapy, we also prescribed a dose of cyclophosphamide 10 mg/kg together with a dose of doxorubicin 2.5 mg/kg to female white rats. It turned out that the combined use of cyclophosphamide and doxorubicin caused a more pronounced decrease in the amount of Tu compared to the indicators of the control group. Thus, while the amount of Tu in the blood of the control group animals was $0.23 \pm 0.02 \text{ nmol/l}$, against the background of repeated use of a dose of cyclophosphamide 10 mg/kg and a dose of doxorubicin 2.5 mg/kg, this indicator was 73.02% $0.06 \pm 0.001 \text{ nmol/l}$ $P < 0.05$. Determination of the amount of Ts showed that, while the amount of this hormone in the control group was $0.81 \pm 0.04 \text{ pg/ml}$, in the blood of animals re-administered with cyclophosphamide at a dose of 10 mg/kg and doxorubicin at a dose of 2.5 mg/kg, this amount decreased by 72.9% to $0.22 \pm 0.01 \text{ pg/ml}$. When determining the amount of FSH, it was found that, while this indicator was $1.60 \pm 0.10 \text{ ME/ml}$ in the blood of animals in the control group, it decreased by 66.3% to $0.54 \pm 0.02 \text{ ME/ml}$ against the background of re-administration of cyclophosphamide at a dose of 10 mg/kg and doxorubicin at a dose of 2.5 mg/kg. Determination of the amount of LH showed that in the blood of the control group of animals, this indicator was $1.74 \pm 0.03 \text{ ME/ml}$, while against the background of repeated administration of cyclophosphamide at a dose of 10 mg/kg and doxorubicin at a dose of 2.5 mg/kg, the amount of LH decreased by 75.9% to $0.42 \pm 0.03 \text{ ME/ml}$, $p < 0.001$. Continuing our experiments and determining the amount of PL in the blood of the control group of animals, it turned out that the amount of this hormone was $242.6 \pm 6.4 \text{ ME/ml}$. In the group administered cyclophosphamide at a dose of 10 mg/kg and doxorubicin at a dose of 2.5 mg/kg, this indicator decreased by 54.4% to $132.0 \pm 2.7 \text{ ME/ml}$. The same decrease was observed in the amount of PG. Thus, while this indicator in the blood of female animals of the control group was $15.1 \pm 0.05 \text{ nmol/l}$, this indicator decreased by 73.3% to $4.01 \pm 0.54 \text{ nmol/l}$ due to the combined administration of cyclophosphamide at a dose of 10 mg/kg and doxorubicin at a dose of 2.5 mg/kg. When studying the amount of ER, it was found that the amount of this hormone in the blood of animals of the control group was $1.86 \pm 0.07 \text{ ng/l}$, while it was statistically significantly decreased by 80.2% to $0.37 \pm 0.01 \text{ ng/l}$ due to the combined administration of cyclophosphamide at a dose of 10 mg/kg and doxorubicin at a dose of 2.5

mg/kg. When determining the concentration of ED, it was found that this indicator in the blood of animals of the control group was 14.41 ± 1.06 pg/ml. In this group, which received a repeated dose of cyclophosphamide 10 mg/kg with a dose of doxorubicin 2.5 mg/kg, the concentration of ED decreased by 83.9% to 2.04 ± 0.002 pg/ml.

We continued our studies against the background of repeated use of cyclophosphamide 20 mg/kg and doxorubicin 5 mg/kg. It turned out that cyclophosphamide 20 mg/kg and doxorubicin 5 mg/kg cause more serious hormonal disorders. Thus, against the background of combined administration of cyclophosphamide 20 mg/kg and doxorubicin 5 mg/kg, there was a sharp decrease in the amount of the hormone Tü compared to the indicators of the control group. While the amount of Tü in the blood of the animals of the control group was 0.23 ± 0.02 nmol/l, against the background of repeated use of cyclophosphamide 20 mg/kg and doxorubicin 5 mg/kg, this indicator decreased by 82.7% to 0.04 ± 0.001 nmol/l $P < 0.05$. Determination of the amount of Ts hormone showed that in the control group this indicator was 0.81 ± 0.04 pg/ml, while its amount decreased by 85.2% to 0.12 ± 0.001 pg/ml. When determining the amount of FSH, it was found that this indicator was 1.60 ± 0.10 ME/ml in the blood of the animals of the control group, but decreased by 69.4% to 0.49 ± 0.01 ME/ml against the background of repeated administration of cyclophosphamide at a dose of 20 mg/kg and doxorubicin at a dose of 5 mg/kg. The determination of the amount of LH showed that in the blood of the control group of animals, this indicator was 1.74 ± 0.03 ME/ml, while in the blood of animals administered cyclophosphamide at a dose of 20 mg/kg and doxorubicin at a dose of 5 mg/kg, the amount of LH decreased by 86.06% to 0.24 ± 0.02 ME/ml, $p < 0.001$. Continuing our experiments and determining the amount of PL in the blood of animals in the control group, it turned out that the amount of this hormone was 242.6 ± 6.4 ME/ml. In the group administered cyclophosphamide at a dose of 20 mg/kg and doxorubicin at a dose of 5 mg/kg, this indicator decreased by 57.9% to 102.14 ± 2.1 ME/ml. The same decrease was observed in the amount of PG. Thus, while this indicator in the blood of female animals of the control group was 15.1 ± 0.05 nmol/l, under the influence of repeated administration of cyclophosphamide at a dose of 20 mg/kg and doxorubicin at a dose of 5 mg/kg, this indicator decreased by 82.6% to 2.64 ± 0.06 nmol/l. When studying the amount of ER, it was found that the amount of this hormone in the blood of animals of the control group was 1.86 ± 0.07 ng/l, under the influence of cyclophosphamide at a dose of 20 mg/kg and doxorubicin at a dose of 5 mg/kg, it decreased by 88.2% to 0.22 ± 0.001 ng/l. When determining the concentration of ED, it was found that this indicator in the blood of animals of the control group was 14.41 ± 1.06 pg/ml. In the group that received a dose of 20 mg/kg

cyclophosphamide and a dose of 5 mg/kg doxorubicin, this indicator decreased by 89.3% statistically significantly to 1.55 ± 0.001 pg/ml.

Thus, analyzing the results of our studies, we come to the conclusion that since both cyclophosphamide and doxorubicin are cytostatics with toxic effects, they cause the development and death of not only atypical cells, but also normal cells, and therefore cause atrophy and damage to the hormone-synthesizing glands, thereby reducing the amount of synthesized reproductive hormones.

Conclusion:

1. Doxorubicin causes a significant decrease in the amount of sex hormones when administered to female rats for treatment compared to cyclophosphamide in a dose-dependent manner.

2. Cyclophosphamide and doxorubicin together cause a depletion in the amount of sex hormones when administered to female rats for treatment.

Keywords: cyclophosphamide, doxorubicin, sex hormones, estradiol, progesterone, testosterone, FSH, LH.

PECULIARITIES OF PREGNANCY IN PATIENTS WITH HYPERTENSION

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Introduction. In developed and developing societies, the number of pregnancies is decreasing and the gestational age is gradually increasing. Again, the increase in awareness along with the improvement of antenatal care increases the diagnosis of hypertension in pregnancy. The diagnosis in pregnancy is made by adhering to the same principles as in normal individuals. The absolute values for the definition are based on Systolic Blood Pressure (SBP) ≥ 140 mmHg or Diastolic Blood Pressure (DBP) ≥ 90 mmHg. Unlike non-pregnant adults, the definition in pregnancy is classified as mild (140-159/90-109 mmHg) or severe ($\geq 160/110$ mmHg) hypertension.

Hypertensive disorders (chronic (CAH), gestational (GAH) hypertension), the frequency of which varies from 2% to 30%, affect the course of pregnancy unevenly. The most formidable complication, accompanied not only by hypertension, but also by multiple organ failure, is preeclampsia (PE), which is often not an independent complication of pregnancy, but develops against the background of a previous hypertensive condition (PE against the background of CAH). In 25% of cases, pregnancy in women with GAG and CAH can be complicated. PE occurs in 2-5% of pregnant women and continues to be the subject of active scientific research due to its significant contribution to dramatic complications during pregnancy, as well as short-term and long-term negative consequences for the life of the woman and her child. Thus, PE remains one of the main causes of maternal, perinatal and infant mortality and morbidity worldwide.

There is also a classification according to the time of occurrence and detection of hypertension, which is special in terms of directing treatment.

a-Pre-existing hypertension: High blood pressure that occurs before pregnancy or develops before the 20th week of pregnancy and continues after the 42nd day of pregnancy. It occurs in 1-5% of pregnancies and is accompanied by increased complications (15%).

b-Gestational hypertension: Hypertension that develops after the 20th week of pregnancy and passes within 42 days after birth. The mechanism of gestational hypertension is an increase in cardiac output above that observed in normal pregnancy, marked vasoconstriction, and increased central and peripheral sympathetic activity. In mothers with previously normal blood pressure (mean arterial pressure range 60-100 mmHg), a sudden increase in blood pressure to 150/100 mmHg can disrupt autoregulation and lead to cerebral edema and convulsions. c-

Preeclampsia: It is defined as the presence of 0.3 g/day proteinuria together with gestational hypertension. It is a condition in which headache, blurred vision, abdominal pain, pulmonary edema, thrombocytopenia and abnormal liver tests are present together with the blood pressure condition. The addition of convulsions to this condition is defined as Eclampsia.

MATERIAL AND METHOD. Materials and Methods: the study included 89 pregnant women (mean age: 31.72 ± 3.47 years), divided into 6 groups: Sub-group IA —patients with early moderate preeclampsia (PE); sub-group IB — patients with early severe PE; sub-group IIA — patients with late moderate PE; sub-group IIB — patients with late severe PE; group III — patients with gestational arterial hypertension (GAH); group IV — patients with chronic arterial hypertension (CAH); group V — CAH-associated PE, group VI (controls) — uncomplicated pregnancy. The women underwent clinical, laboratory and instrumental.

RESULTS. Patients with early severe PE were statistically significantly older than patients with late moderate PE and controls. Body mass index of women with CAH, GAH and CAH-associated PE was higher than that in controls. Differences in family and obstetric history of pregnant women with various hypertensive disorders, which are an unfavourable background affecting the course of pregnancy, were identified.

CONCLUSION: when assessing clinical and history risk factors, while focusing on previous PE, it is advisable to take a group of women for thorough monitoring from the very early stage of pregnancy, in order to prevent failures (miscarriage, hypertensive complications, foetal growth retardation syndrome). Taking into account that early and late severe PE as well as CAH-associated PE are the most severe hypertensive disorders in pregnant women, it is recommended to refer such pregnant women to group 3 treatment and prevention institutions.

Keywords: pregnancy, hypertensive disorders, preeclampsia, gestational complications.

URGENT CERCLAGE

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INTRODUCTION. For the first time, the term "urgent cerclage" has been defined and indications for its implementation have been listed:

- dilation of the cervix by more than 20 mm without visible contractions;
- premature effacement of the cervix by more than 50% of its original length (but with a cervical length of at least 15 mm);
- prolapse of the fetal bladder.

The protocol specifies the need to monitor the nature of vaginal discharge (to exclude premature rupture of the fetal membranes, inflammation and placental abruption) and manifestations of chorioamnionitis, since the risk of complications

in this situation is increased. The requirement for the patient to sign an informed consent form is emphasized.

Such active tactics of pregnancy management in case of Isthmic-cervical insufficiency (ICI) complicated by prolapse of the fetal bladder are recognized as optimal based on data from foreign studies. Thus, German authors, based on the results of a retrospective analysis of the material, found that in case of prolapse of the fetal bladder, surgical correction allows to prolong pregnancy by an average of 10 weeks versus 1 week in case of conservative management of the patient.

The diagnosis of ICI is based on transvaginal scanning of the cervix in the supine position after emptying the bladder. Transvaginal scanning of the cervix can visualize shortening of the cervix, dynamic changes in the structure of the cervix, changes in the anatomy of the internal os, expansion of the cervical canal with prolapse of the fetal membranes into its lumen (formation of a "funnel").

Urgent cerclage differs from similar interventions in the presence of a closed portion of the cervix by greater trauma and worse perinatal outcomes. The prognosis for carrying a pregnancy depends on several factors, including surgical technique, the presence or absence of subclinical chorioamnionitis, and contractile activity of the uterus.

MATERIAL AND METHOD. In this thesis described the treatment results for 40 pregnant women at gestation week 22 to 24 complicated with foetal bladder prolapse into cervical canal or upper third of vagina. Urgent cerclage is performed after tocolysis with Atosiban, antibacterial therapy followed by 2 circular sutures on the vesical cervix after foetal bladder is reset back to the os. Tocolysis with Atosiban lasted for 48 hours together with measures to prevent respiratory distress syndrome.

RESULTS: The average pregnancy prolongation time after surgical correction was 11.6 ± 2.1 weeks. The sutures were removed from the cervix at 37 weeks or if complications arose (premature rupture of membranes in 6 cases — from 29 to 35 weeks, spontaneous development of labor in 4 cases — at 33–35 weeks).

In 33 (83.9%) of 40 women, timely delivery occurred at 37 to 39 weeks after removal of the sutures from the cervix, in 7 patients, premature delivery occurred at 28 to 35 weeks. All full-term newborns were discharged home on the 4th–5th day after observation in the physiological children's department. The premature newborns required treatment in the neonatal intensive care unit with a transition to the second stage of care; they have now been discharged and are developing according to their age.

CONCLUSION: Urgent cerclage with Atosiban and antibacterial therapy may be one of the options to reduce the incidence of very early preterm birth. We believe that emergency cerclage in group 3 facilities will prolong pregnancy and facilitate the birth of children at later gestational ages.

Key Words: cerclage, tocolysis, habitual miscarriage, foetal bladder prolapse, surgical correction of insuficiencia istmicocervical.

IN VİTRO FERTİLİZASYONLA DOĞAN PREMATÜRE BEBEKLERDE NEONATAL MORBİDİTE PROFİLİ: RETROSPEKTİF KARŞILAŞTIRMALI ANALİZ

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ÖZET

Prematüre doğum, küresel çapta önemli bir sağlık sorunu olmaya devam etmektedir ve in vitro fertilizasyon (IVF) yoluyla doğan bebekler, ilişkili maternal ve perinatal risk faktörleri nedeniyle benzersiz klinik profiller sergileyebilir. Bu çalışma, 34. gebelik haftasından önce doğan, tüp bebek ile doğal gebelikle doğan prematüre bebeklerin klinik özelliklerini ve kısa dönem sonuçlarını karşılaştırmayı amaçlamaktadır. 2019-2023 yılları arasında üçüncü basamak bir NICU'dan alınan tıbbi kayıtlar kullanılarak retrospektif, kesitsel bir analiz yürütülmüştür. IVF (n=106) ve IVF olmayan (n=92) gruplar arasında maternal demografi, perinatal faktörler ve neonatal morbiditeler karşılaştırılmıştır. İstatistiksel anlamlılık, t-testleri, Ki-kare ve Fisher'ın kesin testleri ($p<0,05$) kullanılarak belirlenmiştir. IVF bebeklerinde çoklu gebelik oranı (%74,5'e karşı %25,5, $p<0,001$), doğum öncesi steroid maruziyeti (%61,9'a karşı %38,1, $p<0,001$) ve preterm erken membran rüptürü (PPROM) (%66,7'ye karşı %33,3, $p=0,005$) önemli ölçüde daha yüksekti. IVF grubunda anne yaşı önemli ölçüde daha yüksekti ($p=0,039$). Doğum ağırlığında, gebelik yaşında veya çoğu yenidoğan morbiditesinde önemli bir fark gözlenmedi. İlginç bir şekilde, intraventriküler hemoraji (IVH) IVF olmayan grupta daha sık görülürken ($p=0,045$), periventriküler lökomalazi (PVL) IVF grubunda daha yaygındı, ancak istatistiksel olarak anlamlı değildi. IVF gebelikleri artan anne yaşı, çoklu doğumlar ve daha yüksek PPRM ve erken neonatal morbidite riskleriyle ilişkilidir. Bu savunmasız popülasyonda sonuçları optimize etmek için kişiye özel doğum öncesi ve neonatal bakım stratejileri gereklidir.

Anahtar Kelimeler: Yardımcı üreme teknikleri, in vitro fertilizasyon, prematürite, yenidoğan, neonatal morbidite

NEONATAL MORBIDITY PROFILE OF PRETERM INFANTS BORN VIA IN VITRO FERTILIZATION: A RETROSPECTIVE COMPARATIVE ANALYSIS

ABSTRACT

Premature birth remains a significant global health concern, and infants born through in vitro fertilization (IVF) may exhibit unique clinical profiles due to associated maternal and perinatal risk factors. This study aimed to compare the clinical characteristics and short-term outcomes of preterm infants born before 34 weeks of gestation via IVF and natural conception. A retrospective, cross-sectional analysis was conducted using medical records obtained from a tertiary-level NICU between 2019 and 2023. Maternal demographics, perinatal factors, and neonatal morbidities were compared between IVF (n=106) and non-IVF (n=92) groups. Statistical significance was determined using t-tests, Chi-square, and Fisher's exact tests ($p<0.05$). IVF infants had significantly higher rates of multiple gestation (74.5% vs. 25.5%, $p<0.001$), antenatal steroid exposure (61.9% vs. 38.1%, $p<0.001$), and preterm premature rupture of membranes (PPROM) (66.7% vs. 33.3%, $p=0.005$). Maternal age was also significantly higher in the IVF group ($p=0.039$). No significant differences were observed in birth weight, gestational age, or most neonatal morbidities. Interestingly, intraventricular hemorrhage (IVH) was more common in the non-IVF group ($p=0.045$), whereas periventricular leukomalacia (PVL) appeared more frequently in the IVF group, although not reaching statistical significance. IVF pregnancies are associated with increased maternal age, higher incidence of multiple births, and elevated risks of PPRM and early neonatal morbidities. Tailored antenatal and neonatal care strategies are essential to improve outcomes in this vulnerable population.

Keywords: Assisted reproductive technologies, in vitro fertilization, prematurity, newborn, neonatal morbidity

BIOTECHNOLOGY FOR WASTEWATER TREATMENT: INNOVATIVE APPROACHES AND TECHNOLOGIES

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ABSTRACT

Biotechnology plays an important role in improving wastewater treatment through innovative and sustainable approaches. It includes the use of living organisms such as bacteria, fungi, and algae to remove pollutants from water. One study reported that genetically modified bacteria developed using CRISPR-Cas9 technology showed enhanced ability to break down harmful chemicals in wastewater and were more resistant to environmental stress. Another study showed that biofilm-based systems like oxygenic photogranules and phototrophic biofilms were highly stable and effective in removing organic and inorganic pollutants from wastewater. In another study, the fungal strain *Trametes versicolor* was used in mycoremediation and showed good results in degrading pharmaceutical compounds and textile dyes present in wastewater. In one experiment, microbial fuel cells were used for wastewater treatment, and the results showed that they not only helped clean the water but also generated electricity during the process. These studies confirm that biotechnology-based methods are cost-effective, sustainable, and helpful in treating wastewater. It is concluded that biotechnology plays a key role in modern wastewater treatment technologies and will be essential for future water conservation.

Keywords: CRISPR-Cas9, Wastewater treatment, Biofilms, Mycoremediation, Microbial fuel cells, Biotechnology

DENTINE HYPERSENSITIVITY

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Introduction. Tooth sensitivity is a very common clinical presentation which can cause considerable concern for patients. The management of this condition requires a good understanding of the complexity of the problem, as well as the variety of treatments available. Even with the large number of published studies, it has not been possible to reach a consensus about the product that represents the gold standard in the treatment of dentinal hypersensitivity. This article reviews the etiology, incidence and management of dentinal hypersensitivity.

Dentinal hypersensitivity is defined as a condition characterized by short, sharp pain in the exposed dentin to thermal, evaporative, tactile, osmotic or chemical stimuli that cannot be associated with any other dental defect or pathology. Instead of the word dentin, words such as cervical or root have been used to define dentinal hypersensitivity, depending on the region of formation, and the clinical situation has been tried to be defined in this way. This has led to the derivation of a number of different combinations to define the same condition.

Although it affects a wide segment of society, its prevalence in the general population has been reported to be between 8-57%³. This rate is between 72-98% in individuals with periodontal disease. Dentin sensitivity affects a very wide age group, but it is most commonly seen in individuals between the ages of 20-40. Many theories have been developed to understand the mechanism of dentin sensitivity. One of the first hypotheses, the “odontoblastic transduction theory”, also known as the “dentin receptor mechanism”, argues that dentin sensitivity is caused by neuronal extensions ending in dentin. Microscopic and experimental studies have not found any neurotransmitter produced or released by odontoblasts. As a result, the deficiencies of this theory have been revealed and it has not been supported.. With increasing age, decreased sensitivity in the pulp, secondary and tertiary dentin mechanisms come into play, fibrosis in the pulp and sclerosis in the tubules result in decreased permeability of the dentin tubules. It has been shown that women are more affected by dentin sensitivity, especially in early ages. There are also opinions in the literature that women attach more importance to their general health and their oral hygiene is relatively better.

Method. The professional clinical approach in the treatment of dentinal sensitivity primarily recommends starting treatment based on etiological and predisposing factors. Many materials

have been used in literature reviews, and only a few of them have addressed etiological factors and evaluated the subjective findings of pain between individuals by standardizing them. Treatments should be effective and easy to apply over long periods. In addition, the materials used should not cause pain, irritation of the pulp, or staining of the teeth. Treatments are divided into two groups according to their purposes: preventive and therapeutic treatments. In summary, preventive treatment includes reducing risk and etiological factors, routine oral hygiene motivations, periodontal examination, periodontal treatment applications when necessary, and dietary recommendations regarding acidic foods.

Result. As a result, although there are many treatment interventions and methods for dentin sensitivity, which is considered one of the important dental problems of our day, and most of them have been successful in the literature, there is no 'gold standard' in the treatment of dentin sensitivity.

Keywords: Dentinal hypersensitivity, desensitizing treatments, etiology.

NATURAL MODULATION OF THE GUT MICROBIOTA IN PATIENTS WITH FOOD ALLERGIES. IMPACT OF ALERGIPLANT

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ABSTRACT

Background: Dysbiosis or microbial imbalance, can predispose individuals to allergies, while a balanced gut microbiome, fosters immune tolerance. The immune mechanisms involved in food allergies are complex and little is known about the possible role of the gut microbiota in the aetiopathogenesis of food allergies.

Objective: Alergiplant could modulate the immune system through gut microbiota in food allergies. Advancing knowledge of the gut microbiome and its function in modulating the course of food allergies, might result in novel therapeutic strategies.

Materials and methods: The evaluation of the patients was based on history and physical examination. We investigated the effect Alergiplant in patients with food allergies.

Results: Environmental factors such as urbanisation, pollution, and dietary habits also significantly contribute to food allergies risk. It is not clear whether microbial change in food allergies is an outcome of barrier defect or the cause of barrier dysfunction and inflammation. Manipulation of the gut microbiota as a method for modifying atopy, may be attempted in many ways including avoidance of certain foods, supplementation with probiotics and prebiotics, optimising nutrient intake, minimising stress, antimicrobial therapy, correction and prevention of low stomach acid, and faecal microbiota transplantation.

Conclusion: The resident microbiota is important in maintaining structural and functional integrity of the gut and in immune system regulation. There was an increase of the intestinal permeability reported in patients with food allergies and a reduction of the gut microbiome diversity. Modifying gut microbiome by applying Alergiplant during early years may be a preventive and therapeutic option in high risk groups.

Keywords: food allergies, host-microbiome interaction; immune regulation; Alergiplant

SOFT TISSUE SARCOMAS

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Introduction

Soft tissue sarcomas-tumors are that develop in soft tissues such as muscles, ligaments, joints, or nerve tissue. They can be benign, malignant, or intermediate. This text includes information on the clinical presentation, frequency, causes, and symptoms of malignant soft tissue sarcomas and other rare soft tissue tumors, as well as diagnosis, treatment planning, management, and prognosis. The term soft tissue tumors or tissue tumors covers a wide range of different diseases that result from the degeneration (change) of immature precursor cells of soft tissues. Soft tissues include different types of tissue, such as muscle, fat, and connective tissue, as well as blood vessels and peripheral nerve tissue [peripheral nervous system]. Therefore, there is a wide variety of soft tissue tumors. They not only differ in their microscopic (histological) structure and the type of cells from which they develop; they also occur with different frequencies and sometimes show variations in their biological behavior. This means, for example, that they grow and spread (metastasize) at different rates and in different ways, or that they respond differently to treatments such as chemotherapy. Soft tissue tumors can be benign, malignant, or moderately malignant. As a rule, malignant soft tissue tumors are called "soft tissue sarcomas" or "tissue sarcomas"; the term "soft tissue tumor" (also "tissue tumor") is neutral and can include tumors of any behavior. The general terms "soft tissue tumors" and "soft tissue sarcomas" encompass at least 150 histologically (microscopically) different types (varieties) of tumors. Most soft tissue sarcomas – that is, malignant soft tissue tumors – are highly malignant and grow and spread rapidly, so that if left untreated, they can lead to death within a few weeks or months. The majority of less common soft tissue tumors are usually of intermediate malignancy, and in some cases, even benign. The growth behavior of these tumors is very variable; they may regress spontaneously or grow very aggressively locally.

Frequency of occurrence

Soft tissue tumors account for approximately 6% of all cancers in children and adolescents. They are therefore among the most common solid tumors in children and adolescents (after tumors of the central nervous system). According to the German Childhood Cancer Database (Mainz), approximately 10 out of every 1,000,000 children and adolescents under the age of 18 in Germany are diagnosed with a soft tissue sarcoma or tumor, corresponding to approximately

125 new cases per year. More than half of these patients have rhabdomyosarcoma, the most common soft tissue sarcoma in children and adolescents.

Soft tissue tumors are most common in children under the age of five or six. The mean age of onset is 8.5 years. They are slightly more common in boys than in girls (sex ratio 1.3:1). However, both the age distribution and the sex ratio for the different soft tissue sarcomas and tumors vary greatly.

The most common soft tissue sarcomas – that is, malignant soft tissue tumors – in children and adolescents under 18 years of age are:

Rhabdomyosarcoma (RMS): 61%

Extraosseous Ewing tumor group: 16%

Synovial Sarcomas (SySa): 7%

Fibrosarcomas (FS): approximately 3%

Leiomyosarcomas (LMS): approximately 2%

Undifferentiated sarcomas (UDS): 2%

All other soft tissue sarcomas are very rare in childhood and adolescence.

Tumor types - In general, there are a large number of soft tissue tumors, including more than 20 different types of soft tissue sarcoma - i.e. malignant soft tissue tumors.

According to the current clinical classification, soft tissue tumors are divided into three main groups:

Rhabdomyosarcomas (RMS) - Non-rhabdomyosarcoma soft tissue sarcomas (abbreviation NRSTS in English, abbreviation NRWTS in German)

Rare soft tissue tumors - The cooperative soft tissue sarcoma working group (CWS) of the Pediatric Oncology and Hematology Society (GPOH) distinguishes another group in the CWS Guidelines (guidelines, last updated 2014) based on the clinical behavior and treatment of certain tumor types: "rhabdomyosarcoma-like (RMS-like) soft tissue sarcomas". Tumors included in this group (synovial sarcomas and undifferentiated sarcomas) are now considered non-rhabdomyosarcoma-like soft tissue sarcomas (NRSTS) throughout Europe and in the CWS study group. According to WHO, extraosseous tumors of the Ewing group (Ewing sarcomas of soft tissues), formerly called "RMS-like", belong to the general group of Ewing sarcomas and are now treated according to the treatment concepts of the Ewing study group.

Localization and distribution - Since soft tissue is found throughout the body, soft tissue tumors can in principle occur anywhere in the body. Tumors usually spread along anatomical structures, such as muscle sheaths, ligaments or blood vessels. Especially in malignant tumors, but also in moderately malignant tumors, individual cells can break away from the primary

tumor and travel via blood vessels or lymph vessels to other parts of the body, where they can settle and multiply again, developing daughter tumors (metastases). In soft tissue sarcomas, metastases occur particularly in the lungs, adjacent lymph nodes and the skeletal system. However, other organs can also be affected.

The site of origin and growth behavior of soft tissue tumors are significantly related to the type of tumor.

For example, rhabdomyosarcomas can in principle develop in almost any organ, but are particularly common in the head and neck region, the urinary and genital organs and the limbs. Fusion-positive alveolar rhabdomyosarcomas (ARMS) are generally more aggressive than embryonal rhabdomyosarcomas (ERMS), meaning they usually grow faster and sometimes spread more rapidly throughout the body via the blood and/or lymphatic pathways. Fusion-positive ARMS also has a higher risk of recurrence than most ERMS.

Ewing group extraosseous (i.e. outside the bone) tumors occur predominantly in the limbs and trunk. Synovial sarcomas are most commonly seen in the limbs near the joints and in the head and neck region. All of these tumor types tend to metastasize rapidly.

Causes - The exact cause of soft tissue tumors has not yet been elucidated. It is thought that they arise from precursor cells of the connective tissue (soft tissue). These cells are called "mesenchymal stem cells" in medical terms. The faulty development (degeneration) is probably triggered by genetic and/or chromosomal changes in these cells.

Various genetic and chromosomal abnormalities have been detected in degenerated cells, but these changes are very diverse, vary depending on the type of soft tissue tumor and are not definitely found in all tumors. In general, several genetic changes are probably involved in the development of a soft tissue tumor. According to current scientific research, there is no real heredity in most patients.

Therefore, it can be observed that rhabdomyosarcomas are common in some families. In families where carcinomas are common, children are more likely to get rhabdomyosarcomas. This indicates that this disease is genetic. These clinical pictures are complex pictures associated with malformations and increased hereditary cancer risk. Examples of cancer predisposing syndromes that may play a role in the development of soft tissue tumors include neurofibromatosis, Beckwith Wiedemann syndrome, Li-Fraumeni syndrome, Gorlin-Goltz syndrome, and Werner syndrome.

Method

Rhabdomyosarcomas are now evaluated not primarily on their histological features but on the presence or absence of genetic features. Therefore, the definition of the genetic features of

tumors is of great importance in assessing the expected probability of cure and in selecting the appropriate treatment.

Result

Freshly frozen tumor tissue is absolutely necessary for molecular analysis. Therefore, it is particularly important that the biopsy (tissue sampling) be performed in a specialist pediatric oncology center that has both the necessary experience and the necessary facilities for tumor processing. The remaining samples are stored in a tumor bank and can be used for scientific purposes to advance the treatment of tumors.

Keywords: Sarcoma, soft tissue, chemotherapy, malignant, histological, cell.

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YENİ NESİL TERAPİLER: BİYOBENZERLER VE BİYOLOJİK İLAÇLARIN ROLÜ

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ÖZET

İlaçlar, biyolojik sistemler üzerinde terapötik etkiler oluşturarak hastalıkların tanı, tedavi ve önlenmesinde kullanılan kimyasal veya biyolojik bileşiklerdir. Etkili bir ilacın, net bir etki mekanizması, yüksek biyoyararlanım, hücre zarını geçebilme ve kimyasal/metabolik stabilite gibi özellikleri taşıması beklenmektedir. Yeni ilaç keşfi ise ortalama 12–15 yıl süren, milyarlarca dolarlık yatırımı gerektiren ve yalnızca çok az sayıda aday molekülün pazara ulaşabildiği karmaşık bir süreçtir. Biyoteknolojik yöntemlerin gelişmesiyle biyolojik ilaçlar ortaya çıkmış ve özellikle kompleks yapılarından dolayı geleneksel küçük moleküllü ilaçlardan ayrılmıştır. Bu ilaçlar, başta kanser ve otoimmün hastalıklar olmak üzere birçok ciddi hastalığın tedavisinde etkin rol oynamaktadır. Ancak yüksek maliyetleri, sağlık sistemlerinde sürdürülebilirliği zorlaştırmakta ve biyobenzer ilaçlara olan ihtiyacı artırmaktadır. Biyobenzer ilaçlar, referans biyolojik ürünle yüksek düzeyde benzerlik gösteren, ancak üretim süreçlerindeki biyolojik değişkenlik nedeniyle birebir aynı olmayan ürünlerdir. Jenerik ilaçlardan farklı olarak, biyobenzerlerin ruhsatlandırılabilmesi için kapsamlı analitik, klinik ve regülasyon süreçlerinin tamamlanması gereklidir. Geliştirme süreci genellikle 7–8 yıl sürmekte ve oldukça yüksek maliyetlidir. Ayrıca klinik güvenlik ve etkinlik açısından, referans biyolojik ilaçlarla aynı benzerliği göstermeleri zorunludur. Bu özellikleri sayesinde, biyobenzer ürünler, hayat kurtarıcı biyolojik ilaçlara daha geniş bir erişim sağlamayı vaat etmektedir. Ancak, bu vaadin gerçekleştirilebilmesi için biyobenzerlerin geliştirilmesinin, ürün güvenliği, net düzenleyici çerçeveler ve sürdürülebilir politikalarla desteklenmesi gerekmektedir. Biyobenzerlerin sağlık sistemine entegrasyonu, tedaviye erişimi artırmakta, maliyetleri düşürmekte ve ilaç endüstrisinde rekabeti teşvik etmektedir. Özellikle patent süresi dolmuş

biyolojik ilaçların yerine geçebilmeleri, uzun vadede ekonomik sürdürülebilirliği destekleyen önemli bir fırsat sunmaktadır.

Anahtar Kelimeler: Biyobenzerler, Biyolojik ilaçlar, İlaç geliştirme, Regülasyon ve Sağlık ekonomisi

THE NEW GENERATION THERAPIES: THE ROLE OF BIOSIMILARS AND BIOLOGICS

ABSTRACT

Drugs are chemical or biological compounds used in the diagnosis, treatment and prevention of diseases by producing therapeutic effects on biological systems. An effective drug is expected to have a certain mechanism of action, high bioavailability, ability to cross the cell membrane and chemical/metabolic stability. New drug discovery is a complex process that takes an average of 12-15 years, requires billions of dollars of investment and only a very small number of candidate molecules reach the market. The development of biotechnological methods has led to the emergence of biological drugs, which are differentiated from traditional small molecule drugs due to their complex structure. These drugs play an effective role in the treatment of many serious diseases, especially cancer and autoimmune diseases. However, their high costs make sustainability difficult in healthcare systems and increase the need for biosimilar drugs. Biosimilar medicines are products that have a high level of similarity with the reference biological product, but are not identical due to biological variability in production processes. Unlike generics, biosimilars require extensive analytical, clinical and regulatory processes to be completed in order to be authorised. The development process usually extends for 7-8 years and is quite costly. In addition, they must be similar to reference biologics in terms of clinical safety and efficacy. With these features, biosimilars promise to provide wider access to life-saving biological medicines. However, to realise this promise, the development of biosimilars needs to be supported by product safety, clear regulatory frameworks and sustainable policies. The integration of biosimilars into the health system increases access to treatment, reduces costs and promotes competition in the pharmaceutical industry. In particular, their ability to replace biologics with expired patents offers an important opportunity to support economic sustainability in the long term.

Keywords: Biosimilars, Biologics, Drug development, Regulation and Health economics

1. INTRODUCTION

Diagnosis or prevention of diseases and produce specific effects on biological systems (Food and Drug Administration [FDA], 2017). These substances are either derived from natural sources or obtained by synthetic methods. The essential characteristics of an effective drug include having a clear mechanism of action, being chemically and metabolically stable, having high bioavailability and being able to cross cell membranes (Young, 2009).

The discovery of new drugs is a long, costly and risky process involving steps such as identification of disease-related targets, development of lead molecules, and the conduct of preclinical and clinical studies. This process takes an average of 12-15 years and requires a budget of approximately 2-3 billion dollars. Only one among thousands of molecules can reach the commercial market (Zarei & Ghasemi, 2024).

With the development of biotechnological methods, especially recombinant DNA technology in the 1980s, biological drugs emerged as a new class of drugs that differ from traditional small molecule drugs (Wolff-Holz et al., 2019). The production of biological drugs takes place through living cell systems and since these drugs have complex macromolecular structures, they require unique regulations in terms of regulatory and quality control processes (Blandizzi et al., 2017).

2. DISCUSSION

Biological Drugs and Biosimilar Concept

Biotechnology has provided important treatment opportunities in various serious diseases such as cancer, diabetes, rheumatoid arthritis, multiple sclerosis and autoimmune diseases (Kathuria & Srivastava, 2021). However, the high costs of biological drugs make sustainability difficult in healthcare systems and increase the need for biosimilar drugs (Kabir et al., 2019). Biological drugs with expired patents offer an opportunity for the development of biosimilar products (Nicol & Owøye, 2013).

Biosimilar medicines are products that are highly similar to the reference biological product and have no clinically significant differences in quality, safety and efficacy (European Medicines Agency [EMA], 2014). The FDA defines biosimilarity as ‘a product that is highly similar to the reference product with minor differences in inactive ingredients and no clinically meaningful differences in safety, purity and efficacy’ (FDA, 2015). The EMA, on the other hand, defines biosimilars as ‘biological products that are not identical due to complex structures but are sufficiently similar to the reference product’ (EMA, 2009).

Generics are often confused with biosimilars, whereas generics are small molecule and chemically identical products. Since biosimilars are produced by living cells, they may show

differences such as glycosylation even if the amino acid sequence is the same (Mascarenhas-Melo et al., 2024). Therefore, comprehensive analytical and clinical evaluations are required to demonstrate the comparability of biosimilars with the reference product (Alsamil et al., 2020; EMA, 2019).

Biosimilar Development Process

The development process of biosimilars is longer and more costly than that of generics. While the development period of generics is 2-4 years, this period is 7-8 years for biosimilars and the cost can be up to 100 times higher (Blackstone & Joseph, 2013). The development process consists of five main stages: (1) target identification, (2) bioengineering processes, (3) comparative analyses, (4) regulatory submission and (5) clinical trials (Kabir et al., 2019).

The FDA requires the submission of pharmacokinetic, pharmacodynamic and immunogenicity data for biosimilarity approval (Cohen et al., 2017). The comparative approach developed in collaboration between the EMA and the FDA is based on a three-stage model, including physical, chemical and biological quality analyses; non-clinical evaluations; and clinical studies (Edwards & Bellinvia, 2020; Li et al., 2020).

Challenges in the Development Process

The development of biosimilars has been faced with numerous barriers, including analytical complexities, difficulties in accessing reference products, high cost, regulatory differences and public perception (Kathuria & Srivastava, 2021; Kang et al., 2021). The World Health Organisation (WHO) survey conducted between 2019 and 2020 revealed that the main challenges related to biosimilars are naming issues, regulatory uncertainties and lack of information (Kang et al., 2021).

It is necessary to demonstrate the 'high similarity' of biosimilars to the reference drug, not their 'equivalence'. This may cause misunderstandings and mistrust among the public (Cordeiro et al., 2024). Furthermore, the advanced technological equipment and multidisciplinary expertise required for biosimilar production further increase costs.

Contributions to the Health System and Economic Impacts

Biosimilar medicines offer significant cost advantages for healthcare systems. They are usually offered to the market at prices 15-30% lower than reference products (Simoens et al., 2017). This increases patient access and reduces the burden on health insurance systems (McCamish & Woollett, 2012).

Analyses in the US show that biosimilars could reduce biologics spending by \$54 billion between 2017 and 2026 (Mulcahy et al., 2018). Total savings across Europe and the US are expected to exceed \$100 billion by 2020 (Mehr & Brook, 2017).

The utilisation of biosimilars increases clinical benefit by enabling earlier treatment initiation in rheumatoid arthritis and inflammatory bowel diseases, particularly with anti-TNF agents (Smolen et al., 2021). Furthermore, biosimilar developers can skip some clinical phases by utilising existing data from reference drugs, which speeds up the process and reduces cost (Blackstone & Joseph, 2013).

3. CONCLUSION

New drug discovery is an indispensable part of modern medicine and is of great importance for public health. However, the high costs of biological drugs limit access to treatment and make economic sustainability difficult. Biosimilars are innovative solutions developed to overcome this problem. The biosimilars enable healthcare systems to reach more patients at a lower cost; they also encourage innovation by increasing competition in the pharmaceutical industry. The role of biosimilars will become even more important in the future as more biological medicines will come off patent. Therefore, proper understanding and integration of the scientific, clinical and legal aspects of biosimilars will make strong contributions to the drug discovery ecosystem.

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OBEZİTEDE NUTRİGENOMİK VE NUTRİGENETİK**Ayşenur GÜNTAÇ**

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Obezite, genetik, çevresel ve epigenetik faktörlerin etkileşimiyle ortaya çıkan karmaşık ve çok faktörlü bir durumdur. Tüm yaş gruplarında artan yaygınlığıyla birlikte obezite, küresel ölçekte büyük bir halk sağlığı sorunu haline gelmiştir. Obezite; kardiyovasküler hastalıklar, tip 2 diyabet, hipertansiyon ve bazı kanser türleri gibi çeşitli kronik hastalıklarla yakından ilişkilidir. Genomik alanındaki son gelişmeler, obezitenin genetik temellerini aydınlatmış ve enerji dengesi, iştah düzenlemesi ve lipid metabolizmasında rol oynayan belirli gen varyantlarının önemini ortaya koymuştur. Özellikle *FTO* (yağ kütlesi ve obezite ile ilişkili gen), *MC4R* (melanokortin 4 reseptörü), *LEP* (leptin), *LEPR* (leptin reseptörü) ve *POMC* (pro-opiomelanokortin) gibi genlerdeki tek nükleotid polimorfizmleri (SNP'ler), obezite riskini anlamlı şekilde etkilemektedir. Örneğin *FTO* rs9939609 varyantı, artmış enerji alımı ve %20–30 oranında daha yüksek obezite riski ile ilişkilidir. *MC4R* rs17782313 ise çocukluk çağı obezitesi ve azalmış enerji harcaması ile ilişkilendirilmiştir. Bu genetik bulgulara paralel olarak, nutrigenetik ve nutrigenomik gibi yeni gelişen alanlar, gen–diyet etkileşimlerini ve bu etkileşimlerin obezite gelişimine etkilerini anlamada umut vadeden yaklaşımlar sunmaktadır. Bu disiplinler, bireysel genetik varyasyonların beslenmeye verilen yanıtları nasıl etkilediğini ve besin bileşenlerinin gen ekspresyonunu nasıl değiştirdiğini araştırır. SNP analizi ve genetik profillemeye aracılığıyla, obezitenin önlenmesi ve yönetimi için kişiselleştirilmiş beslenme müdahaleleri tasarlanabilir. Bu derleme, obezitenin genetik yapısını kapsamlı bir şekilde ele almakta ve obezitenin önlenmesi ve tedavisinde nutrigenetik ve nutrigenomik yaklaşımların potansiyelini incelemektedir.

Anahtar Kelimeler: Obezite; Gen polimorfizmi; *FTO*; *MC4R*; Nutrigenetik; Nutrigenomik; Kişiselleştirilmiş beslenme; SNP analizi; Metabolik düzenleme

NUTRIGENOMICS AND NUTRIGENETICS IN OBESITY

ABSTRACT

Obesity is a complex and multifactorial condition arising from the interplay of genetic, environmental, and epigenetic factors. With its increasing prevalence across all age groups, obesity has become a major global public health challenge. It is closely associated with a range of chronic diseases, including cardiovascular disorders, type 2 diabetes mellitus, hypertension, and certain types of cancer. Recent advances in genomics have shed light on the genetic underpinnings of obesity, highlighting the roles of specific gene variants involved in energy homeostasis, appetite regulation, and lipid metabolism. Notably, single nucleotide polymorphisms (SNPs) in genes such as FTO (fat mass and obesity-associated gene), MC4R (melanocortin 4 receptor), LEP (leptin), LEPR (leptin receptor), and POMC (pro-opiomelanocortin) have been found to significantly influence obesity risk. For example, the FTO rs9939609 variant is associated with increased energy intake and a 20–30% elevated risk of obesity, while MC4R rs17782313 is linked to childhood obesity and decreased energy expenditure. In parallel with these genetic discoveries, the emerging fields of nutrigenetics and nutrigenomics offer promising approaches for understanding gene–diet interactions and their effects on obesity development. These disciplines aim to identify how individual genetic variations affect nutritional responses and how dietary components, in turn, influence gene expression. Through SNP analysis and genetic profiling, personalized dietary interventions can be designed to prevent or manage obesity more effectively. This review aims to provide a comprehensive overview of the genetic architecture of obesity and explores the potential of nutrigenetic and nutrigenomic applications in the development of personalized nutrition strategies for obesity prevention and treatment.

Keywords: Obesity, Gene polymorphism, FTO, MC4R, Nutrigenetics, Nutrigenomics, Personalized nutrition, SNP analysis, Metabolic regulation

1. INTRODUCTION

Obesity is a multifactorial condition characterized by excessive fat accumulation in the body and is recognized as a global public health problem. The World Health Organization (WHO) defines obesity as having a body mass index (BMI) of 30 or higher (World Health Organization, 2020). Systematic analyses conducted in 2010 showed that 3.4 million deaths worldwide were attributed to obesity and overweight (Lim et al., 2012). Moreover, obesity is closely associated with serious health problems such as cardiovascular diseases, type 2 diabetes, hypertension, and certain types of cancer (Lee et al., 2018).

The development of obesity involves a complex interplay of genetic, environmental, psychological, and metabolic factors (Walley et al., 2009). Genetic factors can contribute to obesity and associated comorbidities by affecting energy homeostasis and body weight regulation (Speliotes et al., 2010). Obesity treatment generally involves multifaceted approaches such as diet, exercise, and surgical interventions (Lean, 2006). However, understanding genetic predispositions and considering individual differences are critically important for preventing weight gain and achieving long-term weight loss (Moreno-Aliaga et al., 2005).

In recent years, there has been a growing interest in the interactions between genetic polymorphisms and nutritional strategies (Martinez et al., 2008). In particular, single nucleotide polymorphisms (SNPs) have emerged as important tools for understanding the genetic basis of individuals' metabolic responses to diet (Ferguson, 2006). SNP analyses contribute to identifying optimal diets and reducing disease risk by exploring the relationship between nutrition and human health (El-Sohemy, 2007).

Nutrigenetics and nutrigenomics help elucidate the mechanisms of obesity by examining the interaction of genetic variations with diet and metabolic processes (Ordovas et al., 2009). Nutrigenomics, as a scientific discipline that investigates the relationship between the human genome, diet, nutrition, and health, enables the development of personalized nutrition approaches (Kohlmeier et al., 2016). Advances in genomic sequencing technologies have made it possible to assess individual genetic differences, offering new strategies for the prevention and management of chronic diseases such as obesity (Goni et al., 2016).

This study discusses the genetic background of obesity and the roles of nutrigenetics and nutrigenomics in obesity management.

Nutrigenetics: Interactions Between Genetic Variations and Diet

Nutrigenetics is a scientific discipline that examines the interactions between an individual's genetic makeup and their dietary habits and nutrition (Ordovas et al., 2009). Although the exact origin of this field is not clearly defined, a study conducted in 1945 on Swiss mice is considered one of the earliest scientific investigations documenting the interaction between genes and diet. In this study, the mice were fed a diet containing whole wheat and full-fat milk. Despite consuming the same diet, significant differences were observed in their lifespans; some mice died earlier compared to others. These findings revealed the effects of genetic variations on the interaction with diet (Brennan and Mulligan, 1977).

The fundamental principle of nutrigenetics is that each individual's genetic profile elicits different physiological responses depending on the bioactive components present in foods. This

creates variations among individuals in nutrient absorption and metabolic effects (Bouchard and Ordovas, 2012). This field aims to understand how genetic variations influence the way individuals metabolize, process, and respond to nutrients (Duarte et al., 2024). It particularly investigates the impact of nutrition-related genetic factors on health and enables the development of personalized nutrition strategies based on this knowledge (Berná et al., 2014).

Nutrigenomics: Gene Expression and Diet Interaction

Nutrigenomics is a scientific discipline that examines the effects of diet and food components on gene expression and regulation (German, 2005). This field aims to understand the positive or negative impacts of dietary components on health and to elucidate gene-diet interactions (Miggiano and De Sanctis, 2006).

Nutrigenomics utilizes data from various disciplines such as biochemistry, physiology, nutrition science, genomics, proteomics, metabolomics, transcriptomics, and epigenomics to explain how dietary components regulate gene expression (Sales et al., 2014). An important focus of nutrigenomics research is on single nucleotide polymorphisms (SNPs), which constitute approximately 90% of DNA sequence variations (Mead, 2007). These genetic variations have been shown to influence the risk of developing various chronic diseases (Ferguson, 2006). By investigating how such genetic variations interact with diet, nutrigenomics aims to contribute to the development of nutrition strategies tailored to individuals' genetic profiles (Mutch et al., 2005).

Genetic Basis of Obesity

Single nucleotide polymorphisms (SNPs) are the most common type of genetic variation in the human genome and occur approximately every 500 to 2,000 base pairs (DeBusk et al., 2005). These polymorphisms are generally found in at least 1% of a population and are therefore considered an important source of genetic diversity (Kruglyak and Nickerson, 2001). Various human studies have demonstrated that SNPs in different genes play a critical role in the interaction between diet and metabolic response (El-Sohemy, 2007). Moreover, SNP analysis is used as a valuable molecular tool to understand the effects of nutrition on human health, its association with diseases, and its contribution to determining individual optimal diets (Ardekani and Jabbari, 2009).

The regulation of eating habits is significantly influenced by SNPs in genes encoding taste receptors and various peripheral signaling peptides such as cholecystokinin, insulin, ghrelin, and leptin (Shamim et al., 2017; Moehlecke et al., 2016). Additionally, chronic inflammation is known to play a critical role in the development of obesity (Dalmel et al., 2012). Research has shown that bioactive compounds found in certain foods can exhibit anti-inflammatory

effects (Cruz et al., 2005). For example, molecules such as lycopene (found in tomatoes and watermelon), quercetin (found in fruits and leafy green vegetables), and tyrosol (found in olive oil) have been shown to inhibit the expression of COX2 and iNOS genes, which regulate inflammatory processes, and reduce the translocation of the transcription factor NF- κ B from the cytoplasm to the nucleus (Dalmel et al., 2012). These mechanisms represent promising approaches for the prevention and treatment of obesity by controlling inflammation (Cruz et al., 2005).

The genetic basis of obesity involves the interaction of various genes regulating energy balance. Several genes, including MC4R, BDNF, FTO, and PCKS1, have been reported to be associated with obesity (Pigeyre et al., 2016).

Fat Mass and Obesity-Associated (FTO) Gene

The FTO gene, which encodes the fat mass and obesity-associated protein, is considered one of the genes most strongly linked to obesity (Scuteri et al., 2007). This gene plays a critical role in controlling neuronal circuits that regulate eating behaviors, appetite, and energy homeostasis (Fang et al., 2010). The rs9939609 polymorphism in the FTO gene can increase obesity risk by 20–30% by promoting higher energy intake (Lagoumintzis et al., 2024). Studies have shown that individuals carrying risk alleles of FTO tend to prefer energy-dense foods and experience reduced satiety (Samutri and Paratmanitya, 2023). In a study by Dina et al. (2007), the rs9939609 polymorphism of the FTO gene was found to be strongly associated with obesity. This polymorphism contributes to weight gain by increasing energy intake (Dina et al., 2007). At the molecular level, FTO increases total ghrelin and acyl-ghrelin levels by demethylating the N6-methyladenosine (m6A) group of ghrelin mRNA; this mechanism triggers food intake (Karra et al., 2013). Additionally, FTO expressed in the liver regulates glucose and lipid metabolism through hepatic signaling pathways, thus affecting metabolic balance (Mizuno, 2018).

Melanocortin 4 Receptor (MC4R) Gene

The MC4R gene plays a key role in regulating eating behavior and maintaining energy balance in the body (Apetroaei et al., 2023). The V103I polymorphism (rs2229616) in this gene has been associated with reduced susceptibility to obesity (Bewick et al., 2005). Various studies have shown that the rare I103 allele is linked to lower body mass index (BMI) and reduced predisposition to obesity in different ethnic groups such as Caucasians and East Asians (Ro, 2023). Furthermore, the I103 allele has been reported to have significant associations with several features of metabolic syndrome, including reduced waist circumference and lower glycated hemoglobin (HbA1c) levels (Young et al., 2007). Loos et al. (2008) reported a strong

association between the rs17782313 polymorphism in the MC4R gene and childhood obesity, investigating the effects of this genetic variation on energy intake and body weight. Their results showed that individuals carrying the MC4R rs17782313 polymorphism had significantly higher BMI, with this variation linked to increased appetite and lower energy expenditure (Loos et al., 2008).

Leptin and Leptin Receptor Genes (LEP and LEPR)

The study by Mammès et al. (2000) examined the relationship between the K109R polymorphism in the LEPR gene, leptin sensitivity, and obesity. The study evaluated the potential effects of this polymorphism on leptin receptor function. Results showed leptin resistance in individuals carrying the K109R polymorphism. Additionally, this genetic variation was associated with decreased energy expenditure and weight gain (Mammès et al., 2000). Furthermore, hypocaloric diet plus exercise induced genotype-specific effects on the LEPR gene, where the AA genotype (Lys656Lys) exhibited greater fat mass loss compared to minor allele carriers (de Luis et al., 2008). Additionally, the A-2549 allele of the LEP gene was associated with lower BMI and leptinemia in women following a hypocaloric diet (Mammès et al., 1998).

Proopiomelanocortin (POMC)

POMC is the precursor protein for various hormones and neuropeptides secreted by hypothalamic neurons in response to leptin and insulin signals (Şahin et al., 2023). Deficiency of the POMC protein leads to impaired production of its proteolytic products, adrenocorticotrophic hormone (ACTH) and α -melanocyte-stimulating hormone (α -MSH) (Shakya et al., 2021). Rare mutations in the POMC gene may cause ACTH deficiency and hypocortisolism. Due to the dual effects of α -MSH on appetite regulation and pigmentation, its deficiency results in individuals having red hair and morbid obesity (Hilado and Randhawa, 2018). Genome-wide association studies (GWAS) conducted on Mexican-Americans, African-Americans, and French Caucasians have shown that DNA regions including the POMC locus are associated with serum leptin levels and fat mass (Baxter et al., 2019).

2. DISCUSSION AND CONCLUSION

This study examined the effects of obesity-related genetic variations on energy balance, metabolic processes, and diet interactions, evaluating their contributions to personalized nutrition strategies from nutrigenetic and nutrigenomic perspectives (Ordovas et al., 2009; Bouchard and Ordovas, 2012). The findings support the significant roles of genes such as FTO, MC4R, LEP, LEPR, and POMC in the development of obesity (Lagoumintzis et al., 2024; Dina et al., 2007). For example, the FTO rs9939609 polymorphism's association with increased

energy intake and elevated obesity risk aligns with previous literature (Samutri and Paratmanitya, 2023; Dina et al., 2007). Similarly, the link between the MC4R rs17782313 polymorphism and childhood obesity, as well as reduced energy expenditure, emphasizes the critical impact of genetic variations on energy balance (Loos et al., 2008).

Moreover, this study revealed the effect of the K109R polymorphism in the leptin receptor gene on leptin sensitivity, providing evidence that this genetic variation reduces energy expenditure (Mammès et al., 2000). Findings linking the POMC locus to serum leptin levels and fat mass are consistent with genome-wide studies (Baxter et al., 2019). These results underscore the importance of considering gene-diet interactions in obesity management (Celis-Morales et al., 2017; Cha et al., 2018; Ferguson, 2006; Pigeire et al., 2016). In conclusion, this study demonstrates that genetic variations can play a critical role in personalized nutrition strategies and that this approach may yield more effective outcomes in obesity interventions. Future research may more comprehensively explore the interactions between genetic variations and environmental factors, revealing how genetic information can be utilized more effectively in the management of multifactorial diseases such as obesity.

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USABILITY OF AEROGEL AND BORON WASTES IN BUILDING MATERIAL PRODUCTION: A COMPILATION

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ABSTRACT

The indispensable part of the structures built to meet the sheltering needs is the building material. All materials used during the formation of the structure are defined as building materials. While concrete used in building construction is defined as a building material, nails are also defined as building materials. In building production, the main building materials are concrete, cement, plaster and brick. Over time, the current status of these building materials has not been sufficient to meet the needs. For this reason, the structure of the building material has been improved with both new materials and waste. As a result of this improvement, new additive materials with superior properties were obtained. In this study, the use of nanomaterial aerogel and industrial waste boron waste in the production of building materials was investigated. Within the scope of this research, national and international literature has been examined in detail. The academic studies examined have been summarized. Studies in the literature have been classified as the use of aerogel and boron waste in concrete, cement, plaster and mortar, brick and other building materials. As a result of the study, it was observed that both additives reduced the compressive strength and heat transfer coefficient of the building materials. It has been observed that the porosity rate of the material has increased and accordingly the water absorption rates have also increased. It has been determined that aerogel causes impermeable pore formation. It has been understood that it improves thermal comfort conditions and minimizes mold formation. In addition, it has been observed that boron waste and aerogel additive can be used in the production of building materials in appropriate proportions. In case of use, it has been determined that the properties of the building material are improved.

Keywords: Aerogel, boron waste, concrete, brick, cement

AEROJEL VE BOR ATIKLARININ YAPI MALZEMESİ ÜRETİMİNDE KULLANILABİLİRLİĞİ: BİR DERLEME

ÖZET

Barınma ihtiyacının karşılanması için inşa edilen yapıların vazgeçilmezi yapı malzemesidir. Yapı oluşumu sırasında kullanılan tüm malzemeler yapı malzemesi olarak tanımlanmaktadır. Yapı inşasında kullanılan beton yapı malzemesi olarak tanımlanırken, çivi de yapı malzemesi olarak tanımlanmaktadır. Yapı üretiminde ana yapı malzeme olarak beton, çimento, sıva ve tuğla gösterilebilmektedir. Zaman içerisinde bu yapı malzemelerinin mevcut durumları ihtiyaçları karşılamaya yetmemiştir. Bu nedenle yapı malzemesi bünyesi gerek yeni malzemelerle gerekse atıklarla iyileştirilmiştir. Bu iyileştirme sonucunda üstün özellikli yeni katkılı malzemeler elde edilmiştir. Bu çalışmada, nanomalzeme olan aerogel ve endüstriyel atık olan bor atıklarının yapı malzemesi üretiminde kullanılması araştırılmıştır. Bu araştırma kapsamında ulusal ve uluslararası literatür detaylı bir şekilde incelenmiştir. İncelenen akademik çalışmalar özet haline getirilmiştir. Literatürde yapılan çalışmalar, aerogel ve bor atığının beton, çimento, sıva ve harç, tuğla ve diğer yapı malzemelerinde kullanımı şeklinde sınıflandırılmıştır. Çalışma sonucunda, her iki katkının da, yapı malzemelerinin basınç dayanımını ve ısı iletim katsayısını azalttığı görülmüştür. Malzemenin porozite oranını arttırdığını ve bununla bağlı olarak su emme oranlarının da arttırdığı görülmüştür. Aerojelin geçirimsiz gözenek oluşumuna neden olduğu tespit edilmiştir. Termal konfor şartlarını iyileştirdiği ve küf oluşumunu minimize ettiği anlaşılmıştır. Ayrıca, bor atığı ve aerogel katkısının uygun oranlarda yapı malzemesi üretiminde kullanılabileceği görülmüştür. Kullanılması durumunda da, yapı malzemesi özelliklerini iyileştirdiği tespit edilmiştir.

Anahtar Kelimeler: Aerogel, bor atığı, beton, tuğla, çimento

1. INTRODUCTION

It is possible to define building materials as all materials used in the formation of a structure. Materials such as concrete, cement, brick are building materials that lead the formation of the structure. Therefore, the development of these materials is very important. It is possible to improve building materials with different additives. This improvement is sometimes done with industrial wastes (Gaikwad and Sathe, 2025; Mahvash et al., 2025), sometimes with organic wastes (Rihan and Alahmari, 2025; Khankhaje et al., 2025) and sometimes with nanotechnological materials (Xiong et al., 2025; Qu et al., 2025).

In this study, examined one of the additives is boron waste. Türkiye has 955,297 thousand tons of B_2O_3 reserves, which is 72.1% of the world. Colemanite ($Ca_2B_6O_{11} \cdot 5H_2O$), ulexite

($\text{NaCaB}_5\text{O}_9 \cdot 8\text{H}_2\text{O}$), borax (tincal) ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$) and boric acid are the most important boron minerals used in the production of different types of borates. During these production processes, wastes containing boron are formed. These wastes pollute the environment. In order to minimize the pollution caused by these wastes, boron wastes are evaluated in different types of processes such as cement, concrete and brick production (Aldakshe et al., 2020).

Another material is aerogel. Aerogel, a nanotechnological material, is actively used in the construction field (Alan et al., 2021; Bostancı, 2021). The biggest reason for preference is that it improves thermal properties to an excellent level.

This study aims to investigate the usability of aerogel and boron waste in the production of building materials. In this context, national and international literature was scanned and a detailed examination was made.

2. AEROGEL AND BORON WASTES

2.1. Aerogel

Aerogels are solid materials in which the liquid in the pores has been replaced with air. It is quite light, has a porous structure and contains air instead of liquid in its pores (Bheekhun et al., 2013). Aerogels are highly porous and lightweight materials as they contain 99% air (Figure 1). The pore sizes are billionths of a millimeter. These pores surround the inside of the material like a network and provide them with properties such as low thermal conductivity coefficient and low dielectric constant. Their insulation capabilities are high and they are 40 times superior to fiberglass insulation materials and are very durable materials (Radha, 2008; Öz et al., 2018).

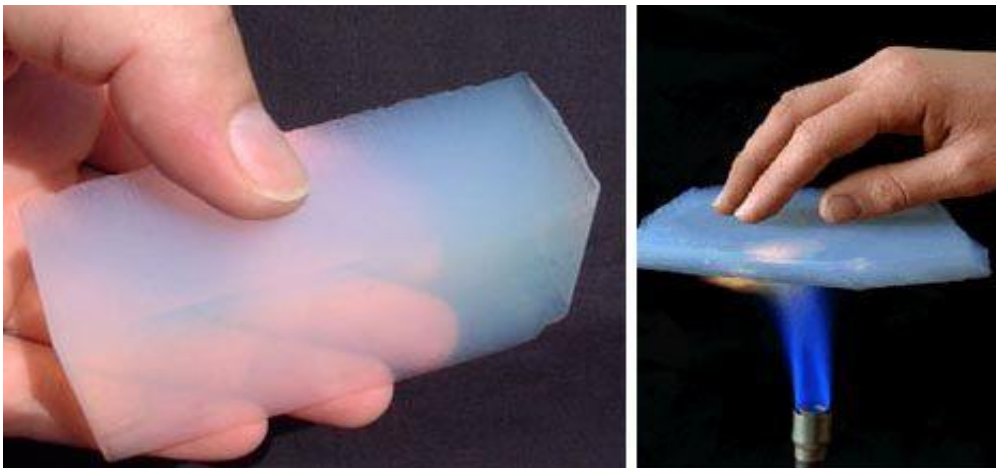


Figure 1. Aerogel (Web message 1)

Due to their properties such as high porous structure, low density and large surface area, aerogels can be used in fields such as chemistry, construction, aviation, electricity, space and biology. However, despite all these advantageous properties, aerogels have not found

widespread use today due to problems such as their fragility, difficulty in producing them on a large scale for industry, and high cost (Aegerter et al., 2011).

Aerogels are divided into 5 groups: alumina aerogels, silica aerogels, alumina-silica aerogels, carbon aerogels and other aerogels (Kılınç, 2024).

The aerogels whose properties are given in Table 1 have poor mechanical properties. This makes the aerogel samples brittle, soft and fragile. These shortcomings limit the development and application areas of aerogels. Nowadays, some fibers and hard materials are added to aerogels to improve the mechanical properties of silica aerogels (Huang et al., 2012).

Table 1. Properties of silica aerogels (Doğdu, 2022)

Feature	Value
Density	0.003 g/cm ³
Surface Area	500-1000 m ² /g
Porosity	%80-99.8
Pore Diameter	20-150 nm
Particle Diameter	2-5 nm
Thermal Conductivity	0.017-0.021 W/mK
Coefficient of Thermal Expansion	2.0-4.0*10 ⁻⁶
Speed of Sound	100 m/s
Dielectric Constant	1.1
Refractive Index	1-1.05

2.2. Boron/Boron Waste

Boron is located in Group IIIA in the periodic table and is shown with the symbol B. Boron, with its atomic number of 5 and atomic weight of 10.81 (Altun, 2005), is the only non-metal element (Çağlar, 2016). Boron element is not found free in nature (Güyağüler, 2001). Although there are more than 250 types of boron minerals on earth, only a few of these minerals have commercial importance (Coşar, 2006). The physical properties of boron element are presented in Table 2.

Table 2. Physical properties of Boron (Ata, 2009)

Feature	Value
Atomic Weight	10.801+0.003
Melting Point	2190+20 0C
Boiling point	3660 0C
Thermal Expansion Coefficient (25-105 0C, for 1 0C)	5x10 ⁻⁶ -7x10 ⁻⁶
Knoop Hardness	2100-2580 HK
Mohs hardness (Diamond-15)	11
Vickers Hardness	5000 HV

The economic value of boron minerals is determined by the B_2O_3 ratio in their structure (Dırak, 2011). The boron minerals with economic value are presented in Table 3. The most important minerals with commercial importance are tincal and colemanite (DPT, 2001).

Table 3. Commercially important boron minerals

Structure	Mineral Name	Chemical Formula	% B_2O_3 Ratio	Location
Sodium Borate	Tincal	$Na_2B_4O_7 \cdot 10H_2O$	36.5	Kırka, Emet, Bigadiç, ABD.
	Kernit	$Na_2B_4O_7 \cdot 4H_2O$	51.0	Kırka, ABD, Arjantin
Calcium Borate	Colemanite	$Ca_4B_6O_{11} \cdot 5H_2O$	50.8	Emet, Bigadiç, ABD
	Pandermite	$Ca_4B_{10}O_{19} \cdot 7H_2O$	49.8	Sultançayır, Bigadiç
Sodium-Calcium Borate	Ulexite	$NaCaB_5O_9 \cdot 8H_2O$	43.0	Bigadiç, Kırka, Emet, Arjantin
	Probertit	$NaCaB_5O_9 \cdot 5H_2O$	49.6	Kestelek, Emet, ABD
Magnesium-Calcium Borate	Hydroboracite	$CaMgB_6O_{11} \cdot 6H_2O$	50.5	Emet

Boron waste is sodium borate-based boron minerals. These wastes, shown in Figure 2, are collected in waste ponds within the facilities in the form of mud (slurry) by adding water. The part called Tinkal Solid Waste is taken from the pond and subjected to ore enrichment processes. These wastes, which contain approximately 25% B_2O_3 , contain valuable clay minerals such as illite, montmorillonite and vermicullite (Sarıağaç, 2012).



Figure 2. Boron waste (Web message 2)

Boron waste contains compounds such as quartz (SiO_2), iron oxide (Fe_2O_3) and alumina (Al_2O_3), which are important for binding. In addition, it is found in potassium oxide (K_2O) and calcium oxide (CaO). Table 4 shows the chemical properties of boron waste taken from Eskişehir Kırka Borax Facilities.

Table 4. Chemical properties of boron waste (Akyıldız, 2012)

Component	B_2O_3	CaO	MgO	SiO_2	Na_2O	Al_2O_3	Fe_2O_3	K_2O	LOI
Boron waste, %	25	10.38	13.94	12.98	5.67	0.96	0.20	0.72	29.15

3. ACADEMIC STUDIES ON THE USABILITY OF AEROGEL AND BORON WASTES IN BUILDING MATERIAL PRODUCTION

Aerogel and tincal wastes are actively used in the production of building materials. In this study, academic studies on the use of aerogel and tincal wastes in concrete, cement, plaster and mortar, brick and other building materials are presented.

3.1 Use of Aerogel and Boron Waste in Concrete Production

In their study, *Li et al., (2024)* investigated the effect pattern of hydrophobic silica aerogel on aerogel foam concrete (AFC). The study results revealed that the density, compressive strength and thermal conductivity of AFCs were affected by the antifoam effect of SA. At the same time, the thermal conductivity of AFCs decreased to the range of 59.0–83.5 mW/m/K due to both the SA content and the antifoaming effect.

In their study, *Wang et al., (2019)* prepared aerogel-infused concrete (AIC) with different aerogel volume additives. The porosity and pore distribution characteristics of AICs were obtained using scanning electron microscopy and microparticle mercury porosimetry. They experimentally investigated the changes in thermal conductivity in the dry state depending on temperature (20-90 °C) and the effect of humidity (35 °C, 0-100% RH) on the thermal conductivity of AICs. Their results show that the thermal conductivity of AIC varies according to a quadratic function depending on the aerogel content. They reported that the highest decrease in thermal conductivity (79.3%) occurred with the increase in aerogel content, and the highest increase was 15.5%.

In his thesis, *Çimen (2023)* synthesized silica aerogel (SA) with Bayburt Stone (BT) waste. It has investigated the effects of substituting SA in lightweight concrete at certain rates on properties such as heat and sound insulation, strength and porosity. Physical (unit weight, porosity, water absorption, thermal conductivity and ultrasound transmission speed) and mechanical (compressive strength) tests were applied to the samples. As a result of the study,

it was determined that thermal insulation would be optimum with (3%, 350% and 0.40%) levels. It was reported that (3%) SA replacement improved (46%) thermal conductivity value, increased porosity (31.48%) and caused a decrease in compressive strength (9.72 MPa). He found that SA is hydrophobic and has good adsorption properties and that a porous structure is formed around SA in concrete. He reported that the polycrystalline structure in concrete increases with the increase in SA concentration. He detected that this increase causes a decrease in the mechanical strength of the material.

In their studies, *Aldakshe et al., (2020)* produced lightweight concrete by using pumice and boron waste as substitution materials at different rates (1%, 3%, 5%, 7% and 9%). As a result, they found that the physical and mechanical properties of the material improved with the increase in boron waste. They achieved the best result with 9% boron waste substitution. They stated that the recycling of environmentally harmful boron waste used in the construction sector will contribute to sustainability.

In their study, *Öztürk et al., (2020)* investigated the mechanical properties, electromagnetic (EM) and shielding effectiveness of concrete samples containing boron products and wastes. They also investigated the effects of additives on the strength behavior of concretes. They stated that the addition of minerals would not reduce the strength parameters, in addition to improving the screening behavior. As a result; concretes containing boron products and wastes reported to provide 3.16 to 100 times better screening effectiveness than the control sample, which was a concrete containing only Portland cement. Additionally, they found that additives in concretes increased the shielding effectiveness without adversely affecting the strength parameters.

In their study, *Yentimur et al., (2022)*, investigated the usability of construction demolition waste (WW) to be generated within the scope of urban transformation by recycling it in concrete. They done experiments using 100% IYA, 100% normal aggregate (NA) and 50% IYA–50% NA. They produced cube samples by adding 2%, 5% boron and 2%, 5% boron waste to the 50% IYA–50% NA sample and measured the compressive strengths of the samples. As a result of the study, the 28-day average compressive strength was;

- ✓ 42.1 MPa for 50% IYA–50% NA sample,
- ✓ 36.2 MPa for 2% boron waste sample,
- ✓ 26.7 MPa for 5% boron waste sample,
- ✓ 35.1 MPa for 2% boron added sample,
- ✓ For the 5% boron added sample, it was determined to be 30.7 MPa.

3.2. Use of Aerogel and Boron Wastes in Cement Production

Kim et al., (2013) investigated the possibility of application of aerogels as insulation building materials and their thermal performance. In the study, aerogels were mixed with cement paste. They reported that the thermal conductivity of aerogel cement was 0.135 W/mK, and the thermal conductivity of cement without aerogel was 0.533 W/mK.

Khamidi et al., (2014) investigated the effect of silica aerogel on the thermal conductivity of cement paste for the construction of concrete buildings in sustainable cities. They prepared samples consisting of ordinary Portland Cement (OPC), free water and different volumes of silica aerogel. They cured for 3, 7 and 28 days. After curing, they applied compressive strength test. At the end of the study, the lowest thermal conductivity of 0.076 W/mK was obtained with the sample mixture containing 20 ml of silica aerogel. They reported that the highest permeable porosity measured for the cement paste containing silica aerogel was 25.6%.

In their study, *Kunt et al., (2015)* added calcined and non-calcined borogypsum to clinker and investigated their effects on cement mortar. They used borogypsum at a rate of 1% to 7% to see the effect of borogypsum on cement properties. They applied setting time and consistency analysis to fresh mortar. They performed X-ray diffraction (XRD) analysis for characterization of chemical structure of 28-day mortars. Optimum results were obtained with 3% substitution for both calcined and non-calcined borogypsum.

In their study, *Korkmaz et al., (2022)*, calculated some radiological parameters of three types of cement at 10–3-105 MeV gamma ray energies. They made the calculations using Phy-X/PSD software. They reported that boron is an ideal material for neutron shielding by simulation, but it is not recommended for gamma ray shielding.

In their study, *Demirel and Nasıroğlu, (2017)* investigated the use of boron ore, minerals and wastes in cement in their study. They examined national and international literature in order to reveal the potential use areas of boron cement. Within the scope of the study, they emphasized the effects of boron minerals and wastes such as colemanite, boric acid, borax, tincal, belite on the setting time of cement, the compressive strength of concrete and the insulation industry.

3.3. Use of Aerogel and Boron Wastes in Plaster and Mortar Production

Stahl et al., (2017) conducted a study on the renovation of historical buildings without compromising their cultural and historical heritage. In the study, they produced a highly insulating plaster based on silica aerogel. They applied plaster to a historical structure. As a result of the study, they stated that the thermal conductivity value of the building walls decreased by one third compared to the initial value with the application of 5-6 cm thick plaster.

Moreover, the risk of mould has been significantly reduced and thermal comfort has been significantly increased.

Abbas et al., (2019) conducted research on the production of lightweight, thermally insulating cement-based mortar. In their study, they produced mortar by partially replacing sand with various proportions of silica aerogel. In order to evaluate the effect of silica aerogel on the mechanical and thermal properties of cement-based mortars, they produced cement-based mortar by replacing sand with silica aerogel at 25%, 50%, 75% and 100% by volume. As a result of their study, they reported that the thermal conductivity of the plaster produced with 25% silica aerogel decreased by 35%. They determined that the thermal conductivity of the mortar produced with 100% silica aerogel by volume was 0.33 W/mK.

In their study, **Can et al., (2024)**, produced silica aerogel from volcanic tuff waste. They produced plaster using silica aerogel powder at different volume ratios (25%, 50% and 75%). They determined the structural and morphological properties of silica aerogel powder with XRD, SEM and BET analyses. At the end of the study, they stated that silica aerogel with the desired properties could be successfully synthesized from volcanic tuff waste. They determined that the BET surface area of the synthesized silica aerogel was 663.0 m²/g and the total pore volume was 0.91 cm³/g.

Batar and Köksal (2009) produced plaster material using different proportions of perlite, waste paper, borax and borax waste. They performed heat permeability and pressure tests on the samples. They compared the obtained results with the existing plaster materials actively used in the market. As a result; they revealed that the strength and heat permeability resistance of the substituted products increased compared to the existing plaster material.

In their study, **Sevim et al., (2019)** investigated the usability of borogypsum as a mineral additive in mortars. They replaced borogypsum with cement at 0%, 3%, 5%, 10% and 15% by mass. They applied flow table, bending and compressive strength, abrasion, carbonation, absorbency and shrinkage tests to mortar samples containing borogypsum. As a result of the study;

- ✓ The compressive and tensile strengths of mortars increased when borogypsum was replaced with cement at 3% and 5%,
- ✓ Mortars containing 10% borogypsum reached high compressive strength,
- ✓ In later ages, these changes caused a decrease in the depth of abrasion and carbonation of the mortars,
- ✓ Increasing borogypsum reduced the consistency of the mortars,

- ✓ They found that the addition of borogypsum reduced the shrinkage of the mortars examined up to the 28th day.

3.4. Use of Aerogel and Boron Waste in Brick Production

In her study, *Çağlar (2023)*, examined the effect of silica aerogel produced from boron waste on the compressive strength and thermal performance of the brick. She carried out her work in three stages. In the first stage, silica aerogel was produced using boron waste supplied from the Eskişehir/Kırka region of Türkiye. In the second stage, the silica aerogel produced was substituted into the brick structure at different ratios by volume (0% (REF), 15% (AB1), 25% (AB2), 35% (AB3), 45% (AB4)). They produced mixed brick samples by firing the samples at 900 °C and 1000 °C. In the third and final stage, She applied to the produced samples to compressive strength and heat transfer coefficient determination tests. Additionally, SEM images were taken to examine the internal structure of the samples. In conclusion;

- ✓ At both temperatures, with the increase of amount of aerogel resulted to decrease in the compressive strength and heat transfer coefficient value,
- ✓ In SEM images, it is seen that as the amount of silica aerogel increases, the amorphous structure increases and voids and cracks form in some places,
- ✓ It has been reported that the use of silica-containing wastes such as boron waste in aerogel production is a suitable solution for the disposal of wastes.

In their study, *Aldakshe and Apay (2024)* investigated academic studies on the use of aerogel in brick production. As a result of the study, they stated that aerogel improves some properties of the brick while negatively affecting others. They reported that aerogel can be used in the re-functionalization of heritage structures. They concluded that sustainable and excellent thermal bricks can be produced with the use of aerogel.

In her study, *Çağlar, (2024)*, examined the effect of granulated aerogel on the properties of lightweight blend bricks. Granulated aerogel was substituted into blend bricks by volume at the rates of 0%, 2.5%, 5%, 7.5% and 10%. Acidic pumice was used at the rate of 50% for the production of lightweight blend bricks. She fired the samples at 900 °C and 1000 °C. He determined the thermal conductivity, unit weight and compressive strength values of blend bricks with granulated aerogel additive. As a result of the study, the thermal insulation properties were improved and blend brick samples with compressive strength in accordance with the standards were produced.

In his study, *Çelik (2010)* produced light brick samples with perlite, boron and clay additives. He applied physical, chemical and mechanical tests to the light brick samples, which produced

in different sizes. As a result of the study, it was revealed that the produced bricks with additives could be used in the construction sector in terms of their technological properties.

Çimen et al., (2020) aimed to improve the properties of brick building materials by using perlite and boron waste. In the study, they kept the perlite material constant at 5%. They produced bricks by substituting boron waste into clay at rates of 5%, 10%, 15% and 20%. They fired the produced samples at 900 °C. As a result of the study; they determined that perlite and boron waste additives can be used in brick production at appropriate rates. They reported that the use of perlite and boron waste does not have any problems on the brick properties. They also stated that the use of boron waste in brick production has a positive effect.

3.5. Use of Aerogel and Boron Waste in Other Building Material Production

In their review article, **Jia et al., (2018)** discussed the latest technology in aerogel-based cementitious insulation materials. As a result of the study, they reported that the stability of aerogel in cement-based insulation materials, interface transition zone, alkali-silica reaction and property optimization are important parameters. They also stated that some unresolved issues highlighted in previous studies should be addressed and studies should be conducted to further promote industrial applications of aerogels in cement-based insulation materials.

Lu et al., (2020) prepared lightweight aerogel/cement composites (ACCs) by insert a nanosilica reinforced cement paste of a silane coupling agent modified aerogel slurry. They investigated the effect of modification on the pore structure and hardened performance of ACCs. As a result of the study, they reported that nanosilica can strengthen the matrix, surface modification of aerogel will result in better compatibility and facilitate the preparation of ACCs with synergistic mechanical properties and thermal insulation properties. They also stated that when the cement paste was replaced by the modified aerogel slurry at 66% volume, an ACC with a thermal conductivity of 0.067 W/mK, a compressive strength of 1.2 MPa, and a density of 390 kg/m³ could be produced.

Lee et al., (2018) investigated the improvement in thermal insulation properties of protein-based silica aerogel composites produced by a new, cheap and applicable method. They concluded that the resulting material exhibited polymeric foam behavior, including high compressibility, superhydrophobic properties, and excellent recovery in addition to low thermal conductivity.

Christogerou et al. (2009) created ceramic dough by adding 0%, 5% and 15% boron waste to the clay used for ceramic production. They fired this dough at different temperatures such as 800 °C, 850 °C, 900 °C, 950 °C. According to the results of the tests they applied on the samples,

they determined that the most suitable results for ceramics could be obtained by firing 5% boron waste at 900 °C.

In his study, *Erdoğan (2016)* produced insulation material by mixing carpet waste with raw colemanite waste and colemanite pond waste added solution. After determining the necessary mixing ratios for mass production, he investigated the physical properties of the product with experiments. He compared the physical properties of the samples he produced with the products on the market. As a result, they have produced an insulation material with high heat and sound insulation properties that can be used in buildings without any problems.

4. RESULTS

In this study, the usability of aerogel and boron wastes in the production of building materials was investigated. The results obtained from the literature research are presented below.

With the use of aerogel in the production of building materials;

- ✓ By using aerogel in concrete building materials, the thermal properties of the concrete are improved,
- ✓ It was observed that porosity and water absorption rate increased and compressive strength decreased.
- ✓ It has been observed that with the use of cement in construction materials, permeable porosity increases, density decreases, and it has an effect on setting time and consistency.
- ✓ When used as plaster in historical buildings, thermal properties are improved,
- ✓ It has been understood that mold formation is minimized, thermal comfort conditions are improved and compressive strength is increased.
- ✓ When used in brick production, it has been observed that the compressive strength and heat transfer coefficient decrease, and voids and cracks form in the microstructure.
- ✓ It was concluded that it can be used in sustainable brick production.
- ✓ It was concluded that both aerogel and boron waste can be easily used in the production of thermal insulation materials, lightweight building blocks and cement-based composite materials.

With the use of boron waste in the production of building materials;

- ✓ It has been understood that the use of aerogel in concrete building material provides shielding effectiveness, and that with the increase in the amount of boron waste, the compressive strength decreases, and the porosity and water absorption rate increase.

- ✓ It has been determined that cement improves thermal performance and is an ideal material for neutron shielding.
- ✓ By using it in plaster production, It has been observed that plaster strength and heat permeability resistance increase compared to the existing plaster material.
- ✓ In the production of mortar material, when borogypsum is replaced with cement at the rates of 3% and 5%, the compressive and tensile strengths of the mortars increase,
- ✓ Mortars containing 10% borogypsum reached high compressive strength, causing a decrease in the depth of abrasion and carbonation of the mortars,
- ✓ It has been understood that increasing borogypsum reduces the consistency of mortars.
- ✓ It has been observed that boron waste additive can be used in brick production in appropriate proportions and does not have any adverse effects on brick properties.
- ✓ It has been determined that there is no harm in using boron waste in the production of ceramic paste and insulation material.

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ACADEMIC PERSPECTIVE ON THE USE OF RAW PERLITE AND AEROGEL IN LIGHTWEIGHT CONCRETE

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ABSTRACT

Concrete is one of the indispensable building materials in the construction sector. Being economical, fire-resistant and easy to shape make it attractive. Concrete is classified according to its usage purposes. In this classification, one of the concrete types defined as special concrete is lightweight concrete. Lightweight concrete is a type of concrete that is frequently preferred among special concrete types. It is a very good alternative especially for those who want to use concrete with low unit weight and superior thermal properties. With the developing technology, lightweight concrete properties have begun to be improved. This improvement is sometimes done with waste materials and sometimes with nanotechnological materials. In addition, the use of natural lightweight aggregates in lightweight concrete production is an important step for improvement. This study aims to examine academic studies on the use of perlite and aerogel in lightweight concrete production. For this purpose, numerous national and international academic studies published have been examined. These studies examined are presented in summary form. As a result of the study, it was determined that the compressive strength and unit weights of lightweight concretes produced with perlite and aerogel decreased. It was observed that the porosity rates of the lightweight concrete samples with additives increased. In parallel, it was determined that the water absorption rate increased. In addition, it was understood that the thermal properties were improved and it exhibited better behavior under seismic loads.

Keywords: Perlite, aerogel, concrete, lightweight concrete

HAFİF BETONDA HAM PERLİT VE AEROJEL KULLANIMINA AKADEMİK BAKIŞ

ÖZET

Beton, inşaat sektörünün vazgeçilmez yapı malzemelerinden biridir. Ekonomik olması, yangına karşı dirençli olması ve kolay şekil verilebilmesi onu cazip hale getirmektedir. Beton kullanım amaçlarına göre sınıflandırılmaktadır. Bu sınıflandırmada özel beton olarak tanımlanan beton çeşitlerinden biri de hafif betondur. Hafif beton, özel beton çeşitleri arasında sıklıkla tercih edilen bir beton çeşididir. Özellikle birim ağırlığı düşük termal özelliği üstün beton kullanmak isteyenler için çok iyi bir alternatiftir. Gelişen teknoloji ile birlikte hafif beton özellikleri geliştirilmeye başlanmıştır. Bu iyileştirme bazen atık malzemelerle bazen de nanoteknolojik malzemelerle yapılmaktadır. Bunun yanı sıra, hafif beton üretiminde doğal hafif agreganın kullanımı iyileştirmenin önemli bir adımı olmaktadır. Bu çalışmada, hafif beton üretiminde perlit ve arojel kullanımı üzerine yapılan akademik çalışmaların irdelenmesi amaçlanmıştır. Bu amaç doğrultusunda yayımlanmış olan çok sayıda ulusal ve uluslararası akademik çalışma incelenmiştir. İncelenen bu çalışmalar özet şeklinde sunulmuştur. Çalışma sonucunda, perlit ve arojel ile üretilmiş hafif betonların basınç dayanımı ve birim ağırlıklarının azaldığı tespit edilmiştir. Katkılı hafif beton numunelerinin porozite oranlarının arttığı görülmüştür. Buna paralel olarak su emme oranının da arttığı tespit edilmiştir. Bunun yanı sıra termal özelliklerin iyileştiği ve sismik yükler altında daha iyi davranışlar sergilediği anlaşılmıştır.

Anahtar Kelimeler: Perlit, arojel, beton, hafif beton

1.INTRODUCTION

The continuous development of the construction industry forces concrete to change (Jiang et al., 2022). With the help of developing technology, the production of special concretes has accelerated in order to meet the needs and expectations in the construction sector (Yazıcıoğlu and Bozkurt, 2006). Lightweight and high-strength concrete is becoming increasingly important (Jiang et al., 2022). It is possible to give these properties to concrete by adding different building materials to the mixture, other than the traditional components of concrete (Gökçe et al., 2010). Lightweight concretes are classified according to their usage areas and properties (Topçu et al., 2023). While concretes with very low unit weight are called insulating concretes, concretes with a unit weight approaching 2000 kg/m³ are called carrier lightweight concretes (Topçu and Uygunoğlu, 2021).

Lightweight concretes are produced using different lightweight aggregates. Sifan et al., (2021) reported in their study that natural and artificial aggregates were mostly preferred (Figure 1).

In addition, they stated that palm oil clinker and slag are also used as aggregate in the production of lightweight concrete.

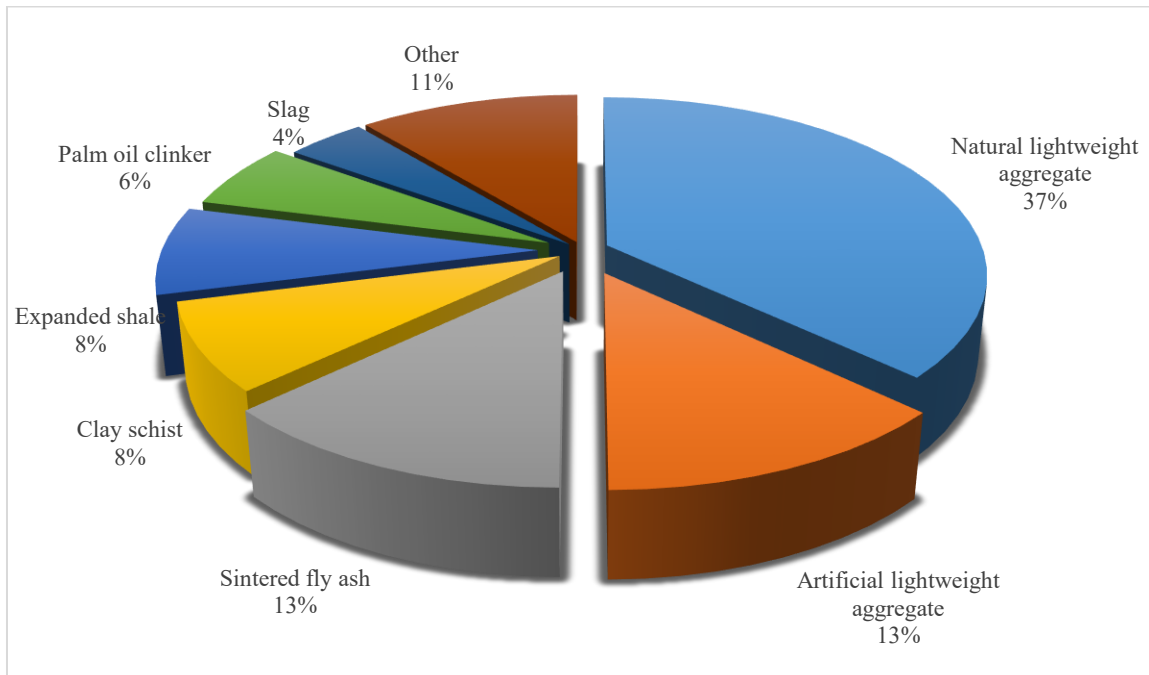


Figure 1. Aggregate ratios used in lightweight concrete production

One of the natural aggregates used in lightweight concrete production is perlite. Perlite is a naturally occurring silica-based volcanic rock. Raw perlite aggregate is obtained by breaking these rocks at certain intervals (Ulus, 2007). It is thought that the effective use of perlite as concrete aggregate in the construction industry will contribute positively to the country's economy and global warming due to its thermal insulation properties and lightness. Thanks to the properties of perlite, in terms of thermal properties, the produced concretes provide better performance than normal concretes and provide energy efficiency (Gökçe et al., 2010). Perlite is frequently used in the production of lightweight concrete (Jedidi et al., 2015; Sriwattanapong et al., 2013; Benjeddou et al., 2023; Bakhshi et al., 2023; Sai et al., 2025).

Another material used in the production of lightweight concrete in the studies examined within the scope of the study is aerogel. Aerogels are solid materials in which the liquid in the pores has been replaced with air. Aerogel, which is quite light, has a porous structure and contains air instead of liquid in its pores (Bheekhun et al., 2013). When their surfaces are physically examined, it is seen that they consist of many small holes and resemble a sponge. Aerogels are a synthetic porous material with very low density and extremely low thermal conductivity as well as high specific surface area (Doğdu, 2022).

This study aims to examine academic studies on the use of perlite and aerogel in lightweight concrete production. For this purpose, many published academic studies were examined and presented in summary form.

2. RAW PERLITE AND AEROGEL

2.1. Raw Perlite

Approximately 74% of the world's perlite reserves are located in Turkey (Azizi, 2007). It is estimated that the world perlite reserves are approximately 6.6 billion tons, and the amount in Turkey is around 4.5 billion tons (DPT, 2001). Other countries with significant reserves are Greece, the USA, Japan, the Philippines, Russia, Hungary, Mexico and Italy (Çelik et al. 2014). The most common use of perlite is the construction sector, both in the world and in our country. Therefore, adverse situations in the construction sector significantly affect perlite consumption (Kaya, 2019). Significant advantages of perlite, such as its good insulation properties and its use in special-purpose concretes, will provide positive economic contributions to the construction sector (Ciminli, 2025).

The state of perlite in rock form after breaking and sizing is called raw perlite. The color of raw perlite can vary from transparent-light gray to shiny black. One of the most important properties of perlite is that it contains approximately 2.5% water (Baradan et al., 2022; General Directorate of Mineral Research and Exploration, 2022). The worldwide production of raw perlite, whose physical and chemical properties are given in Table 1, has increased steadily over the last decade (Olteanu et al., 2024). Raw perlite in gray tones is seen in Figure 2.



Figure 2. Raw perlite (Bergama Perlite, 2025)

Table 1. Physical and chemical properties of raw perlite (Kaya, 2019; Örüç, 2022)

Physical Feature	
Color	Black, grey and shades of grey
Softening Point	800 – 1100 °C
Melting Point	1325 – 1390 °C
PH	6,6 – 8, 0
Hardness	-
Specific Heat	0,2 kcal/ kg°C
Specific Gravity	2200 – 2400 kg/m3
Thermal Conductivity	-
Dissolution in Acid	They dissolve slightly in hot concentrated alkalis and mineral concentrated acids, but very little in dilute minerals or concentrated weak acids.
Chemical Properties	
SiO ₂	73,8
Al ₂ O ₃	13,9
Fe ₂ O ₃	0,9
Ca	0,9
MgO	0,3
Na ₂ O	4,7
K ₂ O	4,3
H ₂ O	<1,0
As	<0,001
Ba	<0,1
B	<0,01
Cl	<0,0005
Cr	<0,007
Cu	<0,0015
Ga	<0,05
Pb	<0,001

2.2. Aerogel

Aerogel was first discovered by Kistler in the 1930s. In the following years, the Teichner group increased the production and popularity of aerogel using the sol-gel method. Its extraordinary properties and wide range of applications make aerogel stand out (Yılmaz, 2013). Aerogels are generally produced by the sol-gel method. The aerogels given in Figure 3 have different mechanical and physical properties depending on the production parameters (aging, initiators, drying, etc.) (Doğdu, 2022). Aerogels are divided into three categories: inorganic (metal and metal oxides), organic (synthetic polymers and biopolymers) and hybrid (organic–inorganic) materials (Meti et al., 2023).



Figure 3. Aerogel (Web Post, 2025)

The aerogels whose properties are given in Table 2 have poor mechanical properties. This makes the aerogel samples brittle, soft and fragile. These shortcomings limit the development and application areas of aerogels. Nowadays, some fibers and hard materials are added to aerogels to improve their mechanical properties (Huang et al., 2012).

Table 2. Properties of silica aerogels (Doğdu, 2022)

Feature	Value
Intensity	0.003 g/cm ³
Surface Area	500-1000 m ² /g
Porosity	%80-99.8
Pore Diameter	20-150 nm
Particle Diameter	2-5 nm
Thermal Conductivity	0.017-0.021 W/mK
Coefficient of Thermal Expansion	2.0-4.0*10 ⁻⁶
Speed of Sound	100 m/s
Dielectric Constant	1.1
Refractive Index	1-1.05

3. EVALUATION OF THE USE OF PERLITE AND AEROGEL IN LIGHTWEIGHT CONCRETE

In their work, *Adhikary et al., (2021)* investigated the effect of carbon nanotubes on the properties of lightweight aggregate concrete containing expanded glass and silica aerogel. Combinations of expanded glass (55%) and hydrophobic silica aerogel particles (45%) were used as lightweight aggregates. In the study, carbon nanotubes were sonicated in water

containing polycarboxylate superplasticizer with ultrasonication energy for 3 minutes. As a result of the study, they reported that the incorporation of multi-walled carbon nanotubes significantly affected the compressive strength and microstructural performance of aerogel-based lightweight concrete. They detected that the addition of carbon nanotubes provided approximately 41% improvement in compressive strength. They reported that in the SEM image of lightweight concrete, carbon nanotubes were distributed homogeneously within the concrete structure. They also observed the agglomeration of carbon nanotubes and the presence of ettringites in the transition zone between the silica aerogel and cementitious materials.

In their study, *Wang et al., (2018)* produced concrete by replacing conventional aggregate with expanded perlite filled with Silica Aerogel granules in different proportions. They investigated the strength and thermal properties of the produced concrete. As a result of their studies, they reported that both the mechanical strength and thermal conductivity of the produced concrete were inversely proportional to the amount of expanded perlite filled with aerogel in the mixture. They also detected that the mechanical strength and thermal conductivity of produced concrete with ungraded aggregate were higher than that of concrete produced with graded aggregate.

In their study, *Adhikary et al., (2020)* prepared four different series of concrete samples using expanded glass aggregates, fly ash, prefabricated plastic bubbles and aerogel to investigate the mechanical properties of lightweight/ultra-lightweight concrete. To analyze the effect of aerogel particles on the hydration process of lightweight/ultra-lightweight concrete, scanning microscopy, thermography, semi-adiabatic calorimetry tests and XRD analysis of concrete samples were performed. As a result, they stated that up to 15% of the cement aerogel particles caused a decrease of more than 42% in the compressive strength of the concrete. They reported that when used with expanded glass aggregate with higher aerogel particle content, concrete density lower than 800 kg/m³ could be achieved. They noticed that there were separation gaps between the aerogel and the surrounding cementitious materials. They stated that this was an indication that the aerogel particles had lower bonding. They concluded that fly ash and precast plastic bubbles are quite useful in the production of fluid lightweight/ultra lightweight concrete.

In his thesis, *Çimen (2023)* synthesized silica aerogel (SA) with Bayburt Stone (BT) waste. It has investigated the effects of substituting SA in lightweight concrete at certain rates on properties such as heat and sound insulation, strength and porosity. Physical (unit weight, porosity, water absorption, thermal conductivity and ultrasound transmission speed) and mechanical (compressive strength) tests were applied to the samples. As a result of the study, it was determined that thermal insulation would be optimum with (3%, 350% and 0.40%) levels.

It was reported that (3%) SA replacement improved (46%) thermal conductivity value, increased porosity (31.48%) and caused a decrease in compressive strength (9.72 MPa). He found that SA is hydrophobic and has good adsorption properties and that a porous structure is formed around SA in concrete. He reported that the polycrystalline structure in concrete increases with the increase in SA concentration. He detected that this increase causes a decrease in the mechanical strength of the material.

In their study, **Jiang et al., (2022)** obtained Aerogel reinforced Epoxy Macrospheres (AR-EMS) using the ball rolling method. They prepared lightweight concrete by mixing AR-EMS, cement and hollow glass beads in the mold. In the experiment, they investigated the factors such as stacking volume ratio, inner diameter, wall thickness, different glass fiber (GF) content and length in the matrix of AR-EMS and different types of hollow glass microspheres (HGMS). As a result of the study, they detected that AR-EMS bonded well to the concrete matrix and the addition of long fibers improved the compressive strength of lightweight concrete. When lightweight concrete was prepared with 12 mm GF and 9–10 mm-2 layer-90% AR-EMS at 2% weight ratio, they achieved both high strength (11.46 MPa) and low density (0.897 g/cm³).

In addition, when comparing concrete without GF and concrete with EPS filler, they detected that the compressive strengths increased by 69% and 398%, respectively.

Shohan et al., (2024) developed ultra-high performance lightweight concrete by combining various levels (5-25%) of dehydrated cement powder (DCP) and aerogel (AG) with double hooked end steel fibers (DHE-SFs). In the study, they aimed to increase strength, durability, density and thermal/acoustic properties. As a result of the study, they found that fluidity decreased with higher DCP and AG content. 5%, 10% and 15% DCP and AG reported improved compressive strength (17.3%) through better packing and bond formation. They reported that modified mixtures resisted sulfate attack and increased compressive strength. They found that sound absorption and pore volume increased in modified mixtures.

In their study, **Chen and Yu (2024)** investigated the surface modification method of a bio-fiber (miscanthus) using hydrophobic silica aerogel. They evaluated the mechanical and insulation performance in lightweight concrete. As a result of the study, it was found that the silica aerogel modified miscanthus fiber increased both compressive and flexural strength. They also reported that it significantly improved the insulation performance of concrete.

In their study, **Mancı and Saruşıık (2019)** examined the effect of tincal waste in mixtures prepared with different amounts of cement. They produced samples with different cement

dosages using pumice aggregate and ground tincal waste additives. They used 0-4 mm Nevşehir region acidic pumice aggregate and 1% tincal waste in the production of lightweight concrete mortars. They determined the 7 and 14-day compressive strength and post-freeze-thaw compressive strength values of concrete samples. As a result of the study;

- ✓ 7-day compressive strength value in the control sample with 176 kg/m^3 dosage is 1.60 MPa,
- ✓ The compressive strength value of the sample with 1% tincal waste added is 1.77 MPa,
- ✓ In the control sample with the same cement dosage, the 14-day compressive strength value is 2.00 MPa,
- ✓ The compressive strength value of the sample with 1% tincal waste additive is 2.03 MPa,
- ✓ They found that 1% tincal waste addition in samples with a dosage of 176 kg/m^3 slightly increased the compressive strength value at both ages.

In their study, **Şengül et al., (2011)** investigated the effects of expanded perlite on the mechanical properties and thermal conductivity of lightweight concrete. In the study, they used partially expanded perlite instead of natural aggregate. They determined the compressive strength, elasticity modulus, water absorption, thermal conductivity and capillarity coefficient of the mixtures. As a result of the experiments, they found that the compressive strength and elasticity modulus decreased with increasing perlite content. They reported that with the increase in perlite content, water absorption and sorptivity coefficient increased. They also stated that thermal conductivity was significantly improved with the use of perlite and that there was a strong relationship between thermal conductivity and unit weight.

In their study, **Topçu and Işıkdag (2011)** investigated the properties of concrete containing expanded perlite aggregate (EPA) by considering cement types (CEM II 32.5R and CEM I 42.5R), dosages (300, 350 and 400) and substitution rates (0, 15, 30, 45 and 60). As a result of the study, they reported that expanded perlite aggregate concrete can be used as lightweight concrete at sufficient replacement rates despite some losses in mechanical properties.

In their study, **İbrahim et al. (2020)** produced durable structural lightweight concrete (LWC) by adding expanded perlite aggregate (EPA) in the range of 0% to 20% by weight. They produced the concrete with low water-cement ratio to ensure its durability when exposed to chloride environment. They replaced ordinary Portland cement (OPC) with 50% and 7% ground granulated blast furnace slag (GGBFS) and silica fume (SF), respectively. They evaluated the

mechanical properties and durability of concrete, unit weight, compressive strength, flexural strength, drying shrinkage, and chloride permeability. The study results;

- ✓ The unit weight of concrete is reduced by 20% to 30% compared to normal weight concrete (NWC),
- ✓ The compressive strength of the developed LWC is sufficient to be used as structural concrete, especially in mixtures containing 10% and 15% perlite aggregate,
- ✓ LWC has superior thermal insulation properties compared to NWC,
- ✓ Increased incorporation of EPA into concrete has shown better behavior under seismic loading.

4. CONCLUSION AND RECOMMENDATIONS

In this study, the use of perlite and aerogel in widely used lightweight concrete was examined from an academic perspective. The results obtained are listed below.

- ✓ The use of perlite and aerogel reduces the compressive strength of lightweight concrete,
- ✓ There is a decrease in unit volume weight value by substituting perlite and aerogel into lightweight concrete,
- ✓ By substituting perlite and aerogel into lightweight concrete, porosity and water absorption values increase,
- ✓ By substituting perlite into lightweight concrete, it exhibits better behavior under seismic loading,
- ✓ Thermal properties of lightweight concrete samples with additives were improved,
- ✓ As the amount of aerogel in lightweight concrete increases, the compressive strength increases,
- ✓ The use of perlite in lightweight concrete production is an important step in terms of the use of our natural raw materials,
- ✓ It was concluded that perlite and aerogel can be used in the production of lightweight concrete.
- ✓ The use of perlite and aerogel not only in the production of lightweight concrete but also in the production of other building materials,
- ✓ It is recommended that these productions be supported by both universities and public institutions and organizations.

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YIĞMA YAPILARIN SİSMİK PERFORMANSININ TÜRKİYE DEPREM YÖNETMELİKLERİ ÇERÇEVESİNDE MAKRO MODELLEME İLE DEĞERLENDİRİLMESİ

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ÖZET

Yığma yapılar, özellikle Türkiye gibi yüksek sismik risk taşıyan bölgelerde geleneksel olarak yaygın şekilde inşa edilmiş olup, günümüzde bu yapıların deprem performansına yönelik değerlendirmeler büyük önem taşımaktadır. Yığma yapıların en büyük zafiyetleri, malzeme olarak gevrek davranış sergilemeleri, düşük çekme ve kesme dayanımlarına sahip olmaları ve düzensiz işçilikle inşa edilmeleridir. Bu çalışma, yığma duvarların farklı yükleme koşullarındaki davranışlarını deneysel olarak ortaya koymak amacıyla gerçekleştirilmiştir. Bu kapsamda, harman tuğlası ve fabrikasyon tuğla gibi farklı tuğla tipleri, doğal taşlar ve çeşitli harçlarla oluşturulmuş duvar örnekleri üzerinde 30°, 60° ve 90° açılarla yükleme testleri uygulanmıştır. Deneysel sonuçlar, yükleme açısının kırılma mekanizmaları üzerinde belirleyici etkisi olduğunu göstermiştir. Özellikle 60°'lik açı altında en yüksek kayma dayanımı elde edilmiş; bu değerden daha düşük açılarda kayma, daha yüksek açılarda ise basınç kırılmaları baskın hale gelmiştir. Ayrıca, dikey delikli tuğlaların dolu tuğlalara kıyasla harçla daha iyi kenetlenme sağladığı ve bu nedenle daha yüksek kesme dayanımı sunduğu gözlemlenmiştir. Harç dayanımının ise, tuğla tipiyle uyumlu olmadığında yapısal bütünlüğe anlamlı bir katkı sunmadığı belirlenmiştir. Elde edilen bulgular, yığma yapıların deprem davranışlarının anlaşılmasına katkı sağlamanın yanı sıra, tarihi yapıların korunması ve güçlendirme yöntemlerinin geliştirilmesine yönelik yol gösterici niteliktedir.

Anahtar Kelimeler: Yığma yapılar, deprem davranışı, harman tuğlası,

SEISMIC PERFORMANCE EVALUATION OF MASONRY STRUCTURES THROUGH MACRO MODELING WITHIN THE FRAMEWORK OF TURKISH SEISMIC CODES

ABSTRACT

Masonry structures have been traditionally and extensively used in earthquake-prone regions such as Türkiye. Today, the seismic performance of these structures constitutes a major engineering concern due to their inherent material brittleness, low tensile and shear strength,

and frequent construction irregularities. This study experimentally investigates the structural behavior of masonry wall specimens built with various combinations of brick types (traditional and factory-made), natural stones, and mortars, under loading angles of 30°, 60°, and 90°. The experimental findings reveal that the angle of loading significantly influences the failure mechanism. At an angle of 60°, the highest shear strength was recorded, while lower angles led to dominant shear failures and higher angles caused compressive crushing. The geometry of the masonry units also proved to be a determining factor. Vertically perforated bricks exhibited better mortar interlock compared to solid bricks, thereby achieving superior shear capacity. However, it was observed that the use of high-strength mortar alone did not substantially improve the overall performance when used with weak masonry units, emphasizing the need for material compatibility. These results offer critical insights into the seismic behavior of masonry structures and underline the importance of understanding failure mechanisms in different structural configurations. Furthermore, the findings support the development of informed retrofitting strategies, particularly for the preservation of historical buildings. The study contributes to the broader goal of enhancing the seismic resilience of masonry buildings, which continue to constitute a significant portion of the building stock in many earthquake-prone regions.

Keywords: Masonry structures, seismic behavior, traditional brick

1. INTRODUCTION

Masonry structures have been integral to the architectural and cultural heritage of many civilizations, especially in seismically active regions like Türkiye. Traditionally constructed using stone, adobe, or clay bricks bonded with mortar, these buildings often lack formal engineering oversight. Their inherent brittleness and low tensile capacity make them particularly vulnerable under lateral seismic loads, despite performing adequately under gravity loads.

The traditional clay brick production in historical cities such as Diyarbakır reflects centuries-old craftsmanship involving hand-molding, sun-drying, and open-kiln firing. However, the lack of quality control in raw materials and production processes leads to significant variability in the mechanical properties of the bricks used in construction (Dalkılıç and Nabikoğlu, 2017). In monumental masonry such as the Diyarbakır city walls, basalt stone was widely used due to its local availability and durability; however, even these robust materials show limitations when subjected to out-of-plane seismic forces (Halifeoğlu, 2013).

Recent earthquakes, notably the Mw 7.7 and Mw 7.6 Kahramanmaraş earthquakes of 6 February 2023, have demonstrated the critical vulnerabilities of masonry buildings. Field

surveys revealed prevalent damage mechanisms including corner separation, out-of-plane wall failure, and partial or total collapse of walls with weak mortar joints and poor interlocking. Finite element modeling and nonlinear time history analyses on typical masonry buildings supported these observations and highlighted the structural consequences of inadequate connections and materials (İzol et al., 2024).

Given the vast and diverse masonry building stock in Türkiye, detailed structural assessments for each building are impractical. Therefore, rapid assessment techniques, such as the First-Stage Evaluation Method introduced by the Ministry of Environment and Urbanization and the Canadian Seismic Screening Method, have proven valuable in identifying high-risk buildings for prioritized intervention. These methods were effectively applied in the historic Sur district of Diyarbakır, demonstrating their utility in practice (Karaşin et al., 2016).

In response to these challenges, this study investigates the structural behavior of masonry wall specimens constructed with different types of bricks, natural stones, and mortars. The experimental program focuses on the failure modes induced by various loading directions and aims to contribute to a more comprehensive understanding of the seismic performance of masonry elements, ultimately supporting improved design and retrofit strategies.

2. MATERIALS AND METHODS

2.1 Bricks

In masonry wall construction, two primary types of bricks are utilized: harman bricks (traditionally fired bricks) and factory-made bricks. The technical specifications for harman bricks are provided in Turkish Standard TS 704, while those for factory-made bricks are outlined in TS 705.

2.1.1 Harman Bricks

Harman bricks are building materials produced by kneading clay, clayey soil, or loam—either separately or in combination—and mixing them with additives such as water, sand, ground brick, or tile dust when necessary. The mixture is then molded, dried, and typically fired in open kilns located at traditional production sites. These bricks are commonly used in traditional masonry construction due to their accessibility and cost-effectiveness.

Harman bricks are classified based on compressive strength and geometric form, as follows:

- Based on Compressive Strength:
 - ✓ Medium-strength harman brick
 - ✓ Low-strength harman brick

- Based on Shape:
 - ✓ Solid Harman Brick (*DOHT*)
 - ✓ Perforated Harman Brick (*DEHT*)

This classification is essential for selecting appropriate bricks based on structural performance criteria and architectural design requirements in masonry applications.

Table 1. Classification of Harman Bricks by Shape and Compressive Strength

Class	Brick Symbol	Max. Bulk Density (kg/dm ³)	Min. Avg. Compressive Strength (kg/cm ²)	Min. Compressive Strength (kg/cm ²)
Solid Harman Brick	DOHT/50	Not limited	50	40
	DOHT/30	Not limited	30	25
Perforated Harman Brick	DEHT/50	1.40	50	40
	DEHT/30	1.40	30	25

* **DOHT:** Solid Harman Brick

* **DEHT:** Perforated Harman Brick

The compressive strength is categorized as either medium strength (50/40 kg/cm²) or low strength (30/25 kg/cm²) depending on the classification.

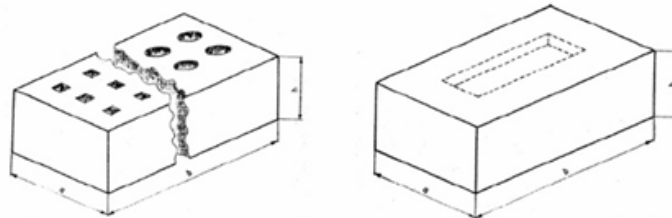


Fig. 1. (a) Harman Brick with Vertical Voids (b) solid harman brick

2.1.2 Factory-Made Bricks

Factory-made bricks are produced by mixing clay, clayey soil, or loam—either individually or blended—with additives such as water, sand, ground brick or tile dust, ash, and similar materials. The mixture is mechanically shaped, dried, and then fired in industrial kilns. These bricks are widely used in masonry wall construction.

In historical buildings, the materials used to produce fired clay bricks were often sourced from sediments accumulated in streambeds. Depending on the availability of kiln technology, the bricks were either fired at high temperatures or sun-dried in regions lacking proper firing

facilities. The strength of the brick is determined by the quality of the raw materials, the type of mortar used, and the bonding pattern. Compressive strength typically ranges from 10 MPa to 30 MPa. Well-fired bricks can be up to three times stronger than poorly fired ones. Generally, the tensile strength is about 10% and the shear strength about 30% of the compressive strength.

2.2 Natural Stones

Natural building stones are homogenous, weather-resistant materials extracted from quarries, suitable for construction based on their petrographic and technological properties [5]. Stones used in masonry construction must be free of cracks and weathered or deteriorated zones. Especially in historical buildings, stones were selected from fresh quarry faces, and any discolored or decayed parts were removed on-site before construction.

Stone is one of the oldest known construction materials, especially favored in long-lasting structures due to its local availability and durability. Its structural performance depends on its geological and chemical composition. While stone is highly resistant to compressive forces, it is weak under tension. Therefore, it is most suitable for arches, vaults, and domes that primarily carry compressive loads. Structural members like piers and load-bearing walls were traditionally built from stone. Some stones have deformation characteristics under pressure that are comparable to or lower than concrete. For example, the modulus of elasticity for concrete is given eq.1

$$E = (14-30) \times 10^4 \text{ kg/cm}^2 \quad (1)$$

Whereas for granite eq.2

$$E = (15-70) \times 10^4 \text{ kg/cm}^2 \quad (2)$$

The deflection of structural members can be calculated by knowing the modulus of elasticity. The strength and durability of stone masonry depend on the properties of both stone and mortar, the workmanship, and the bonding technique.

3. STRUCTURAL BEHAVIOR OF MASONRY BUILDINGS UNDER LOADS

The loads acting on masonry structures can be classified as vertical and horizontal loads. Vertical loads include dead loads and live loads. Dead loads are constant forces that act on the structure without variation over time. Live loads, in contrast, are movable or variable forces that do not act continuously on the structure.

Masonry buildings are constructed with brittle materials that have low ductility. The ability of such structures to resist vertical and lateral (seismic) loads depends on several factors, such as wall geometry, the strength of the materials used, and the method of bonding between individual masonry units .

3.1 Stress Conditions in Masonry Structures

Masonry structures exhibit good resistance to compressive stresses; however, they are not capable of withstanding tensile stresses to the same extent. Bending moments that are not accompanied by compressive forces can lead to the development of tensile stresses within the structure.



Fig. 2. Behavior of Masonry Elements Subjected to Flexural Action

When a force is applied to a masonry element, even if it is nominally axial, the presence of a bending moment M introduces eccentricity. Under known loads, such as dead loads, a load-bearing element designed appropriately for compressive forces can balance the induced bending moment. Structural members must therefore be designed in such a way that their dead weight counteracts the effects of bending.

Additional imposed loads may generate bending moments, some of which could lead to structural failure. The fundamental principle in the dimensioning of structural members is to avoid excessive stress and cracking by designing an appropriate shape or cross-section.

A bending moment alone cannot induce significant tensile stress unless it surpasses the effect of the normal compressive force. Until that point is reached, the resultant eccentric compressive force remains within the core region of the section. For a rectangular cross-section, the core region is defined as a trapezoid formed by connecting points located at one-sixth of the edge lengths from the centroid. As a general rule in masonry construction, it is preferred to maximize this core area, which is inherently dependent on the geometric properties of the section .

If the resultant force falls outside the core region of the cross-section, tensile stresses will develop. This means that the stresses caused by the bending moment exceed the compressive stresses produced by the normal force. Such tensile stresses can lead to cracking or failure in masonry elements, or the member may adapt to a new load transfer mechanism in response to the tension.

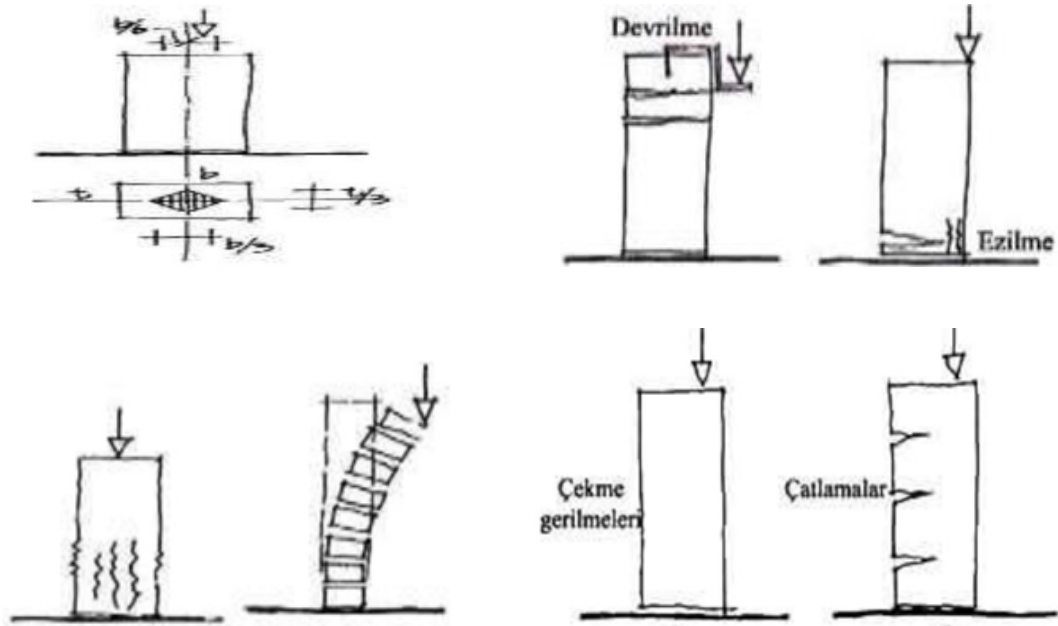


Fig. 3. Overturning, crushing, cracking, and buckling behaviors,

If the resultant force extends beyond the thickness of the column or wall, the masonry element will fail under the high tensile stress generated. Additionally, when the resultant force is located very close to the edge of the cross-section, the compression zone becomes extremely limited, making it unlikely for the element to safely carry the load (Figure 3.. Masonry elements subjected to compressive forces may fail due to their inability to resist the induced stresses, typically through crushing, buckling, or a combination of both failure modes (Figure 3).

3.2 Seismic Behavior of Masonry Walls

Although the seismic behavior of reinforced concrete structures is well understood, the response of masonry structures during earthquakes remains less predictable. Compared to reinforced concrete, masonry structures exhibit significantly lower ductility. Even in reinforced or confined masonry systems with strengthened mortar, the level of ductility achieved is still inferior to that of reinforced concrete members.

In masonry buildings, vertical loads are transferred from the floors to the load-bearing walls and then down to the foundation. In the event of seismic motion, inertial forces act upon the structure. The horizontal inertial force is transmitted from the floor systems, which typically behave as rigid diaphragms, to the walls, inducing shear and bending effects in them.

In the behavior of masonry structures, the compressive strength of the blocks forming the wall plays a critical role, as their tensile strength is minimal. Therefore, under seismic loading, the

flexural strength of the wall, both in-plane and out-of-plane per unit weight, is considerably low.

In masonry construction, walls are subjected to three primary actions: vertical loading, in-plane shear force, and out-of-plane bending moment. When all these forces act simultaneously on a wall, estimating the point of failure is possible through simplified assumptions. An increase in the tensile strength of the material enhances both the moment capacity and the axial load-carrying capacity of the masonry wall.

In Figure 4., the main actions on a masonry wall are illustrated: the axial force N , the in-plane shear force V , the in-plane bending moment M , the out-of-plane shear force V' , and the out-of-plane bending moment M' . All these forces can act in opposite directions as well.

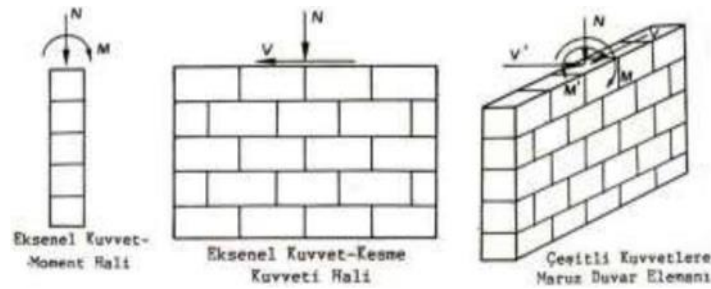


Fig. 4. Loading Conditions in Masonry Walls

An increase in axial compressive force can lead to an enhancement in the shear capacity of a masonry wall. However, beyond a certain threshold, compressive strength becomes the dominant factor. With increased tensile strength, improvements in both moment (M) and shear (V) capacities may be observed, provided that failure is not governed by compressive stress.

If the tensile capacity of timber tie beams placed along the masonry wall is considered as being distributed over the wall surface, the resulting improvement in overall structural behavior can be explained accordingly. Load-bearing walls generally exhibit greater shear and bending capacities compared to non-load-bearing walls.

Figure 3.8a shows walls connected by flexible floor systems. In such configurations, moment transfer between adjacent walls is reduced. Masonry walls typically contain window openings within otherwise solid wall segments (Figures 5). Under lateral forces, these solid wall segments represent the critical weak points of the structure.

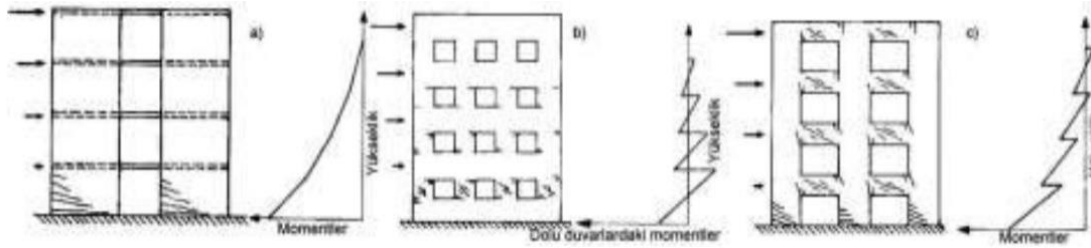


Fig. 5. Seismic Response of Masonry Shear Walls

When loads are applied to wall specimens composed of masonry units and mortar at angles of 30°, 60°, and 90°, the ratio of the component of the force parallel to the horizontal bed joints to the component perpendicular to them can be expressed as " $\cot \alpha = Q / N$ ". When the angle α exceeds a critical value ($\alpha \geq 60^\circ$), the observed failure mode in the wall is compressive failure. If the angle is below this critical value, shear failure becomes dominant (Figure 3.9).

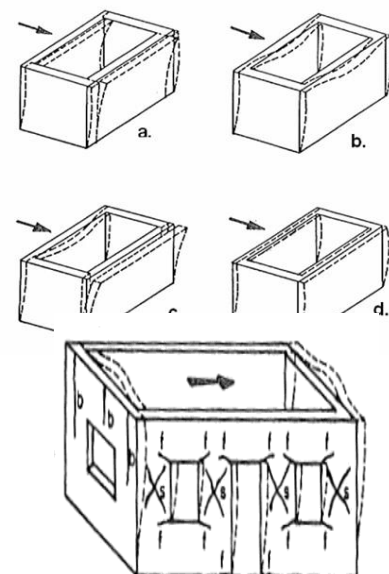
The maximum shear strength occurs at 60°, reaching a value of $\sigma = 17.5 \text{ kg/cm}^2$. As the angle decreases, the horizontal component of the force increases, which reveals the insufficient bond between the masonry units and the mortar joints, resulting in a reduction of shear strength down to $\sigma = 5.2 \text{ kg/cm}^2$. This highlights the importance of the bond strength between the masonry units and the mortar in the wall assembly.

Accordingly, it can be stated that vertically perforated bricks may demonstrate higher shear performance due to the mortar penetrating into the perforations, thereby improving the mechanical interlock. Another important conclusion is that using high-strength mortar in combination with low-strength masonry units does not provide significant structural benefits .

a and b: Structural walls are not connected to each other.

c: Structural walls are connected by tie beams.

d: Structural walls are connected with a rigid floor slab.



b – out-of-plane flexural cracks

s – Diagonal tension cracks

f – Flexural tension cracks

Fig. 6. Oscillations experienced by a masonry building during earthquake ground motion

CONCLUSIONS

This study aimed to investigate the structural behavior of masonry walls constructed using different types of bricks (traditional and factory-made), natural stones, and mortar under various loading angles (30°, 60°, and 90°). The experimental findings revealed that the angle of loading significantly affects the failure mechanisms, with shear failures being predominant at lower angles and compressive failures becoming dominant beyond 60°. The maximum shear strength was observed at 60°, highlighting a critical transitional point in load orientation.

The results further indicated that the geometry of the masonry units plays a crucial role in structural performance. Vertically perforated bricks provided higher shear capacity due to improved mortar interlock, while solid bricks exhibited more brittle behavior under lateral loads. Moreover, the use of high-strength mortar alone was not sufficient to compensate for the poor mechanical properties of low-strength units, emphasizing the need for balanced material selection in masonry construction.

These findings contribute to a better understanding of the seismic behavior of masonry elements, especially in heritage or non-engineered buildings that are common in seismically active regions like Türkiye. The outcomes of this research support the development of more reliable structural assessment models and highlight the importance of considering unit geometry and mortar compatibility in retrofit strategies.

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PREDICTION OF COMPRESSIVE STRENGTH OF CONCRETE CONTAINING SILICA FUME USING THE RESPONSE SURFACE METHOD

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ABSTRACT

This study aims to develop a mathematical model that can accurately and practically predict the compressive strength of concrete produced using silica fume. Within this scope, 63 experimental data sets obtained from various scientific studies previously published as a result of literature reviews were compiled and formed the basis for statistical analyses. Three important variables were considered among the inputs: water-to-binder ratio (W/B), aggregate-to-binder ratio (A/B), and silica fume-to-binder ratio (SF/B). The response (output) variable was the compressive strength values. The data includes compressive strength values ranging from 40 MPa to 110 MPa, enabling the creation of a general model that represents not only a specific concrete class but also mixtures with a wider range of strength levels. The Response Surface Method was used statistically in the modelling process. This method allowed for a detailed analysis of the interactions between parameters and a parameter-based evaluation of the effects of concrete mixture ratios on compressive strength. The performance of the mathematical model obtained was very high, with a determination coefficient (R^2) of 0.96. Additionally, absolute relative deviations were calculated to further examine the reliability of the predictions. According to the results, the absolute relative deviations were below 10% for nearly all values. This indicates that the developed model is not only statistically significant but also provides predictive capability for engineering applications.

Keywords: Silica fume, Response surface method, Compressive strength, Mathematical modelling.

ÖZET

Bu çalışma, silis dumanı kullanılarak üretilen betonların basınç dayanımını yüksek doğrulukla ve pratik biçimde tahmin edebilen bir matematiksel model geliştirmeyi amaçlamaktadır. Bu kapsamda, literatür taramaları sonucunda daha önce yayımlanmış çeşitli bilimsel çalışmalardan elde edilen 63 deneysel veri seti bir araya getirilmiş ve istatistiksel analizler için temel oluşturulmuştur. Girdiler arasında su/bağlayıcı oranı (S/B), agrega/bağlayıcı oranı (A/B) ve silis dumanı/bağlayıcı oranı (SD/B) olmak üzere üç önemli değişken dikkate alınmıştır. Yanıt (çıkıtı) değişkeni olarak ise basınç dayanımı değerleri esas alınmıştır. Veriler, geniş bir aralık olan 40 MPa ile 110 MPa arasında değişen basınç dayanımı değerlerini içermekte olup, bu sayede yalnızca belirli bir beton sınıfına değil, daha çeşitli dayanım düzeylerine sahip

kariřımları temsil eden genel bir model oluřturulması hedeflenmiřtir. Modelleme srecinde istatistiksel olarak Tepki Yzeyi Metodu kullanılmıřtır. Bu yntem sayesinde parametreler arasındaki etkileřimler detaylı řekilde analiz edilmiř ve beton kariřım oranlarının basın dayanımına olan etkileri deėiřken tabanlı deėerlendirilmiřtir. Elde edilen matematiksel modelin performansı olduka yksek dzeylerde olup, belirlilik katsayısı (R^2) 0.96 olarak hesaplanmıřtır. Ayrıca, tahminlerin gvenilirliėini daha ayrıntılı incelemek amacıyla baėlıl hata oranları da hesaplanmıřtır. Elde edilen sonulara gre, neredeyse tm deėerler iin baėlıl hata oranları %10'un altında kalmıřtır. Bu durum, geliřtirilen modelin yalnızca istatistiksel olarak anlamlı olmayıp, mhendislik uygulamalarına da bir ngr saėlayacaėını gstermiřtir.

Anahtar Kelimeler: Silis dumanı, Tepki yzeyi metodu, Basın Dayanımı, Matematiksel Modelleme.

1. INTRODUCTION

The rapid increase in the world population has made growth in the industrial and construction sectors inevitable. The growing demand for housing, infrastructure and consumer products has led to more intensive use of natural resources and increased energy demand. This situation causes environmental problems such as global warming and climate change by increasing greenhouse gas emissions (Ulucan & Alyamac, 2022). Additionally, the construction sector's use of raw materials, environmental degradation, and loss of biodiversity have ecological impacts, while also contributing to issues such as waste production and water pollution. This process, triggered by population growth, underscores the importance of policies aimed at improving resource efficiency, promoting renewable energy use, and reducing environmental impacts in line with sustainable development principles (Ulucan, 2024).

The construction sector is a critical area that directly affects both the economic and environmental dimensions of sustainable development. Concrete, in particular, stands out as the most widely used construction material in building activities, and its production process causes significant carbon dioxide (CO_2) emissions along with high energy consumption (Zhang et al., 2012). The increasing demand for concrete has led to a rapid rise in cement production, increasing greenhouse gas emissions and triggering the excessive consumption of natural resources (e.g. sand, gravel and water). This situation also brings with it environmental problems such as the disruption of ecosystem balances, a decrease in biological diversity and waste management issues. In this context, the use of alternative binding materials, the preference for recycled aggregates, and the widespread adoption of low-carbon production

technologies are of great importance for achieving sustainable development in the construction sector (Ulas et al., 2024).

Cement production accounts for approximately 7-8% of global CO₂ emissions, posing a serious threat to climate change (Andrew & Global, 2018). This high environmental impact stems from both chemical emissions generated during the calcination of limestone and energy consumption in the cement production process. The rise in cement production alongside increasing demand for concrete has necessitated the search for solutions in terms of environmental sustainability. In this context, the use of supplementary cementitious materials (SCM) has emerged as an effective strategy for both reducing the carbon footprint and increasing resource efficiency. SCMs such as fly ash, blast furnace slag, silica fume, and natural pozzolans contribute to the binding properties of cement while also enabling the utilization of industrial waste (Mehta & Monteiro, 2006). For example, various studies have demonstrated that replacing up to 50% of cement with blast furnace slag results in significant reductions in carbon emissions while also improving the durability of concrete (Juenger & Siddique, 2015). Additionally, SCMs positively influence concrete properties such as permeability, sulphate resistance, and long-term durability (Onyelowe et al., 2022). Therefore, the use of SCMs contributes to reducing environmental impacts while providing a scientific basis for sustainable construction practices. Silica fume, with its extremely fine particle size and high SiO₂ content, provides significant contributions to both the microstructure of high-performance concrete and environmental benefits, making it a prominent material in the SCM literature. Studies show that applying silica fume at ratios of 10–20% significantly improves durability criteria such as permeability, sulphate and chloride resistance in concrete. For example, a study conducted by Mansoura University found that concrete containing 16% silica fume exhibited superior mechanical and long-term durability performance. Research observed significant improvements in critical parameters such as water permeability, carbon dioxide carbonation resistance, and freeze-thaw resistance as the silica fume content increased (Rostami & Behfarnia, 2017). Similar results have been obtained in Turkey; for example, in a study conducted by Ahmet Benli and Karataş (2017), self-compacting mortar mixtures containing high levels of silica fume achieved the highest tensile and compressive strengths at 180. days, along with significant improvements in porosity and density (Benli et al., 2017). These findings clearly demonstrate that silica fume enhances the binding properties of cement through pozzolanic reactions, thereby densifying the microstructure and potentially increasing the strength and durability of concrete. Therefore, the use of silica fume as a SCM not only contributes to reducing the environmental footprint but also scientifically enhances the performance of concrete.

This study focuses on developing a mathematical model capable of accurately predicting the final age compressive strength of concrete produced using silica fume. The study highlights the environmental impacts of silica fume used as a SCM, as well as its effects on mechanical properties. In this context, data sets obtained from different articles published in the literature were modelled using the response surface method. Subsequently, absolute relative deviations (ARD) were calculated to examine the effectiveness of the model, and the outputs were compared with the results in the literature.

2. MATERIAL AND METHODS

2.1. Data collection and preparation

In the study, a mathematical model was developed using the data obtained from different articles published in the literature. While developing the model, 8 different articles were taken into consideration and analyses were performed on 63 data. The articles and data sets considered are presented in Table 1.

Table 1. Articles considered in the analyses and number of data used

Publication Name	Number of data used in the analysis
Comparison of artificial neural network and fuzzy logic models for prediction of long-term compressive strength of silica fume concrete	21
Mechanical and durability properties of high-performance concretes containing supplementary cementitious materials	8
Practical evaluation of relationship between concrete resistivity, water penetration, rapid chloride penetration and compressive strength	6
Predicting properties of High-Performance Concrete containing composite cementitious materials using Artificial Neural Networks	4
Mechanical and durability properties of ternary concretes containing silica fume	4
Permeability properties of self-consolidating concrete containing various supplementary cementitious materials	4
Strength and drying shrinkage properties of self-compacting concretes incorporating multi-system blended mineral admixtures	4
Efficiency of calcined kaolin and silica fume as cement replacement material for strength performance	12
Total	63

2.2. Response surface method

The Response Surface Methodology (RSM) is a statistical and mathematical approach developed to model and optimise the effect of one or more independent variables on a response variable, based on experimental design techniques (Ulucan & Ulas, 2024). The fundamental

structure of this method relies on creating second-order (or sometimes higher-order) polynomial regression models that approximately describe the system's behaviour. RSM first collects data using factorial or central composite experimental designs, then creates a mathematical model suitable for the obtained experimental results (Ulucan & Alyamac, 2023). Using this model, interactions between variables can be visualised, and conditions under which the response will reach maximum or minimum values can be predicted. RSM is particularly effective in optimising multi-variable systems and is widely used in engineering, materials science, chemistry, and environmental fields.

3. RESULTS AND DISCUSSION

3.1. Development of mathematical model and evaluation of outputs

Central Composite Design was used during the analyses on RSM. 63 data were considered as output values while water-to-binder (W/B), aggregate-to-binder (A/B), and SCM-to-binder (SCM/B) ratios were considered as variables. The change ranges of the variables are presented in Table 2.

Table 2. Intervals of change for variables

Factor	Name	Min	Max
A	W/B	0.27	0.60
B	A/B	2.97	7.42
C	SCM/B	0.00	0.15

In the light of the data obtained from the literature, ANOVA analyses were performed and a mathematical model was developed. The developed model and the outputs of the variables considered in the model were analysed comprehensively. In statistical terms, it was ensured that the p-values considered in the model were < 0.05 . The results of the variables and the model are presented in Table 3. The formulation of the developed model is given in Equation 1.

$$f_c,90 = -349.7 * W/B -26.5 * A/B +235.6 * SCM/B +8.9 * W/B * A/B -164.4 * W/B * SCM/B +0.7 * A/B * SCM/B +187.5 * W/B^2 +2.9 * A/B^2 -584 * SCM/B^2 +220.8 \quad (1)$$

Table 3. ANOVA analysis outputs of the model and variables.

Source	F-value	p-value
Model	173.6	< 0.0001
A – W/B	95.6	< 0.0001
B – A/B	25.4	< 0.0001
C – SCM/B	38.2	< 0.0001
AB	0.7	0.3961
AC	4.3	0.0442
BC	0.01	0.9425
A ²	12.9	0.0007
B ²	23.2	< 0.0001
C ²	9.2	0.0037

The comparison of the prediction results of the developed model and the experimental results is presented in Table 4 by calculating the relative error ratios. The ARD values were calculated using Equation 2 (Alyamac et al., 2017). The values given as Actual represent the experimental results, while the values given as Predicted represent the prediction results of the model. As the ARD values calculated in Table 4 approach 0, the prediction accuracy of the model also increases. It can be observed that nearly all of the obtained ARD values remain below 10%, indicating that the model predictions are at an impressive level.

$$\text{ARD (\%)} = [(\text{Experimental} - \text{Predicted}) / (\text{Experimental})] * 100 \quad (2)$$

Table 4. Model prediction and ARD results.

Seri No	Actual	Predicted	ARD	Seri No	Actual	Predicted	ARD
1	55.3	56.6	-2.3	33	59.1	64.2	-8.8
2	66.1	66.4	-0.5	34	65.3	67.1	-2.8
3	68.1	67.0	1.7	35	60.7	65.4	-7.7
4	40.1	44.7	-11.4	36	69.0	65.3	5.4
5	51.9	52.9	-1.9	37	75.4	76.7	-1.7
6	52.2	52.6	-0.7	38	52.6	53.3	-1.3
7	53.5	51.4	4.0	39	55.3	63.2	-14.2
8	66.7	61.2	8.3	40	73.0	68.5	6.1
9	64.8	61.7	4.8	41	77.0	72.5	5.8
10	44.5	40.1	9.9	42	84.0	75.8	9.7
11	51.0	48.2	5.5	43	85.0	78.4	7.8
12	53.1	47.9	9.8	44	56.5	59.1	-4.7
13	78.4	83.5	-6.4	45	58.8	64.8	-10.2
14	96.7	96.5	0.2	46	64.6	68.7	-6.3
15	63.4	98.7	-5.7	47	66.8	70.7	-5.9
16	54.5	50.8	6.8	48	81.1	82.9	-2.2
17	59.7	60.5	-1.4	49	91.8	90.8	1.1
18	58.7	61.0	-3.9	50	99.2	95.8	3.5
19	41.0	40.0	2.5	51	96.7	97.8	-1.1
20	44.5	48.0	-7.9	52	87.5	90.8	-3.8
21	46.6	47.7	-2.4	53	96.5	99.0	-2.6
22	84.0	84.0	0.1	54	104.0	104.4	-0.4
23	94.3	95.0	-0.8	55	106.0	106.8	-0.7
24	97.1	99.8	-2.7	56	85.5	84.7	1.0
25	81.3	80.4	1.1	57	95.5	92.7	2.9
26	84.1	84.7	-0.7	58	99.0	97.8	1.2
27	73.5	70.6	3.9	59	104.0	99.9	3.9
28	81.9	81.7	0.2	60	79.0	78.6	0.5
29	74.5	72.7	2.4	61	90.0	86.4	4.0
30	56.0	58.0	-3.7	62	92.0	91.3	0.8
31	61.9	64.2	-3.8	63	95.5	93.2	2.4
32	66.3	67.1	-1.1				

The perturbation curves and model outputs, which significantly affect the prediction results of the developed model and demonstrate the effectiveness of the model, are presented more clearly in Fig. 1. The determination coefficient of the model is 0.96, which clearly demonstrates the effectiveness of the model. A comprehensive examination of Fig. 1 reveals that the compressive strength decreases as the W/B ratio increases. As the A/B ratio increases up to a certain ratio, the compressive strength decreases, and after a certain value, the compressive strength increases. The SCM/B ratio contains similar results to the literature and has significant effects on compressive strength in uses up to approximately 15%.

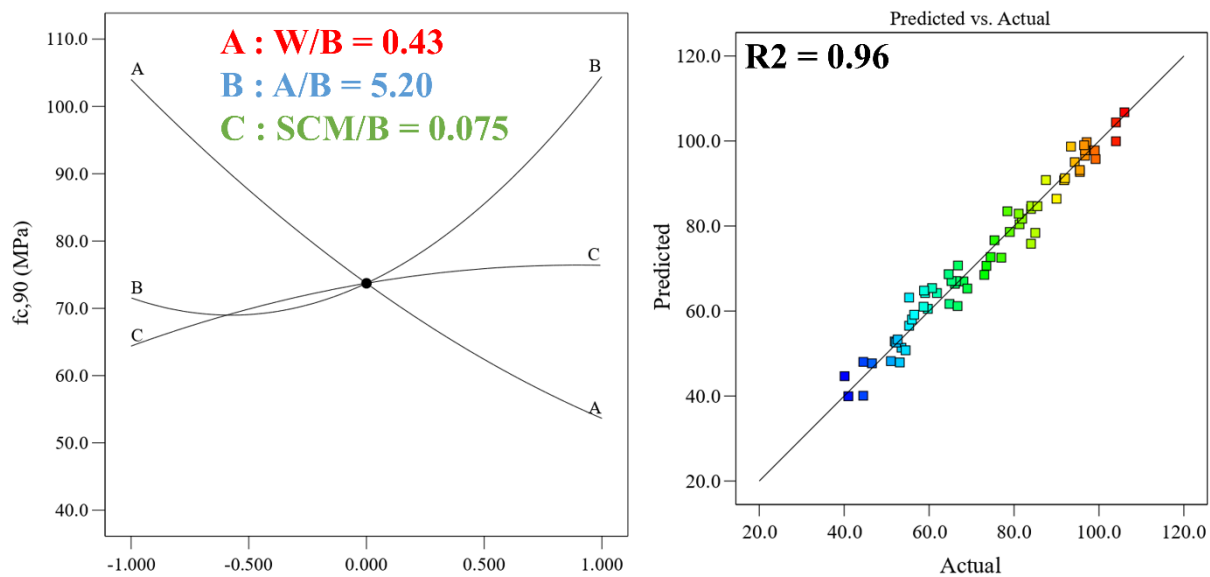


Fig. 1. Perturbation curve and prediction results for the model

To examine the effects of the considered variables on the response value more clearly, the obtained 3-dimensional effect graphics are presented in Fig. 2. A comprehensive examination of Fig. 2 reveals that results similar to the perturbation curve have been obtained. This graphic, which is an output of parameter-based analyses, clearly demonstrates that there is a continuous decrease in compressive strength values with an increase in the W/B ratio. Similarly, a slight decrease in compressive strength is observed for the initial values of the A/B variable, while an increase in compressive strength occurs in the 4.08-7.42 range. The SCM/B value indicates an increase in compressive strength as it increases in the range of 0-0.151. However, a decrease in the rate of increase in compressive strength occurs in the range of 0.091-0.151.

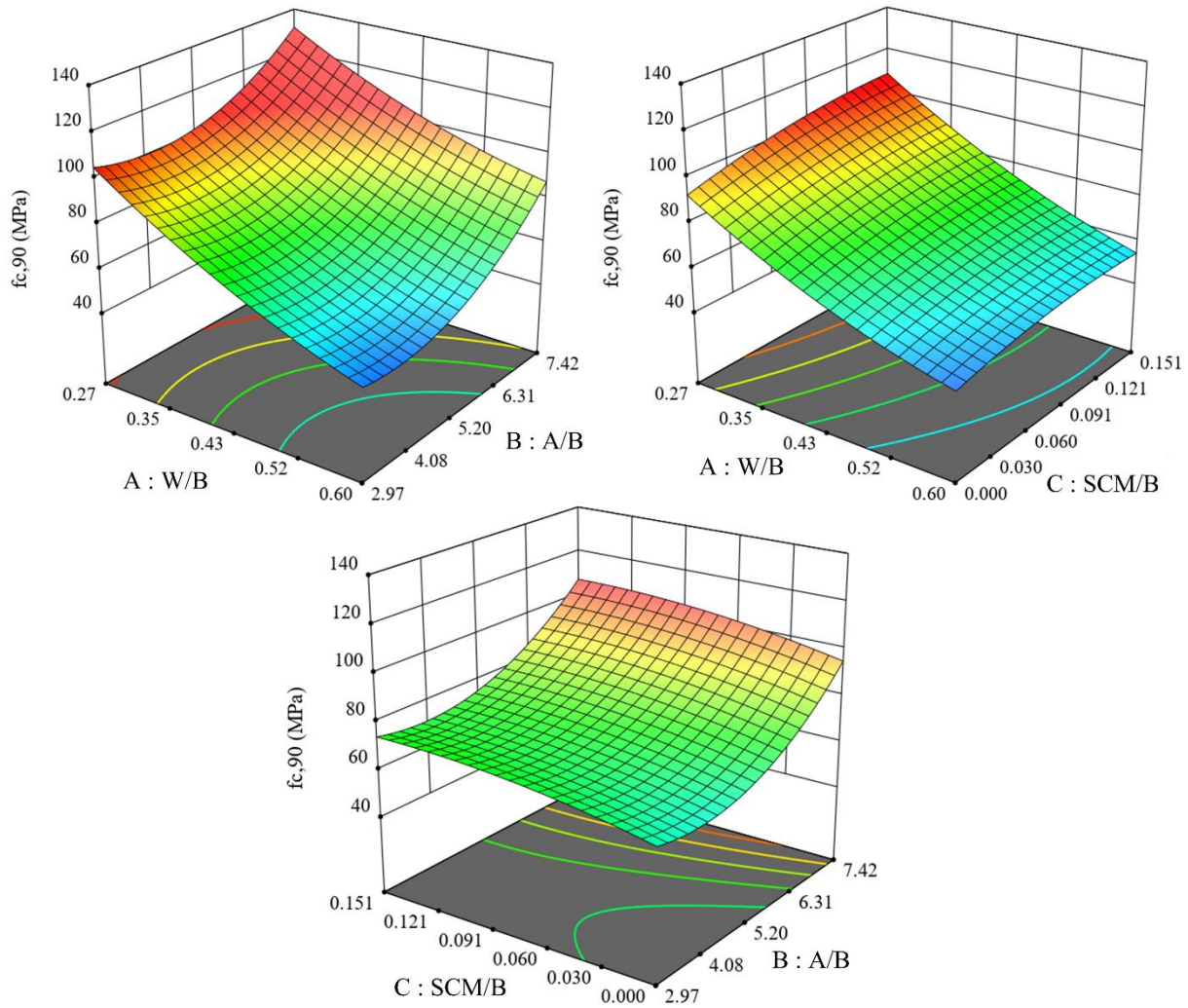


Fig. 2. 3D effect graphic of developed model.

CONCLUSIONS

This study focuses on developing a mathematical model that accurately predicts the final age compressive strength of concrete produced using silica fume. Some of the results of the study are presented below:

- The determination coefficient of the developed model was determined to be 0.96, and it was observed that it successfully predicted the final age concrete strengths. It is believed that the application of this developed model in structures where final age concrete strength is important will provide significant benefits.
- It has been determined that the model developed using RSM has yielded highly successful results. RSM has been observed to yield highly successful results in predicting the model for each response, creating robust models, and finding the most appropriate response, and to provide important outputs as a result of parameter-based analyses.

- In addition, silica fume, which is used as a supplementary cementitious material, is considered to be of critical importance in reducing environmental outputs by significantly reducing the amount of cement used. Literature studies have also revealed that the use of silica fume makes significant contributions in terms of global warming potential and energy consumption.

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DİZİMSSEL VE KULLANICI TABANLI GÖSTERGELERLE MEKÂN ALGISININ ÇÖZÜMLEMESİ: FAKÜLTE BİNASI ÖRNEĞİ

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ÖZET

Mekân algısı, bireyin fiziksel çevreyle etkileşimi sonucu oluşan ve zihinsel haritalar aracılığıyla biçimlenen dinamik bir süreçtir. Bu algı yalnızca yapının fiziksel sınırlarıyla değil; görsel açıklık, yön bulma kolaylığı, kullanım alışkanlıkları ve sosyal deneyimlerle de şekillenir (Lynch, 1960; Gibson, 1979). Algının çözümünde farklı yöntemler devreye girmektedir. Bu yöntemlerden biri olan mekân dizimi, yapı ve kent ölçeğindeki mekânsal örüntülerin sosyal ilişkiler üzerindeki etkisini analiz etmeye yönelik kuramsal ve analitik bir yaklaşımdır. Fiziksel mekânın biçimsel özelliklerini erişilebilirlik, hareket yoğunluğu ve etkileşim potansiyeli gibi sosyal değişkenlerle ilişkilendirerek okunmasını sağlar (Hillier & Hanson, 1984). Bu bağlamda sunulan araştırma, bir Mimarlık Fakültesi binasında kullanıcı algısı ile mekânsal bütünleşme örüntülerini birlikte değerlendirmek amacıyla mekân dizimi ve katılımcı haritalama yöntemlerini karşılaştırmalı olarak ele almaktadır. Yapıdaki katların dizimsel analizi gerçekleştirilmiş; elde edilen bütünleşme değerleri görselleştirilerek mekânsal erişilebilirlik haritaları oluşturulmuştur. Paralel olarak, 20 mimarlık öğrencisine yapıya ait temiz kat planı şemaları verilmiş ve kendi deneyimlerine dayanarak, en sık bulundukları ve sosyalleştikleri alanları kırmızıdan maviye uzanan bir renk skalasında boyamaları istenmiştir. Böylece, öğrencilerin mekâna dair öznel algılarını yansıtan bireysel renkli planlar elde edilmiştir. Bulgular, dizimsel analizlerle öğrencilerin deneyim temelli renklendirmeleri arasında kısmi örtüşmelerin olduğunu göstermektedir. Özellikle dış mekân ile kurulan görsel ve fiziksel bağlantıların güçlü olduğu alanlar, hem dizimsel analizde yüksek bütünleşme değeri taşımakta hem de öğrenciler tarafından yoğun kullanılan bölgeler olarak işaretlenmektedir. Buna karşın, bazı kırmızı ile vurgulanan sosyal odakların mekân dizimi açısından düşük bütünleşme değerine sahip olduğu; buna rağmen işlevsel kullanım, topluluk pratiği ve programatik yoğunluk gibi etkenlerle öne çıktığı görülmüştür. Bu durum, mekânsal deneyimin yalnızca biçimsel erişilebilirlikten ibaret olmadığını; sosyal dinamikler, kullanım alışkanlıkları ve mekânın anlam yükleriyle birlikte şekillendiğini ortaya koymaktadır. Genel olarak çalışma,

mekân algısını çok boyutlu olarak ele alabilmek için nicel (dizimsel) ve nitel (katılımcı haritalama) yöntemlerin birlikte kullanımının sunduğu imkânlara dikkat çekmekte ve bu iki yaklaşımın birbirini tamamlayan yönlerini metodolojik açıdan tartışmaya açmaktadır.

Anahtar Kelimeler: Mekân algısı, mekân dizimi, katılımcı haritalama, karşılaştırmalı analiz, bütünleşme, kullanıcı deneyimi

A SPATIAL PERCEPTION ANALYSIS VIA SYNTACTIC STRUCTURES AND USER-BASED MAPPING: A FACULTY BUILDING CASE STUDY

ABSTRACT

Spatial perception is a dynamic process shaped by the individual's interaction with the physical environment and constructed through mental maps. This perception is not solely influenced by the physical boundaries of a structure, but also by factors such as visual openness, ease of orientation, patterns of use, and social experience (Lynch, 1960; Gibson, 1979). Various methods are employed to analyze this perceptual process. Among them, space syntax offers a theoretical and analytical approach to examining how spatial configurations at the architectural and urban scales influence social relationships. It allows for an interpretation of the formal characteristics of physical space in relation to variables such as accessibility, movement intensity, and interaction potential (Hillier & Hanson, 1984). In this context, the presented study conducts a comparative analysis of user perception and spatial integration patterns within a Faculty of Architecture building, using space syntax and participatory mapping methods. A syntactic analysis of the building's floors was conducted, and spatial accessibility maps were generated based on integration values. In parallel, twenty architecture students were given clean schematic floor plans of the building and asked to color-code them using a scale from red (frequently used and socially active areas) to blue (least used and socially passive areas), based on their personal experiences. This approach produced individual color maps that visualized subjective perceptions of space. The findings reveal partial overlaps between the syntactic analysis and the student-generated mappings. Areas with strong visual and physical connections to outdoor spaces were both highly integrated syntactically and frequently used by students. Conversely, certain red-coded social hubs identified by students had low integration values in the syntactic analysis, yet emerged as significant due to functional use, collective practices, and programmatic intensity. These results suggest that spatial experience is shaped not only by formal accessibility, but also by social dynamics, usage routines, and the symbolic meanings attached to space. Overall, the study highlights the potential of combining quantitative (syntactic) and qualitative (participatory mapping) methods to address spatial perception in a

multidimensional way, offering a methodological discussion on how these approaches can complement one another.

Keywords: Spatial perception, space syntax, participatory mapping, comparative analysis, integration, user experience

1.INTRODUCTION

Spatial perception is a holistic construct shaped by individuals' interactions with the physical environment, encompassing cognitive, sensory, and experiential processes. This perception is not limited to the visual or geometric features of a structure; rather, it is enriched through wayfinding behavior, patterns of time spent, usage habits, and social interactions (Lynch, 1960; Gibson, 1979; Rapoport, 1977). Accordingly, space should be understood not merely as a physical entity, but as a multilayered environment that gains meaning through social and cultural patterns and guides user behavior (Barker, 1968).

One of the theoretical approaches developed to analyze this multidimensional structure is *space syntax*, introduced by Hillier and Hanson (1984), which has been widely adopted as an analytical method that links formal spatial configurations to patterns of social organization. Through parameters such as connectivity, integration, and intelligibility, space syntax expresses the structural relations of a building in quantitative terms, revealing circulation patterns, movement density, and potential zones of social interaction with objective data (Hillier et al., 1993). However, spatial experience is a more complex phenomenon that extends beyond these formal structures. The formal configuration of a space may fall short in conveying insights into users' experiences, habits, and social relations.

For this reason, it becomes important to support formal analyses with user-centered methods. Qualitative approaches such as *participatory mapping* enable users to express their environmental experiences through mental representations, making visible the subjective, social, and emotional dimensions of perception. Spatial traces preserved in memory, orientation tendencies, and preferred areas can be externalized through such methods.

In this context, the present study evaluates spatial perception based on both structural arrangements and user experience, integrating these two approaches through a comparative analysis. Integration values obtained through space syntax are analyzed alongside user-identified warm–cold zones on floor plans, represented using a color gradient from red to blue. The methodological novelty of this study lies in the direct integration of the color gradient used in space syntax analysis into the participatory mapping process. In doing so, both methods are aligned within the same visual language, establishing a strong analytical bridge between qualitative and quantitative data. In particular, the study interrogates to what extent the areas

identified as “warm” through high integration values in syntactic analysis overlap with those perceived as such by users, offering a multilayered assessment of the relationship between spatial configuration and subjective perception.

2.CONCEPTUAL APPROACH

Spatial perception emerges from an individual's cognitive and sensory relationship with the physical environment. It is shaped not only by environmental data but also by personal experiences, bodily movement, and social interaction (Tuan, 1977; Pallasmaa, 2005). The time users spend within a space, their wayfinding processes, interactions, and action-based practices are among the key components shaping their mental representations of that space (Tunçok Sarıberberoğlu, 2018). Therefore, spatial perception is not a static phenomenon; it is a multidimensional process that evolves over time and is enriched through movement.

Lynch (1960) emphasized that the legibility of an environment is directly linked to user experience, while Gibson (1979) argued that spatial elements are perceived not only visually but also functionally. Similarly, researchers such as Rapoport (1977) and Zeisel (2006) have drawn attention to the significance of factors like ease of wayfinding, freedom of movement, and social interaction in shaping spatial perception.

In recent years, there has been a growing interest in studies that evaluate spatial perception through both physical structural configurations and user experiences. Particularly, the integration of quantitative spatial analyses with user-centered methods offers a more holistic perspective in spatial research. For instance, studies that combine cognitive mapping with space syntax analyses examine the intersections between subjective experiences and formal structures (Çanakçıoğlu, 2015; Golick & Thompson, 2010). This approach suggests that not only the physical structure but also user perception can be influential in shaping design decisions.

2.1. Space Syntax Analyses

Space syntax is a theoretical and methodological approach used to analyze the relationship between physical environments and their potential for social interaction. It assesses the interrelations of spatial components using quantitative and visual parameters, allowing inferences to be made regarding user movement patterns (Hillier & Hanson, 1984; Hillier et al., 1993).

One of the most commonly used parameters within this approach is the "integration" value, which indicates a space's accessibility to other areas and is used to explain natural movement tendencies (Hillier & Vaughan, 2007). Analysis results are typically visualized using a color gradient from red to blue: red tones represent high integration (more accessible and socially

active spaces), while blue tones indicate low integration (more isolated or segregated spaces) (Peponis, Zimring & Choi, 1990).

Recent research has sought to compare the outputs of space syntax analyses with user experiences, evaluating how these numerical data correspond with subjective spatial perceptions (Kim & Penn, 2004; Haq & Luo, 2012). This enables a clearer understanding of how formal accessibility and spatial legibility are cognitively represented in users' minds.

In the present study, the integration values derived from space syntax analysis were compared with users' perceptions of spatial warmth and coldness, as marked on floor plans. The color scale used in visual representations was consistently applied in both the syntactic analysis and user-generated maps, ensuring visual alignment between quantitative and qualitative data. Consequently, space syntax proves to be an effective and measurable tool for assessing the potential for social interaction within a physical environment.

2.2. Participatory Mapping

Participatory mapping is a qualitative technique that allows individuals to express their spatial experiences, memories, and usage patterns on a map (Downs & Stea, 1973; Canter, 1977). This method highlights users' emotional, functional, and directional relationships with their environment, contributing to a better understanding of subjective spatial perception.

Golicnik and Thompson (2010) emphasize the effectiveness of participatory mapping in understanding how users experience space and incorporating these insights into the design process. Additionally, Kim and Penn (2004) empirically demonstrated how cognitive maps intersect with the spatial structure of environments.

In this study, users were asked to identify “warm” (frequently used, preferred) and “cold” (less used, overlooked) areas within the building using a color scale. This representation was structured to mirror the color coding used in the space syntax analysis, enabling a visual and analytical comparison between user memory-based perceptions and the formal spatial configuration.

3. METHODOLOGY OF THE STUDY

This study, conducted in the Faculty of Architecture building at Bolu Abant İzzet Baysal University, employed two primary analytical methods: space syntax and participatory mapping. As part of the space syntax method, the building's floor plans were analyzed, and integration values for each spatial unit were calculated. These values provide quantitative data that reflect the intensity of spatial connections and the internal navigability of the building. The results of the analysis were visualized using a color gradient ranging from red to blue—where red tones

indicated high integration (warm zones), and blue tones represented low integration (cold zones).

In the second phase, the same floor plans were distributed to 20 architecture students, and the participatory mapping method was implemented. Students were asked to color the areas they most frequently used and socially engaged in, using the same red-to-blue scale based on their personal spatial experiences. This visualization technique was deliberately designed to align with the color scheme used in the space syntax analysis, creating a foundation for comparative evaluation between users' perceived spatial warmth–coldness and formal integration values. Through this methodological alignment, both the spatial patterns derived from the building's configuration and the subjective spatial representations based on user experience were evaluated together. The study thus examined how students conceptualized and articulated spatial “warmth” and “coldness” through their individual interactions with the environment.

3.1. The Study Area

This research was conducted in the Faculty of Architecture building located on the Gölköy Campus of Bolu Abant İzzet Baysal University (Figure 1). The building consists of three main blocks, each differentiated by function and connected to one another via upper-level passage bridges. This multi-segmented spatial configuration provides a rich environment in terms of user movement, wayfinding behavior, and social interaction, thus offering a suitable context for both formal spatial analysis and user experience-based evaluation.



Figure 1. Faculty of architecture building, Bolu Abant İzzet Baysal University (Url-1)

The building is composed of three main blocks: A, B, and C. Block A is designated for administrative units of the faculty and is used by students only for indirect purposes such as passing through, seeking information, or short-term waiting. Block B contains classrooms, seminar rooms, and academic offices. This block hosts theoretical courses and academic advising activities, with vertical circulation provided by staircases located on both sides of the central atrium. Block C houses the studio spaces and is intensively used by students of the Department of Architecture. Design-based studio courses are conducted in this block, and

students engage in long-term spatial interactions within these areas. Additionally, Block C includes two staircases that facilitate vertical circulation (Figure 2).

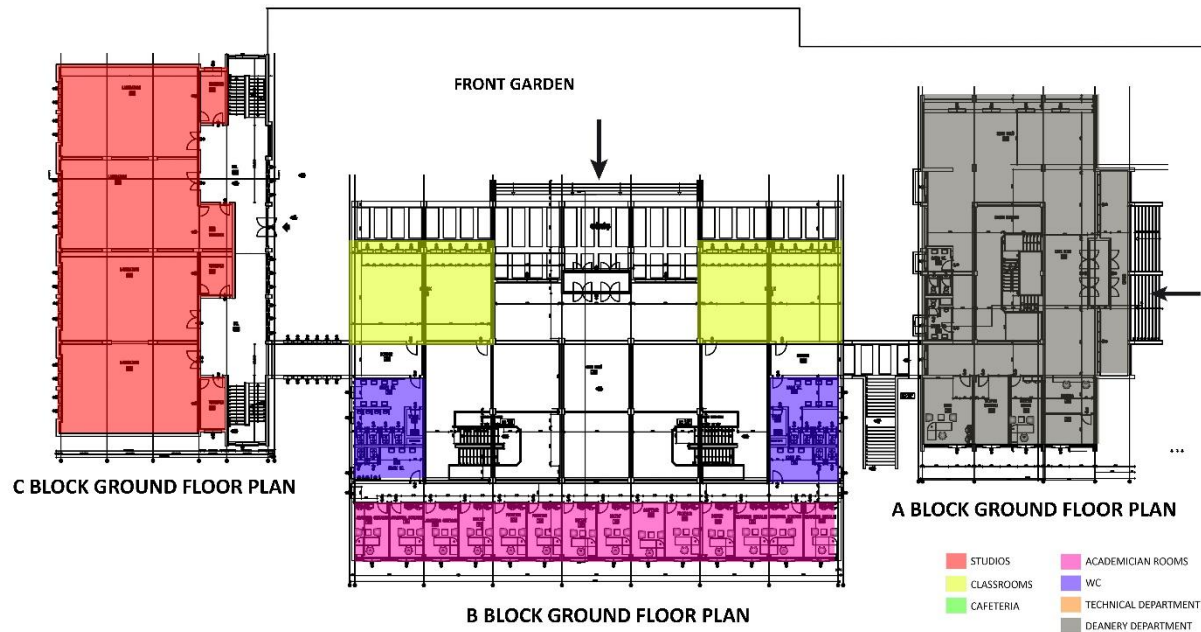


Figure 2. Ground floor plan of BAIBU faculty of architecture – block layout

Physical circulation between the blocks is primarily provided through enclosed bridges located on the upper floors, which directly influences the building's internal spatial continuity and wayfinding behavior. This particular spatial organization offers a suitable basis for both the formal analysis of the building's spatial configuration via space syntax and the application of participatory mapping methods based on user experiences (Figure 3).

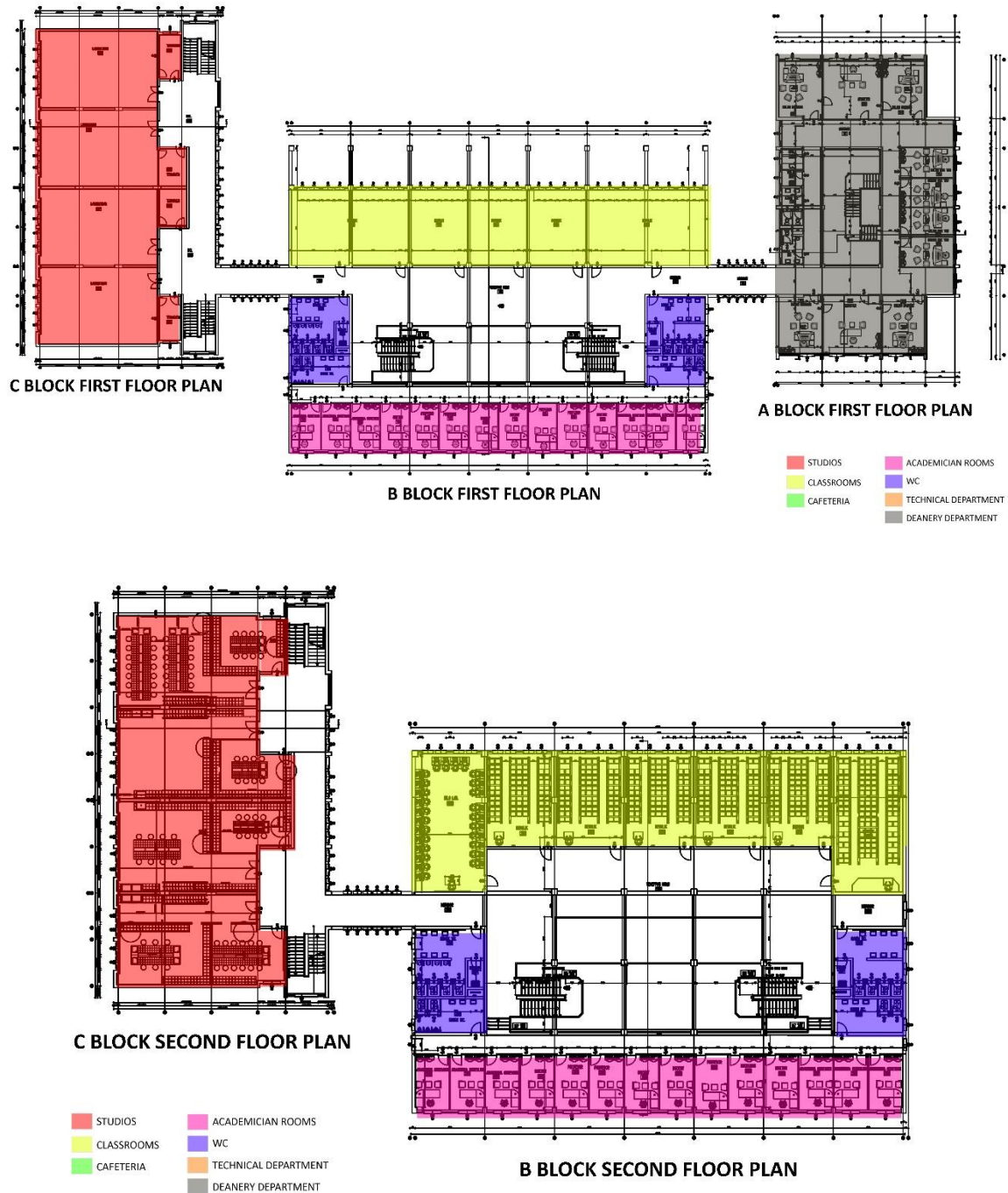


Figure 3. First and second floor plans of BAIBU faculty of architecture building

In addition, the main entrance to the building for students is located on the north façade of Block B, while the basement-level cafeteria provides access to the rear garden on the south side. This circulation structure plays a significant role in shaping students' movement patterns both within and between the blocks (Figure 4).

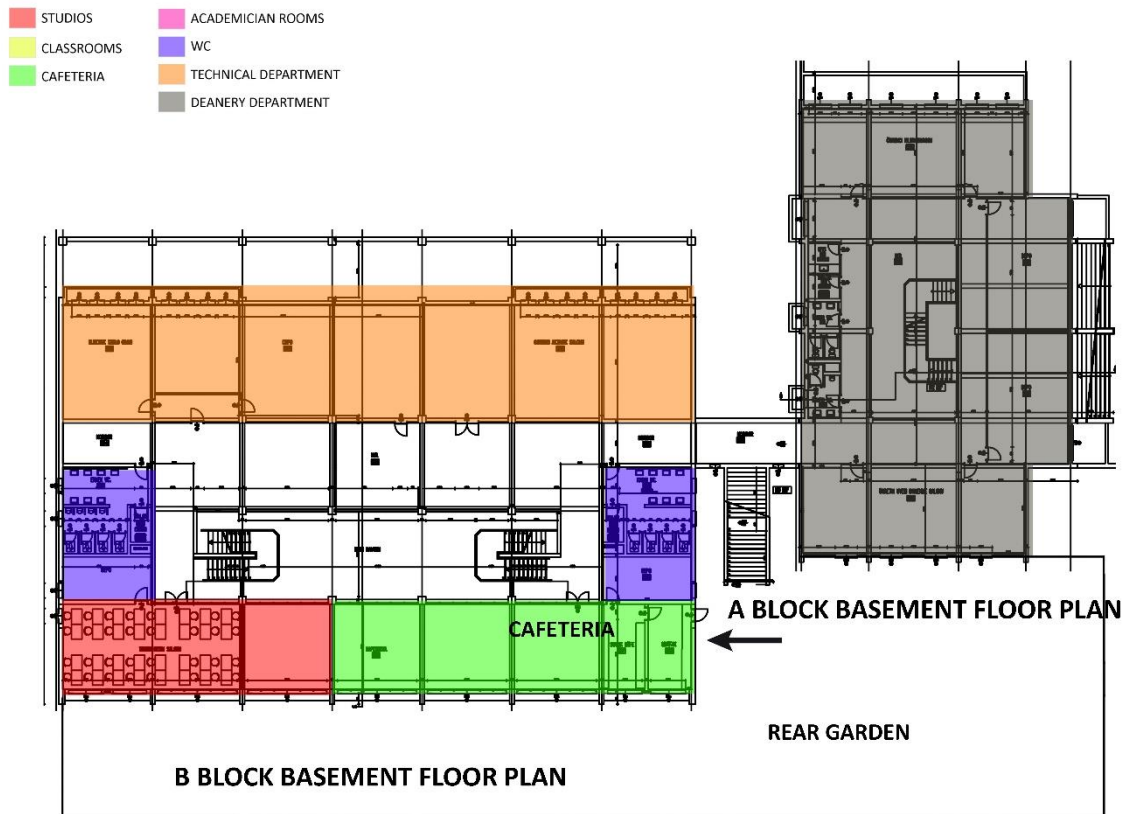


Figure 4. Basement floor plan of BAIBU faculty of architecture building showing connection to the garden

4.FINDINGS

The findings of the study reveal significant relationships between the integration values calculated through space syntax analysis and participants' perceptions of spatial warmth and coldness. This relationship is particularly important as it demonstrates the extent to which formal spatial characteristics align with or diverge from user experiences. The comparative analysis was conducted on a space-by-space basis.

Among the spaces that exhibit both high integration values and are marked as “warm” in participant maps, the entrance hall and studio areas on the ground floor stand out. This indicates that centrally located, guiding spaces within the building are also perceived by users as frequently used and meaningful zones (Figure 5).

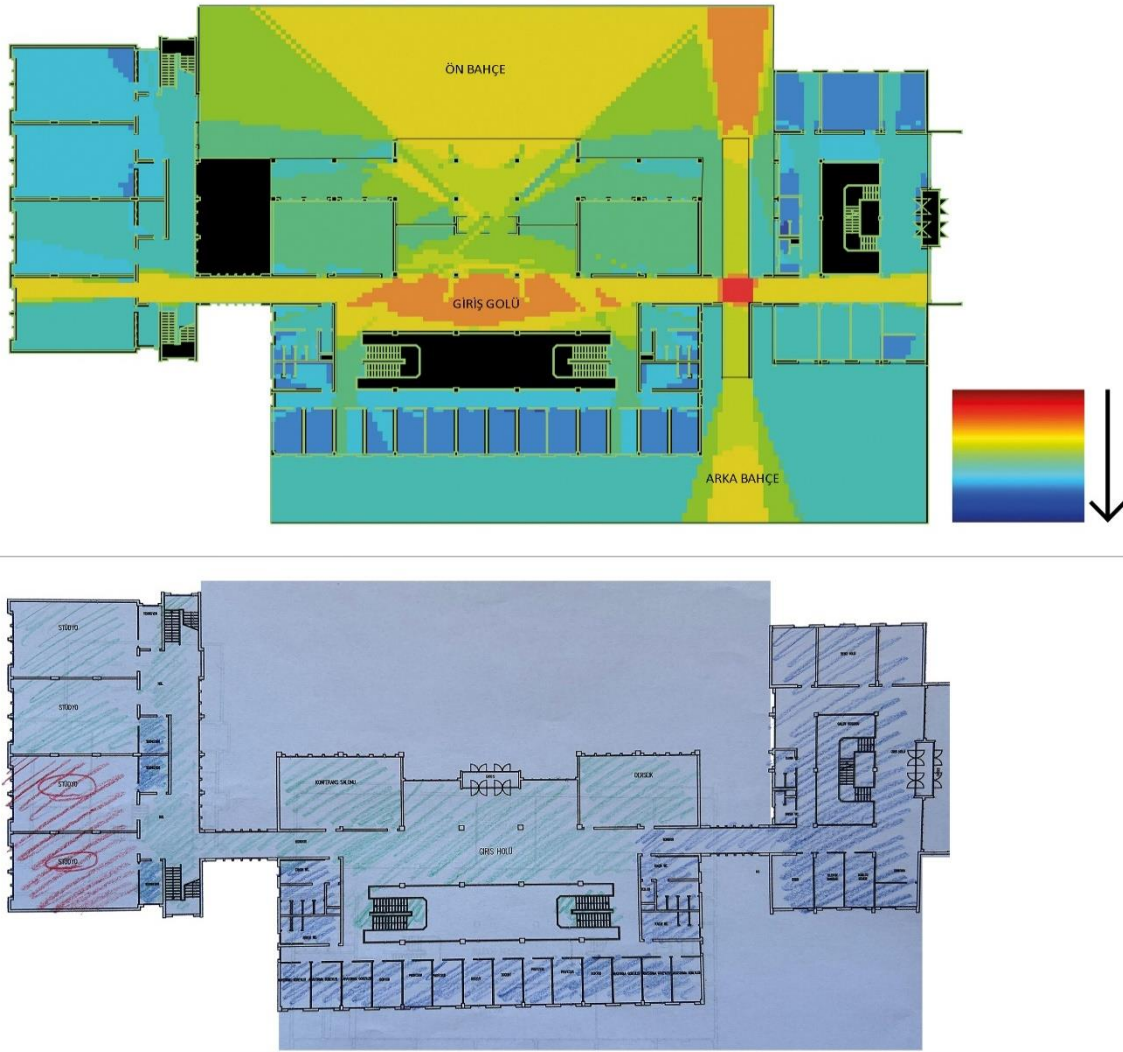


Figure 5. Ground floor integration graph and sample participant map of the BAIBU faculty of architecture building

However, there are also spaces with high integration values that were perceived as “cold” by participants. For example, the prayer room and technical unit located in the basement, although structurally connected, were perceived as inaccessible or irrelevant in terms of user experience. This indicates that despite physical accessibility, the functional role of a space may not be cognitively or perceptually represented. Conversely, the basement areas opening onto the cafeteria and rear garden, while possessing only moderate integration values in the syntactic analysis, were marked with high warmth by users. Such spaces gain greater significance through social and cultural functions that cannot be predicted solely by spatial analysis (Figure 6).

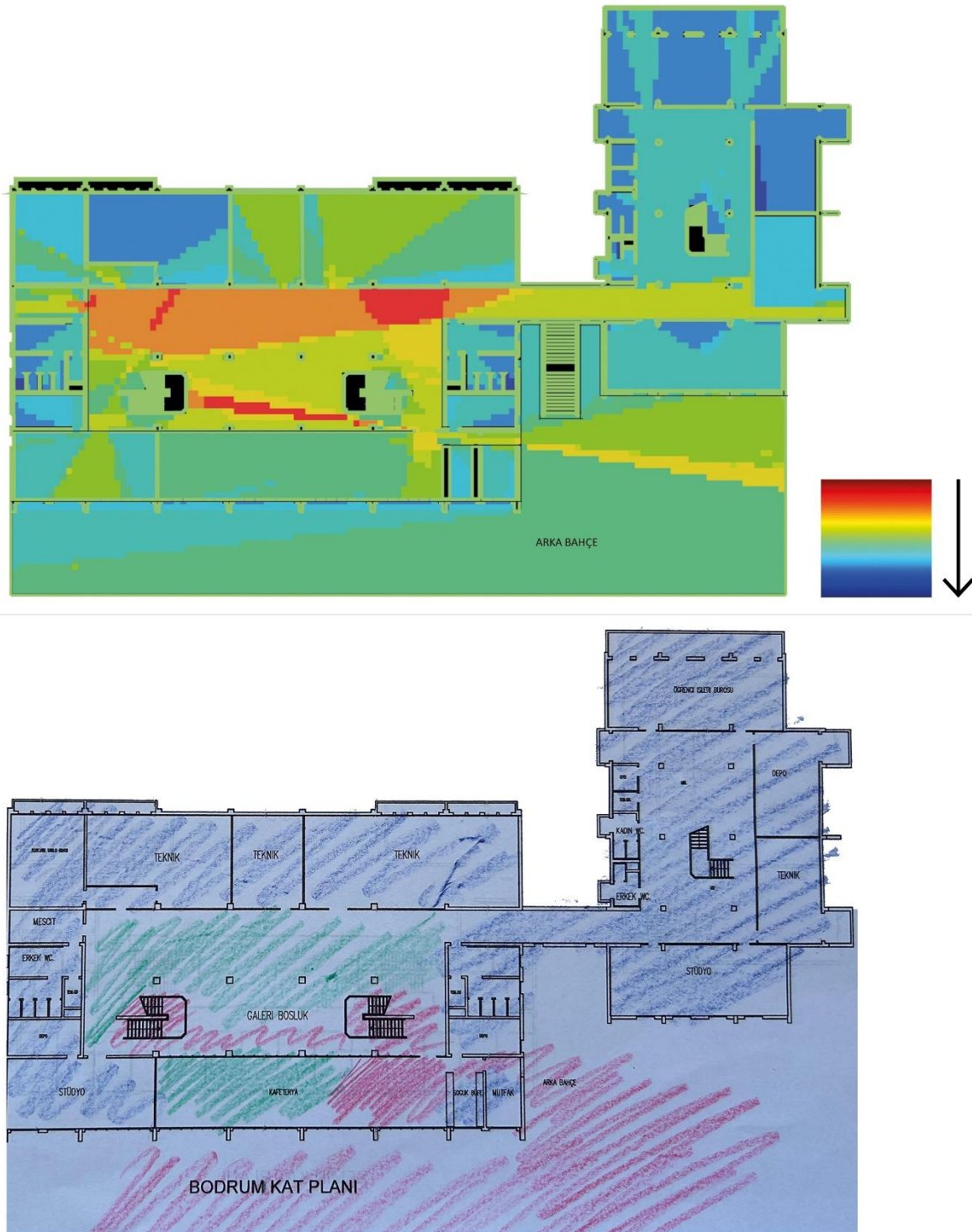


Figure 6. Basement floor integration graph and sample participant map of the BAIBU faculty of architecture building

Academic offices were rated low in both the space syntax analysis and participant maps across all floors. The enclosed, individual, and access-controlled nature of these spaces limits social interaction, which leads them to be perceived as segregated both physically and cognitively.

Similarly, vertical circulation areas and floor corridors, although offering moderate levels of integration, were generally perceived as cold zones by participants. This suggests that users primarily experience these areas as transitional spaces rather than sites for social engagement (Figure 7).

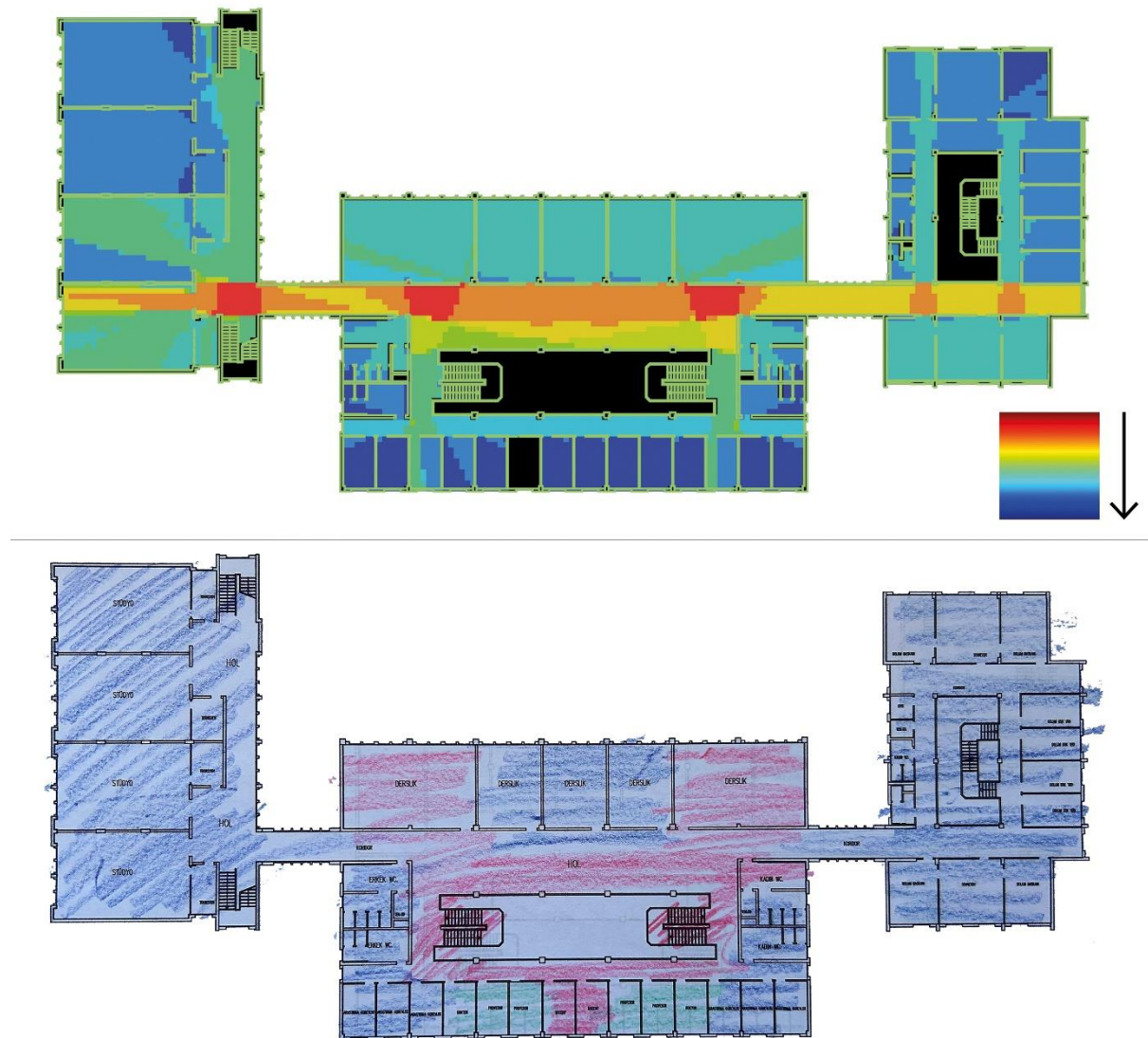


Figure 7. First floor integration graph and sample participant map of the BAIBU faculty of architecture building

According to the space syntax analysis, on the second floor of the building, the main corridors and the area surrounding the atrium in Block B stand out with moderate integration values. These areas provide a centrally organized layout with vertical circulation elements located on both sides, offering a degree of spatial continuity. However, due to a structural change in the floor plan, this connection does not extend to Block A, which is physically separated from Block B on the second floor. This disconnection weakens Block A's role within the spatial continuity of the building and results in a low integration value in the analysis.

Participant mapping data also supports this structural separation at a perceptual level. The areas marked by students are mostly located near the studios in Block C. Although Block C has low integration values in the spatial analysis, it is frequently used by students and perceived as a “warm” zone. This finding indicates that function and user experience can be more influential in spatial perception than formal accessibility alone.

Although the corridors of Block B on the second floor offer moderate integration according to the syntactic analysis, they were generally coded as neutral or “cold” in participant maps. This finding suggests that physical continuity alone does not generate a strong mental representation in users' minds; instead, users tend to assess spaces based on social intensity and functional relevance. On the other hand, the complete absence of markings in Block A at this level clearly indicates that areas with no physical access also fail to register in users' spatial perceptions (Figure 8).

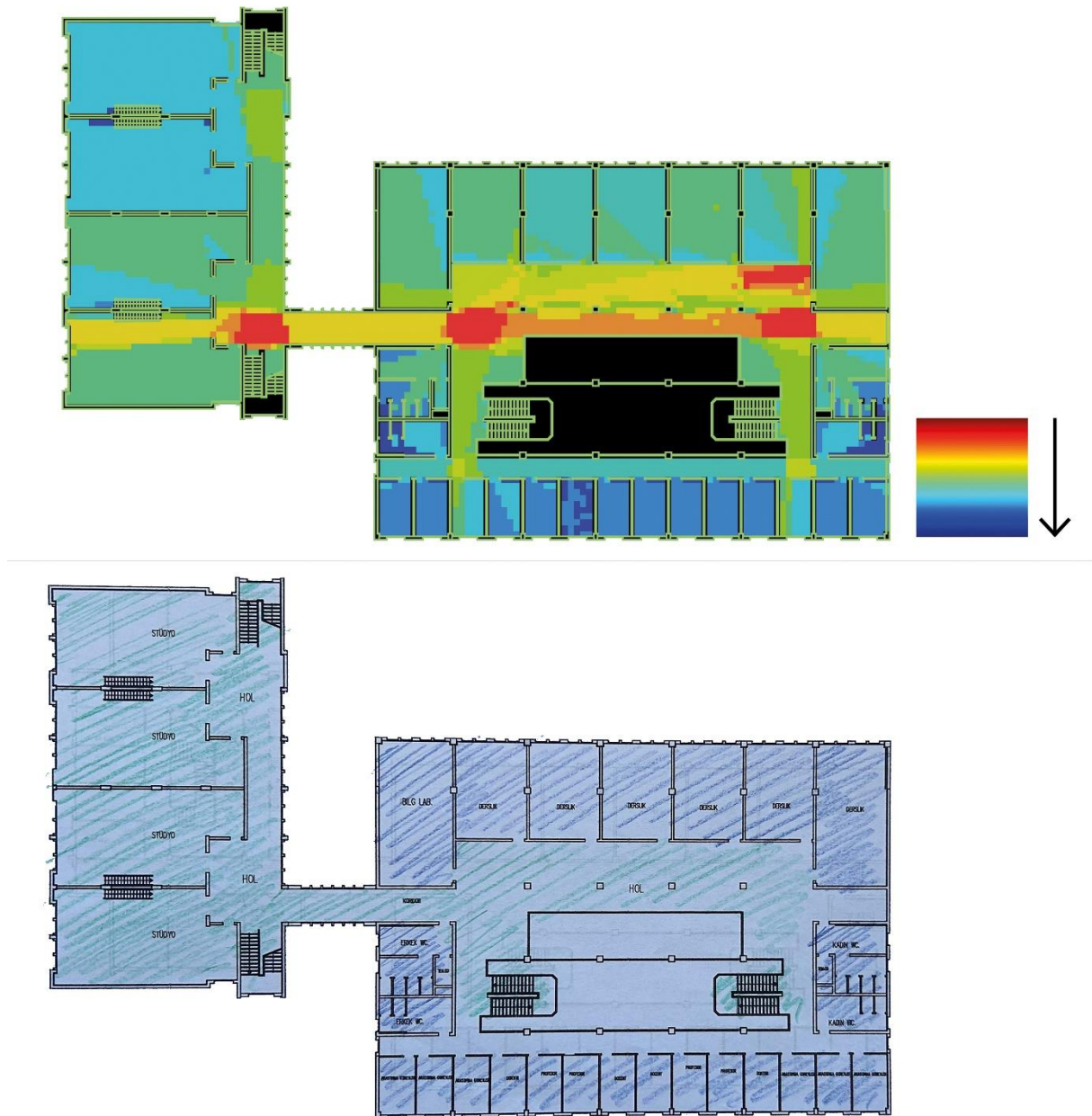


Figure 8. Second floor integration graph and sample participant map of the BAIBU faculty of architecture building

The outputs of the quantitative and qualitative methods used in spatial analysis are often interpreted on different levels. In this study, the integration values obtained through space syntax analysis and the perceived spatial warmth–coldness data derived from participatory mapping were comparatively evaluated across specific spatial units. For this purpose, a table was prepared to systematically present how various areas on different floors of the building are represented in both methods (Table 1).

Table 1. Comparison table of integration values from space syntax analysis and results from participant mapping

Floor / Area	Integration	Participant Map
Basement – Prayer Room & Technical Unit	High	Low
Basement – Administrative Office	Low	Low
Basement – Cafeteria → Rear Garden	Moderate	High
Ground – Entrance Hall	High	High
Ground – Studios	Low	Moderate
Ground – Connection Point	Very High	Low
Ground – Dean’s Office	Low	Low
1st Floor – Corridors	High	High
1st Floor – Studios	Low	Low
1st Floor – Academic Offices	Low	Low
2nd Floor – Corridors	Moderate	Moderate
2nd Floor – Studios	Low	Moderate
2nd Floor – Academic Offices	Low	Low

An examination of the table reveals that spaces frequently experienced by users -such as the studio areas and the main entrance hall -also exhibit high integration values in the space syntax analysis. In contrast, some social areas such as the cafeteria and the rear garden, while displaying lower or moderate integration values, were marked with high warmth in the participant maps. This indicates that social functions and usage habits play a determining role in spatial perception. On the other hand, spaces such as academic offices and administrative units in Block A were represented with low values in both methods, highlighting a direct relationship between limited spatial accessibility and user experience.

5.CONCLUSION

This study was conducted using a holistic approach that evaluates spatial perception through both structural configurations and user experiences. Accordingly, space syntax analysis and participatory mapping were employed together, and the same spatial system was interpreted using both quantitative and qualitative data. The findings demonstrate that these two methods complement each other in understanding spatial perception. While space syntax provides objective and measurable data on the level of integration within the physical structure, participant maps make users' subjective experiences, spatial preferences, and remembered uses visible in qualitative terms.

The comparative analyses show that the results from both methods largely overlap in areas such as outdoor connections and common-use zones. For instance, spaces like the entrance hall,

which have high integration values, were also marked as “warm” and frequently used by participants. This illustrates the significant impact of structural accessibility on user perception. However, a noteworthy finding is that some social hubs were heavily preferred by users despite having low integration values in the space syntax analysis. Spaces such as the cafeteria, studios, or specific classrooms became perceptually “warm” areas -not only because of their physical characteristics, but also due to their functional value shaped by users’ everyday practices, programmatic needs, and social interactions. This highlights that spatial experience cannot be reduced solely to geometric or accessibility-based data; it must be considered in conjunction with social dynamics and individual experiences.

One of the study’s unique contributions lies in directly adapting the red-to-blue color gradient used in space syntax analyses into the participatory mapping process. This visual language enabled participants to convey their experiences effectively, making qualitative data visually comparable with syntactic outputs. This method enabled a deeper evaluation, both analytically and intuitively, of the relationship between formal spatial patterns and subjective representations.

In conclusion, while users’ spatial perceptions and preferences do not entirely align with structural integration values, they demonstrate meaningful correlations. Therefore, the combined use of quantitative and qualitative methods in spatial perception research is crucial for generating more comprehensive and multilayered results. Such integrated approaches not only enhance the evaluation of existing spaces but also contribute significantly to the development of user-centered, highly responsive, and socially inclusive design strategies.

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EFFECT OF NON-BIODEGRADABLE ORGANIC SOLIDS IN MIXING WATER ON CEMENT MORTAR

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Abstract

The aim of this project is found out effect of non-biodegradable organic solids (NBOS) in mixing water on cement mortar. Various codes (IS:456, BS:3148, ASTM C94, EN1008) have given standards for mixing water for concrete. Indian standard code IS: 456-2000 has given a permissible limit of organic solids i.e., 200mg/L, but organic matter has biodegradable and non-biodegradable organic solids. IS:456 has not mentioned the permissible limit of non-biodegradable organic solids in mixing water on cement or concrete. Hence, the experimental study was carried out on the effect of non-biodegradable organic solids in mixing water on cement mortar. Compressive strength and setting times were performed in the laboratory. Results reveal that the compressive strength at 500 mg/L concentration is 55.65 MPa and 0.46% strength greater compared to reference cubes cast with Rainwater. The Initial and final setting times at concentration 500 mg/L are 150 minutes and 330 minutes respectively. The initial and final setting times at these concentrations got 43 minutes and 28 minutes greater than the reference cement.

Keywords: Clayey soil, Base shear, Story drifts, Displacement, Time period and Stabilization

CRACK DETECTION ON CONCRETE STRUCTURES USING CONVOLUTIONAL NEURAL NETWORKS ARCHITECTURE

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Abstract

Concrete structures and the associated cracking represent a persistent challenge within the fields of construction and civil engineering, a dilemma that has persisted for decades. Generally, cracks arise from the expansion and contraction of materials, which can lead to various forms of damage within buildings. Engineers typically address these damages and irregularities through manual inspections or by employing predictive models developed using machine learning techniques, thereby facilitating a comprehensive assessment of the structural health of the edifices. This research aims to implement tools such as the VGG 16 network model alongside other machine learning methodologies to identify cracks in concrete structures. We propose a model that integrates Convolutional Neural Networks (CNN) with a VGG-based architecture. For image processing and segmentation, we have employed the gradient boosting algorithm. The datasets utilized in this study were sourced from the Kaggle platform, and the Hugging Face Transformers library was leveraged for implementation. To assess the performance of the developed models, metrics including precision, accuracy, recall, and F1 score were employed. The accuracy achieved by our model can be benchmarked against the accuracy rates of Vision Transformers (ViT). The proposed method demonstrates significant validation accuracy rates, positioning it as a highly innovative and novel machine learning model capable of effectively predicting cracks in concrete structures.

Keywords: VGG16-Net; concrete cracks; concrete non-cracks; convolutional neural network; Structural health; concrete structures; ViT; vision transformers

DEMİR ŞELATÖRLERİ VE ANTİBİYOTİK KOMBİNASYONLARININ VİBRİO ANGUİLLARUM VE VİBRİO HARVEYİ'NİN KONTROLÜNDE SİNERJİK ETKİLERİ

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ÖZET

Su ürünleri yetiştiriciliği, günümüzde hızla büyüyen bir endüstridir. Ancak yoğun üretim ortamları bakteriyel hastalıkların kontrolü için antimikrobiyal madde kullanımının zorunlu hale getirmektedir. Bu durum su kaynaklı patojen bakterilerde antibiyotik dirençli suşların ortaya çıkmasına ve antimikrobiyal direnç (AMR) tehdidinin küresel düzeyde artmasına yol açmaktadır. Bu çalışmada, FDA onaylı üç demir şelatöründen ikisi olan Desferal (Deferoksamin) ve Enferox Easy (Deferipron) kullanılarak, bu ajanların su ürünleri yetiştiriciliğinde yaygın olarak kullanılan antibiyotiklerle (tetrasiklin, ampisilin, sülfametaksazol ve florfenikol) kombinasyonlarının *Vibrio anguillarum* ve *Vibrio harveyi* suşlarının hücre büyüme kapasiteleri ve biyofilm oluşumları üzerindeki etkileri değerlendirilmiştir. Bulgular, *V. anguillarum*'da Enferox'un %1 ve %2 konsantrasyonlarda büyümeyi baskıladığını, artan konsantrasyonlarda (%4 – 10) ise antagonistik etkileşim yaptığı görülmüştür. Aksine *V. harveyi*'de Enferox, test edilen tüm antibiyotik kombinasyonlarında hücre büyümesini desteklemiştir. Biyofilm oluşumu açısından değerlendirildiğinde, *V. anguillarum*'da hem Desferal hem de Enferox kombinasyonları yüksek biyofilm inhibisyonu sağlarken, *V. harveyi*'de Desferal'in belirli antibiyotiklerle kombinasyonlarında biyofilm oluşumunu yaklaşık %40 - %50 oranda baskıladığı gözlenmiştir. Elde edilen bulgular, FDA onaylı ve klinik olarak anemi tedavisinde kullanılan demir şelatörlerinin antibiyotiklerle birlikte kullanımının, su ürünleri yetiştiriciliğinde sinerjistik bir etki oluşturarak alternatif bir antimikrobiyal strateji olarak değerlendirilebileceğini ve AMR ile mücadelede potansiyel bir katkı sağlayabileceğini ortaya koymaktadır.

Anahtar Kelimeler: *Vibro* spp., Demir şelatörü, Antimikrobiyal direnç (AMR), su ürünleri yetiştiriciliği, antibiyotik

SYNERGISTIC EFFECTS OF IRON CHELATORS AND ANTIBIOTIC COMBINATIONS IN THE CONTROL OF *VIBRIO ANGUILLARUM* AND *VIBRIO HARVEYI*

ABSTRACT

Aquaculture is a rapidly growing industry today. However, intensive production environments necessitate the use of antimicrobial agents to control bacterial diseases. This situation leads to the emergence of antibiotic-resistant strains in waterborne pathogenic bacteria and the global threat of antimicrobial resistance (AMR). In this study, two of the three FDA-approved iron chelators, Desferal (Deferoxamine) and Enferox Easy (Deferiprone), were used to evaluate the effects of these agents in combination with antibiotics commonly used in aquaculture (tetracycline, ampicillin, sulfamethoxazole and florfenicol) on cell growth capacity and biofilm formation of *Vibrio anguillarum* and *Vibrio harveyi* strains. The findings showed that Enferox suppressed growth at 1% and 2% concentrations in *V. anguillarum*, while it had an antagonistic interaction at increasing concentrations (4–10%). On the contrary, Enferox supported cell growth in all tested antibiotic combinations in *V. harveyi*. When evaluated in terms of biofilm formation, both Desferal and Enferox combinations provided high biofilm inhibition in *V. anguillarum*, while Desferal in combination with certain antibiotics suppressed biofilm formation by approximately 40% - 50% in *V. harveyi*. The findings suggest that the use of FDA-approved iron chelators, which are used clinically in the treatment of anemia, together with antibiotics can be evaluated as an alternative antimicrobial strategy by creating a synergistic effect in aquaculture and can potentially contribute to the fight against AMR.

Keywords: *Vibrio* spp., Iron chelators, Antimicrobial resistant (AMR), aquaculture, antibiotics

1. INTRODUCTION

Aquaculture has become one of the fastest-growing sources of animal protein worldwide, particularly in low- and middle-income countries, contributing approximately 17% of the global animal protein intake (FAO, 2018). Since 2001, the increasing demand for animal-derived proteins, especially in rapidly developing economies, has driven the global aquaculture sector to grow at an average annual rate of 5.8%. Nevertheless, this expansion has been accompanied by the intensification of production systems and a concurrent rise in the incidence of waterborne pathogens. These developments have led to increased reliance on antimicrobial agents, subsequently accelerating the emergence and dissemination of antimicrobial resistance in farmed aquatic species (Miller et al., 2018).

Bacterial fish diseases represent a major cause of economic losses across aquaculture industries worldwide (Austin & Austin, 2016). Among these, vibriosis is recognized as one of the most prevalent bacterial infections, affecting not only a wide range of economically significant cultured species but also various marine and freshwater fish (Mohamad et al., 2019). Vibriosis has been reported to cause mass mortalities and substantial economic losses in aquaculture systems (Ina-Salwany et al., 2019). Species such as *Vibrio anguillarum*, *V. parahaemolyticus*, *V. damsela*, *V. vulnificus*, *V. alginolyticus*, *V. harveyi*, *V. ordalii*, *V. owensii*, and *V. campbellii* are among the most frequently isolated strains associated with vibriosis in a wide range of finfish species (Austin & Austin, 2012). In particular, infections caused by antibiotic-resistant *Vibrio* spp. are emerging as a growing threat to the sustainability and productivity of the aquaculture industry.

Iron is an essential element for most life forms due to its redox properties, which allow it to participate in a wide array of biochemical reactions (Dev et al., 2017). For optimal growth, bacteria require iron concentrations in the range of 10^{-5} to 10^{-7} M. Under aerobic and neutral pH conditions, however, iron predominantly exists in the ferric [Fe(III)] form, which has extremely low solubility (Braun et al., 1999). To overcome this limited bioavailability, bacteria secrete potent iron-chelating molecules known as siderophores, which exhibit a high affinity for ferric iron (Hider et al., 2011). Siderophores possess remarkably high ferric ion binding constants and can effectively sequester iron from host iron–protein complexes (Raymond et al., 1984).

Iron chelators have been developed for the treatment of clinical conditions that cause iron overload, such as thalassemia. Currently, there are three iron chelators approved by the Food and Drug Administration (FDA): deferasirox (DFX), deferoxamine (DFO), and deferiprone (DFP). These small molecules can enter the cell and reduce excess iron accumulation. Deferasirox (Exjade®) is a tridentate iron chelator and is the first approved drug for oral use against chronic iron overload. Deferoxamine (Desferal®) is a trihydroxamate that can bind to both extracellular aluminum and iron. Deferiprone (Ferriprox®), on the other hand, has a higher affinity for iron, but can also bind to other metals such as zinc, copper, and aluminum (Gumbau-Brisa et al., 2020).

In this study, the effects of FDA-approved iron chelators Desferal (Deferoxamine) and Enferox Easy (Deferiprone) in combination with tetracycline, ampicillin, sulfamethoxazole and florfenicol antibiotics, which are widely preferred in aquaculture, on cell growth capacity and biofilm formation potential of *Vibrio anguillarum* and *Vibrio harveyi* strains known as vibriosis

agents will be investigated. The findings to be obtained in this context aim to contribute to the development of alternative or complementary strategies to current antibiotic applications.

2. MATERIAL AND METHODS

2.1. Activation and Purity Control of Bacterial Strains

In this study, *V. anguillarum* and *V. harveyi* isolates isolated and defined within the scope of the Ege University Scientific Research Project coded FYL-2021-23352 and 32655 were used. Strains taken from the stock were inoculated into TSB medium containing 1.5% NaCl for activation. After incubation at 27°C for 24-48 hours, the tubes with turbidity were cultured onto selective and differential TCBS (Thiosulfate Citrate Bile Sucrose) Agar medium for *Vibrio harveyi* and *Vibrio anguillarum*.

2.2. Determination of Minimum Inhibitory Concentration (MIC)

The MIC values of tetracycline, ampicillin, sulfamethoxazole, and florfenicol against the bacterial strains were determined using the 96-well microdilution method. Equal cell densities from previously activated *V. anguillarum* and *V. harveyi* isolates were transferred into the wells of 96-well microplates. The antibiotics were serially diluted (50%, 25%, 12.5%, 6.25%, 3.12%, 1.56%, 0.78%, 0.39%, and 0.19% v/v) and added to the growth medium. Control groups included wells containing only sterile medium and wells containing both sterile medium and bacterial inoculum. After incubation at 26°C for 24 hours, 0.1% Triphenyltetrazolium chloride (TTC) was added to each well, and MIC values were determined based on colorimetric changes indicating bacterial viability.

2.3. Determination of Bacterial Growth Capacity

Vibrio anguillarum and *Vibrio harveyi* strains were inoculated into 96-well microplates in triplicate using TSB liquid medium supplemented with 1.5% NaCl. In each well, 100 µL of TSB medium and 50 µL of bacterial suspension were added. Commercially available iron chelators, Desferal® (500 mg IM/IV/SC) and Enferox Easy® (360 mg), were prepared at final concentrations of 0.5 µg/mL, 1 µg/mL, 2 µg/mL, 4 µg/mL, and 5 µg/mL. Sub-inhibitory concentrations (below the determined MIC values) of antibiotics—tetracycline, ampicillin, sulfamethoxazole, and florfenicol—were added to each chelator concentration group in equal proportions. Control groups were prepared with bacteria, the corresponding iron chelator concentrations, and sterile growth medium. The prepared microplates were incubated at 27 °C for 24 hours. Following incubation, optical density (OD) at 600 nm was measured using a microplate reader to evaluate bacterial growth.

2.4. Determination of Biofilm Production Capacity

The biofilm-forming capacities of *Vibrio anguillarum* and *Vibrio harveyi* isolates were assessed using the crystal violet (CV) staining method as described by O'Toole (1998). Flat-bottom 96-well microplates were used in the experiments. Iron chelators Desferal® (500 mg IM/IV/SC) and Enferox Easy® (360 mg) were added to the medium at concentrations of 0.5 µg/mL, 1 µg/mL, 2 µg/mL, 4 µg/mL, and 5 µg/mL. To each iron chelator concentration, the respective antibiotics were added at sub-MIC levels in equal volumes. The microplates were incubated at 27 °C for 48 hours. After incubation, planktonic cells were carefully removed, and the wells were gently washed with PBS. The remaining biofilm cells were stained with 0.1% crystal violet solution for 15 minutes. Excess dye was then removed, and the wells were washed again with PBS. The fixed biofilms were solubilized with 95% ethanol, and biofilm biomass was quantified by measuring absorbance at 590 nm using a microplate reader.

3. RESULTS AND DISCUSSION

3.1. Purity Control of Microorganisms

To revive the *Vibrio anguillarum* and *Vibrio harveyi* strains used in this study, initial inoculation was performed into TSB broth supplemented with 1.5% NaCl, followed by subculturing onto Thiosulfate Citrate Bile Salts Sucrose (TCBS) agar, a selective medium for *Vibrio* spp. Incubation was carried out at 27 °C for 24 hours. Following incubation, characteristic colony morphologies were observed on TCBS agar. Both strains formed yellow colonies on the green-colored medium (Figure 1). This appearance is consistent with the literature and is considered a typical trait of *Vibrio* species capable of fermenting sucrose (Larsen et al., 1982). The colony morphologies of *V. harveyi* and *V. anguillarum* observed on the selective medium confirmed both the viability of the strains and the successful achievement of pure cultures.

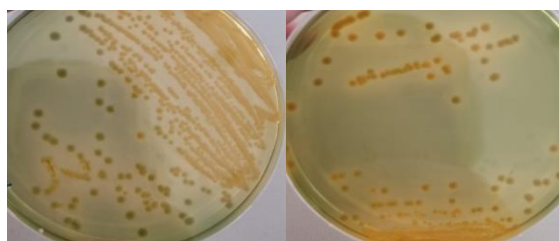


Figure 1. Pure colony morphology of *Vibrio* isolates on TCBS agar.

3.2. Determination of Minimum Inhibitory Concentration (MIC)

The susceptibility of *Vibrio anguillarum* and *Vibrio harveyi* strains to tetracycline, ampicillin, sulfamethoxazole, and florfenicol was assessed using the microdilution method in 96-well

microplates. Each antibiotic was tested at a range of concentrations. Following 24 hours of incubation at 27 °C, 2,3,5-Triphenyl tetrazolium chloride (TTC) was added to each well, and color changes indicating metabolic activity were monitored. The last well showing no visible color change was recorded as the minimum inhibitory concentration (MIC). Based on the results, the *V. anguillarum* strain was found to be susceptible to all tested antibiotics, exhibiting no resistance. In contrast, the *V. harveyi* strain showed susceptibility to tetracycline, but demonstrated resistance at 50 µg/mL for both ampicillin and sulfamethoxazole, and at 3.12 µg/mL for florfenicol (Table 1).

Table 1. The minimum inhibitory concentration (MIC) values of *Vibrio anguillarum* and *Vibrio harveyi* isolates against tetracycline, ampicillin, sulfamethoxazole and florfenicol are presented.

	Tetracycline	Ampicillin	Sulfamethoxazole	Florfenicol
<i>V. anguillarum</i>	0.19 (S)	0.19 (S)	0.19 (S)	0.19 (S)
<i>V. harveyi</i>	0.19 (S)	50 µg/MI (R)	50 µg/mL(R)	3.12 µg/mL(R)

*S: Sensitive; R: Resistance

Antibiotics are widely used in aquaculture to prevent and treat bacterial diseases. However, this leads to the development of antibiotic and multidrug resistance in bacterial populations in the environment, making the control and treatment of infections increasingly difficult (Avsever et al., 2010). This study found that the *V. harveyi* strain was particularly resistant to ampicillin, sulfamethoxazole and florfenicol. In contrast, the *V. anguillarum* strain was susceptible to all the antibiotics tested. Similar studies in the literature also support these findings. In a study by Deng et al. (2020), moderate to high levels of tetracycline resistance were reported in *Vibrio* species, whereas lower levels of resistance or susceptibility were observed for sulfamethoxazole, ampicillin, and florfenicol. These differences may vary depending on the isolate type, source, regional antibiotic use frequency, and environmental conditions.

3.3. Analysis of Cell Growth in the Presence of Iron Chelators

The effects of various concentrations (0.5 µg/mL, 1 µg/mL, 2 µg/mL, 4 µg/mL, 5 µg/mL) of the commercial Desferal and Enferox iron chelators in combination with antibiotics at sub-MIC values on the growth of *V. anguillarum* and *V. harveyi* strains were investigated. It was observed that Desferal and Enferox chelators had an effect on the growth capacity of *V. anguillarum* cells when added to the medium with antibiotics at MIC values. Significant growth inhibition was demonstrated by Enferox when used with tetracycline and ampicillin, particularly at

concentrations of 0.5 $\mu\text{g/mL}$ and 1 $\mu\text{g/mL}$. This effect decreases as the concentration increases, and it seems that there may be a possibility of antagonistic interaction at high rates. Combinations of sulfamethoxazole and florfenicol generally showed lower inhibition (Fig. 2).

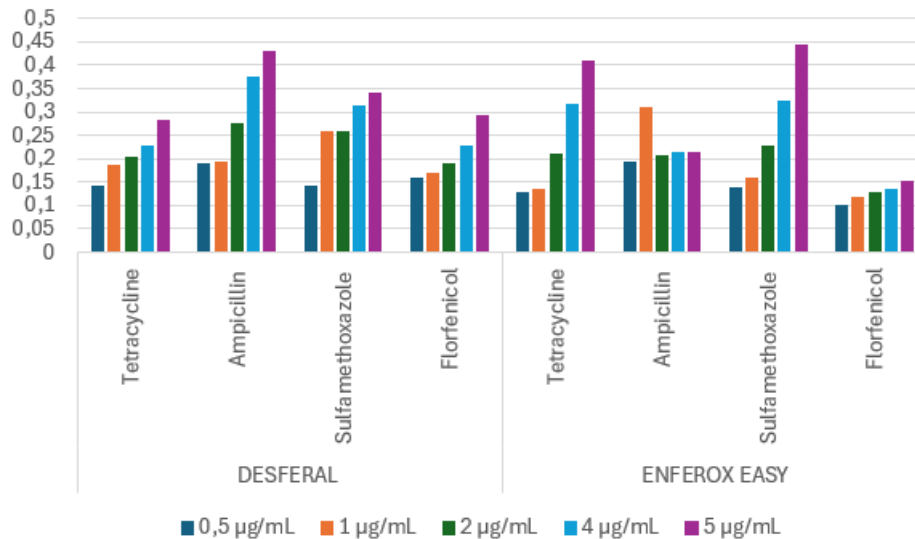


Fig. 2. Effect of iron chelator and antibiotic combinations on cell growth of *V. anguillarum*

When the cell growth capacity of *Vibrio harveyi* is examined, it is seen that Desferal and Enferox have different effects. It was observed that Enferox supported cell growth together with all tested antibiotics. Notably, Enferox exhibited a weaker inhibitory effect than Desferal, particularly when used in conjunction with florfenicol (Fig. 3).

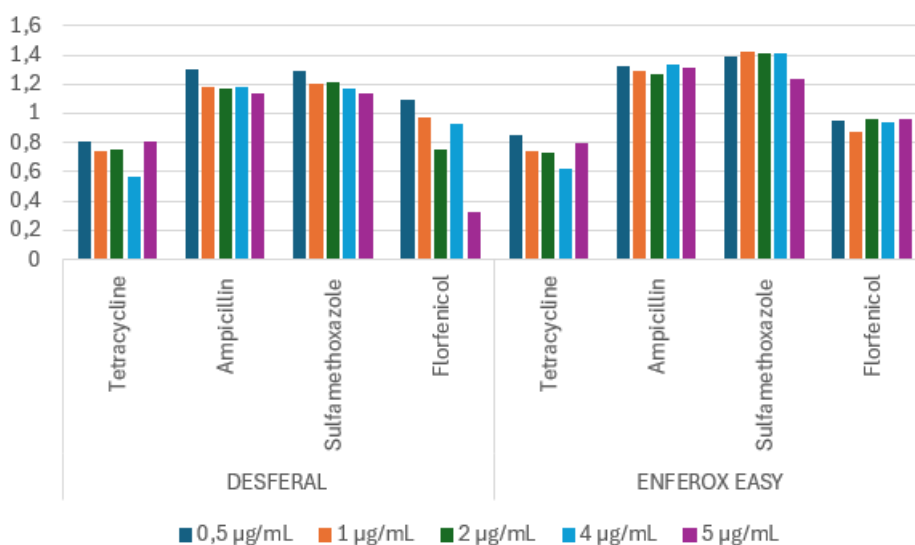


Fig. 3. Effect of iron chelator and antibiotic combinations on cell growth of *V. harveyi*

Iron is a vital element for the multiplication of pathogenic bacteria during the course of an infection. Consequently, bacteria have evolved sophisticated iron acquisition systems, such as siderophores, to circumvent host defences (Ratledge, 2007). Siderophores function as virulence factors by promoting microbial growth. The effects of FDA-approved iron chelators, such as deferoxamine and deferiprone, on certain bacteria have been the subject of prior research. In particular, deferiprone has been reported to inhibit the growth of important pathogens such as *Pseudomonas aeruginosa* at high concentrations (Banin et al., 2005; Thompson et al., 2012). This effect is due to the removal of iron from the access of the microorganism. However, it was observed that deferoxamine did not inhibit growth at similar concentrations and its antimicrobial effect was limited. It is important to note that some iron chelators may exhibit bidirectional effects, i.e. they may both suppress and, in some cases, promote microbial growth (Kontoghiorghes et al., 2010). Consequently, the combination of chelators with antibiotics has the potential to produce synergistic effects in situations where antibiotics alone may be ineffective.

3.4. Determination of biofilm production capacity in the presence of iron chelators

Vibrio cells were incubated in wells containing combinations of iron chelators and antibiotics at Sub-MIC concentration. Biofilm inhibition results of *Vibrio anguillarum* showed that DESFERAL in combination with Tetracycline exhibited a strong biofilm inhibition of over 70% at high concentrations (4 µg/mL, 5 µg/mL) and over 70% at 4 µg/mL concentration with Ampicillin. In contrast, the combination of sulfamethoxazole with DESFERAL provided more moderate, yet still significant, inhibition, ranging from 45% to 65%. Conversely, ENFEROX demonstrated effective inhibition of approximately 80% with tetracycline at concentrations of 0.5 µg/mL and 4 µg/mL, and over 70% with ampicillin at 4 µg/mL. Combining Florfenicol with ENFEROX produced high levels of inhibition (75–85%) at all concentrations, whereas combining Sulfamethoxazole with ENFEROX produced a wide range of inhibition (15–75%) (Fig 4).

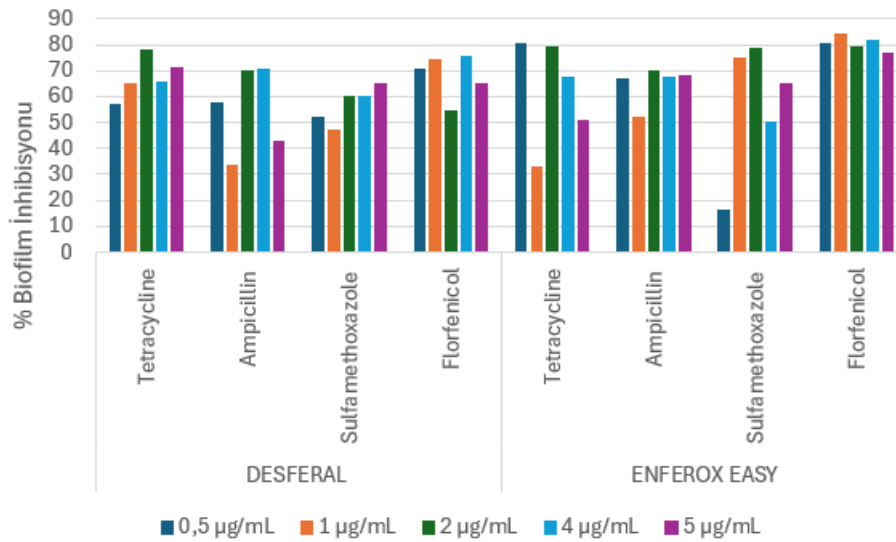
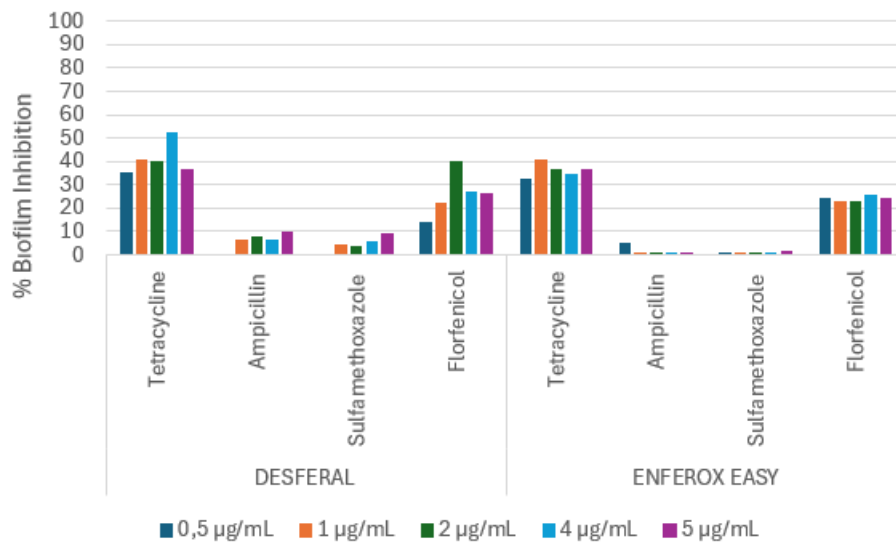


Fig 4. Effect of iron chelators and antibiotic combinations on biofilm production in *V. Anguillarum*

When the biofilm inhibition graph of *Vibrio harveyi* was analysed, it was observed that desferalin provided the highest biofilm inhibition (over 50%) with tetracycline at a concentration of 4 µg/mL, showed low inhibition (~5-10%) with ampicillin and sulfamethoxazole, and exhibited an effective inhibition with florfenicol at a concentration of 2 µg/mL (~40%). Enferox was found to provide biofilm inhibition at low concentrations (~20-25%) with tetracycline and florfenicol, but almost no biofilm inhibition with ampicillin and sulfamethoxazole (Fig. 5).



Şekil 5. The impact of combinations of iron chelators and antibiotics on the production of biofilms by *V. harveyi*

Bacterial biofilms represent a significant cause of morbidity and mortality due to infectious diseases and play a critical role in the emergence of treatment-resistant infections. Consequently, the determination of the biofilm formation capacity of pathogens, in conjunction with the discovery of compounds exhibiting antibiofilm activity, occupies a pivotal role in the formulation of efficacious treatment strategies. A plethora of studies in the extant literature have revealed the potential of iron chelators in this particular context. For example, Temel et al. (2024) evaluated the effect of iron depletion by applying deferoxamine (DFO) on preformed biofilms in vitro and reported a more than 60% reduction in biofilms, especially in carbapenem-resistant *Acinetobacter baumannii* (CRAB) strains. Similarly, Visca et al. (2013) also demonstrated the antibiofilm effects of DFO, deferiasirox, and deferiprone against various bacterial and fungal species. Moreau-Marquis et al. (2009) applied a combination of tobramycin and iron chelators (DFO or deferiasirox) on *Pseudomonas aeruginosa* biofilms, resulting in approximately 90% reduction in biofilm biomass and a 7 log unit decrease in bacterial viability. However, some studies suggest that the effect of iron deficiency on biofilm formation may vary depending on the microorganism species. For example, in a study by Gentile and colleagues, it was reported that the biofilm formation capacity of *A. baumannii* strains under iron deprivation was not significantly affected (Nazik et al., 2015). Similarly, experiments with *Aspergillus fumigatus* reported that DFO had no significant inhibitory or stimulatory effects on planktonic cell growth. The data obtained in this study show that the use of iron chelators in combination with antibiotics in *Vibrio anguillarum* isolates resulted in high levels of biofilm inhibition. In contrast, the percentage of inhibition was observed at a lower level in *Vibrio harveyi* isolates. These findings suggest that iron chelators have a significant potential as antibiofilm agents, although they may show species-specific differences when used in combination with antibiotics. This situation is promising for the development of new generation treatment strategies targeting iron bioavailability in the control of aquaculture pathogens.

CONCLUSIONS

In conclusion, our findings suggest that the combination of iron chelators—Deferal (Deferoxamine) and Enferox Easy (Deferiprone)—widely used in the treatment of thalassemia and antibiotics may increase antibiotic efficacy. This synergistic interaction may be effective against biofilm-associated infections caused by *Vibrio anguillarum* and *Vibrio harveyi*. The prevalence of high rates of antibiotic resistance and the rapid development of resistance even to the newest antimicrobial agents highlight the urgent need for innovative treatment approaches to combat infections. In today's world, where antibiotic discovery is limited and antibiotic resistance causes global health problems, studies on drug repositioning are becoming

increasingly important. Iron chelation stands out as a promising strategy in combating drug-resistant pathogens. Further research on the effects of iron chelators on microorganisms and their interactions with antibiotics will make significant contributions to infection control. The use of iron chelators in combination with antibacterial agents may increase susceptibility to antibiotics, providing clinical benefits in the treatment of outbreaks in aquaculture.

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INHIBITION OF *P. AERUGINOSA*, A ESCAPE PATHOGENS, WITH THE QUORUM QUENCHING APPROACH

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ÖZET

Pseudomonas aeruginosa, hastane enfeksiyonlarıyla ilişkili önemli bir fırsatçı patojendir ve yüksek düzeyde çoklu ilaç direnci gösterir. Bakterilerde hücre yoğunluğuna bağlı bir düzenleyici sistem olan çoğunluk algılama (QS), biyofilm oluşumu da dahil olmak üzere virülans faktörlerinin düzenlenmesinde kritik bir rol oynar. Bu çalışma, *Bacillus cereus* tarafından üretilen ekstrasellüler laktonaz enziminin *P. aeruginosa* QS mekanizması üzerindeki çoğunluk söndürme (QQ) potansiyelini araştırmayı amaçlamıştır. Bu amaçla bakteriyel suşlar kontrollü koşullar altında aktive edilerek ve *B. cereus* izolatlarının AHL laktonaz üretimi indüklenmiştir. *B. cereus* süpernatantlarının *P. aeruginosa* üzerindeki etkileri büyüme eğrisi analizi, membran potansiyeli ölçümü ve biyofilm oluşumu testleri yoluyla değerlendirilmiştir. QQ pozitif *B. cereus* süpernatantları *P. aeruginosa*'nın büyümesini önemli ölçüde etkilemezken, membran potansiyelinde azalmaya neden olmuştur. Daha da önemlisi, biyofilm oluşumu *B. cereus* izolatlarının QQ aktivitesi tarafından çeşitli derecelerde engellenmiştir. Test edilen suşlar arasında, G30 izolatı %35,2 ile en yüksek biyofilm inhibisyonunu sağlamıştır. Bulgularımız, AHL laktonaz enzimine sahip *B. cereus* suşlarının *P. aeruginosa* virülansını azaltarak antimikrobiyal dirençle mücadele etmek için umut verici bir alternatif strateji sunabileceği yönündedir.

Anahtar Kelimeler: *P.aeruginosa*, *B. cereus*, Quorum sensing, Quorum quenching, biyofilm

INHIBITION OF ESKAPE PATHOGENE *P. AERUGINOSA* WITH QUORUM QUENCHING APPROACH

ABSTRACT

Pseudomonas aeruginosa is an important opportunistic pathogen associated with nosocomial infections and shows a high level of multidrug resistance. Quorum sensing (QS), a cell density-dependent regulatory system in bacteria, plays a critical role in the regulation of virulence factors including biofilm formation. This study aimed to investigate the quorum quenching (QQ) potential of extracellular lactonase enzymes produced by *Bacillus cereus* on the QS mechanism of *P. aeruginosa*. For this purpose, bacterial strains were activated under controlled conditions and AHL lactonase production by *B. cereus* isolates was induced. The effects of *B. cereus* supernatants on *P. aeruginosa* were evaluated by growth curve analysis, membrane potential measurement, and biofilm formation tests. QQ positive *B. cereus* supernatants did not significantly affect the growth of *P. aeruginosa* but caused a decrease in membrane potential. More importantly, biofilm formation was inhibited to various degrees by the QQ activity of *B. cereus* isolates. Among the tested strains, G30 isolate provided the highest biofilm inhibition with 35.2%. Our findings suggest that *B. cereus* strains possessing AHL lactonase enzyme may offer a promising alternative strategy to combat antimicrobial resistance by reducing *P. aeruginosa* virulence.

Keywords: *P. aeruginosa*, *B. cereus*, Quorum sensing, Quorum quenching, biofilm

1.INTRODUCTION

One of the most critical issues currently threatening healthcare systems is hospital-acquired infections caused by antibiotic resistant bacteria (Centers for Disease Control and Prevention [CDC], 2019). In this context, particular attention has been drawn to ESKAPE pathogens that can develop high levels of resistance to antibiotics and significantly limit treatment options (Boucher et al., 2009). This group includes *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa* and *Enterobacter* species (Rice, 2008). These pathogens are associated with high morbidity and mortality rates in infected individuals and significantly reduce the effectiveness of antibiotic treatments (Pendleton et al., 2013).

P. aeruginosa, a member of the ESKAPE group, is a Gram negative, aerobic and motile bacterium known for its exceptional resistance to environmental conditions (Lister et al., 2009). Thanks to its wide metabolic diversity, it can survive in a wide variety of habitats, including moist soil, water and the surfaces of medical devices. This organism acts as an opportunistic

pathogen, especially in immunocompromised individuals (Moradali et al., 2017). *P. aeruginosa* can cause various clinical conditions such as respiratory tract infections, urinary tract infections, wound infections and septicemia (Gellatly and Hancock, 2013).

One of the most important factors that makes this pathogen difficult to treat is its ability to form biofilms. A biofilm is a structured community formed when bacteria adhere to surfaces and settle into a self-produced extracellular polymeric matrix (Flemming & Wingender, 2010). This matrix protects bacterial cells from antibiotics, host immune responses, and environmental stressors. Bacteria living in biofilms can exhibit up to 1,000 times more antibiotic resistance than their planktonic counterparts (Donlan & Costerton, 2002).

Another critical mechanism in the regulation of biofilm formation and virulence is quorum sensing (QS), a bacterial cell-cell communication system. QS enables cells to detect population density and coordinate the expression of specific genes, particularly those involved in virulence factors and biofilm development (Waters & Bassler, 2005). In *P. aeruginosa*, QS is primarily mediated by the *Las* and *Rhl* systems, which play important roles in environmental adaptation and host interactions (Venturi, 2006).

The global increase in antibiotic resistance has significantly compromised the efficacy of traditional antibacterial therapies. Consequently, there is an urgent need to develop new therapeutic strategies that target bacterial virulence factors rather than relying solely on bactericidal approaches (WHO, 2014). In this context, quorum sensing systems have emerged as promising targets for antivirulence-based therapies. Quorum quenching (QQ) strategies, which aim to disrupt bacterial communication by disrupting QS signaling molecules or blocking signal transduction, aim to suppress pathogenic behaviors without directly killing bacteria. Since these approaches do not impose lethal selective pressure, they have the potential to reduce the likelihood of resistance development compared to traditional antibiotics (Kalia, 2013).

2.METHODS

2.1. 2.1.Bacterial Strains and Culture Conditions

2.1.1.Activation of *P. aeruginosa*

Pseudomonas aeruginosa ATCC 15422 strain was retrieved from -80°C glycerol stock and incubated in Tryptic Soy Broth (TSB) at 37°C for 24 hours. Following incubation, the culture was streaked onto Tryptic Soy Agar (TSA) plates to confirm purity.

2.1.2.Activation of *B. cereus* Isolates

Bacillus cereus isolates previously characterized in earlier studies and identified to harbor the *aiiA* gene were preserved in -20°C glycerol stocks. The isolates G220 (Accession No: WP_098347486.1), G30 (Accession No: OP548103.1), and G33 (Accession No:

WP_000216587.1) were inoculated into TSB medium and incubated at 30 °C for 24 hours in a shaking incubator. Following incubation, turbid tubes were streaked onto TSA plates and incubated at 30 °C for 24 hours to ensure the purity of the resulting colonies.

2.2. Induction of AHL-Lactonase Production in *B. cereus*

Pure isolates containing the *aihA* gene were cultured on Minimal Isolation Medium (MIM). To enhance selectivity during the isolation of quorum quenching (QQ) bacteria capable of degrading AHL molecules, C6-HSL was added as the sole carbon source. In addition, Penicillin G was supplemented into the MIM medium to further strengthen the selective isolation of QQ bacteria (Bulut et al., 2023).

2.3. Investigation of the Effects of QQ Bacterial Supernatants on *P. aeruginosa* Growth

P. aeruginosa was activated in TSB medium. A 48-h growth curve analysis was performed using *P. aeruginosa* cultures treated with and without QQ bacterial supernatants. The first measurement was taken at OD600 at 0 h, followed by readings at 2, 4, 6, 12, 18, 24 and 30 h during incubation.

2.4. Investigation of the Effects of QQ Bacterial Supernatants on *P. aeruginosa* Membrane Potential and Biofilm Formation

The impact of QQ bacterial supernatants on membrane permeability was determined using a crystal violet uptake assay. *P. aeruginosa* suspensions (1×10^6 CFU/ml) were incubated in LB broth containing QQ supernatants or antibiotics. The antibiotic-containing LB broth served as a control to indicate membrane damage. After incubation, cells were collected in Falcon tubes and centrifuged at 5,000 rpm for 10 minutes. The cells were then washed twice with 50 mM PBS and centrifuged again at 5,000 rpm for 10 minutes. The resulting pellet was resuspended in PBS containing 10 µg/ml crystal violet.

At various time intervals (10, 20, 30, 40, and 60 minutes), 1 ml aliquots were taken, centrifuged at 10,000 rpm for 5 minutes, and the absorbance of the supernatants was measured at OD590nm. Crystal violet uptake percentage was calculated using the following formula:

$$\% \text{ dye uptake} = 100 - (\text{Sample OD} / \text{Crystal violet solution OD}) \times 100$$

The inhibitory effect of *Bacillus* spp. isolates on *P. aeruginosa* biofilm formation was evaluated based on the method described by O'Toole and Kolter (1998).

Biofilms formed by QQ supernatant-treated and untreated cells in microplate wells were quantified using the crystal violet staining method. Each well was washed three times with 1 M PBS and dried at 80 °C for 30 minutes. The same volume of 0.1% crystal violet solution was added to each well and incubated for 10 minutes. After staining, the wells were washed again

with PBS and filled with 95% ethanol. Absorbance was measured at 545 nm using a microplate reader. Biofilm inhibition percentage was calculated using the following formula:

$$\text{Biofilm inhibition (\%)} = [(\text{OD positive control} - \text{OD sample}) / \text{OD positive control}] \times 100$$

ODc: Optical density at 590 nm of control wells not treated with QQ;

ODt: Optical density at 590 nm of wells treated with QQ supernatants.

3.DENEYSEL SONUÇLAR

3.1. Activation of *P. aeruginosa* and *Bacillus* Isolates

To revive *P. aeruginosa* isolates preserved in -80°C glycerol stocks, cultures were inoculated into Tryptic Soy Broth (TSB) and incubated at 37°C for 24 hours. *Bacillus* spp. isolates previously obtained from environmental samples and characterized by the presence of the *aiiA* gene were also stored in -80°C glycerol stocks (20% glycerol). For use in this study, appropriate volumes of these stocks were inoculated under sterile conditions into TSB (Merck) liquid medium. Cultures were incubated at 30°C with shaking at 150 rpm for 24 hours. The active cultures obtained were prepared for subsequent experimental steps. Following incubation, tubes showing turbidity were streaked onto TSA plates, and after a 24-hour incubation at 30°C , yellow colonies were observed.

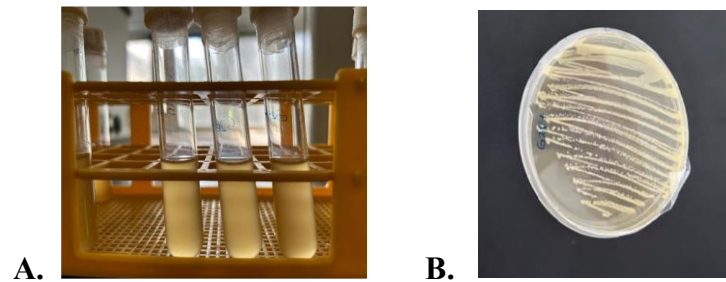


Figure 3.1. Images from microbiological cultures performed in the study (A: *P. aeruginosa* liquid culture, B: *Bacillus cereus* line culture)

3.2. Growth Curve Analysis of *P. aeruginosa* Treated with QQ Bacterial Supernatants

Growth media containing *P. aeruginosa* and *Bacillus* supernatants were subjected to periodic spectrophotometric measurements. The results showed that there was no statistically significant reduction in the growth of *P. aeruginosa* cells treated with *Bacillus* supernatants. This finding suggests that AHL-lactonase exerts its effect without killing the bacterial cells.

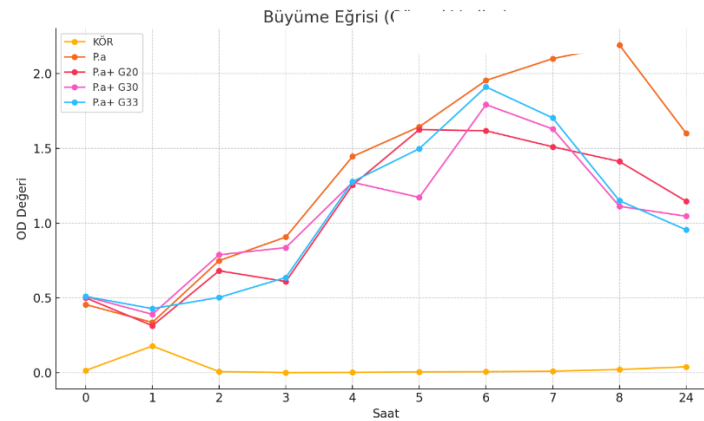


Figure 3.2. Growth Curve Analysis of *P. aeruginosa* Treated with Supernatants of QQ Bacteria (Positive sample: *P. aeruginosa* inoculated medium, Negative sample: Blank (sterile medium))

3.3. Effect of QQ *Bacillus* Supernatants on the Membrane Potential of *P. aeruginosa*

To investigate the effect of QQ *Bacillus* supernatants on the membrane mechanism of *P. aeruginosa*, a crystal violet (CV, 10 µg/ml) uptake assay was performed. CV uptake was monitored for up to 1 hour in the presence of QQ supernatants and Penicillin G (PenG).

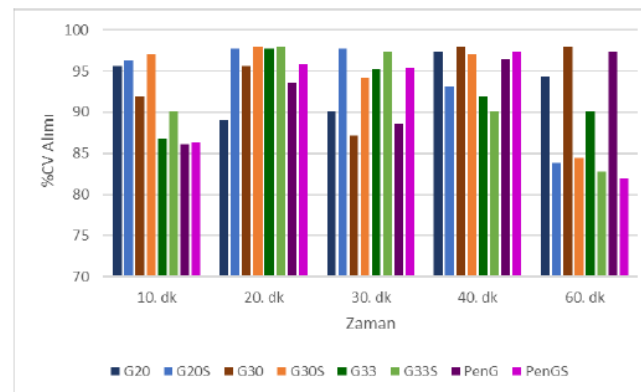


Figure 3.3. *P. aeruginosa* %CV uptake graph

The highest dye uptake (%97.93) was observed at the 20th minute in the presence of G30 and G33 supernatants. Similarly, G30 also showed the highest uptake at the 40th and 60th minutes (%97.93). The lowest dye uptake was recorded at the 60th minute in the presence of G33 supernatant (%82.79). In the presence of Penicillin G, the lowest dye uptake was observed at the 10th minute (%86.10), while the highest uptake was recorded at the 40th and 60th minutes (%97.31). These results indicate that the presence of *Bacillus* supernatants caused only a slight reduction in the membrane potential of *P. aeruginosa*, suggesting that these supernatants exert their effects without inducing lysis of the bacterial cells. Approaches that attenuate virulence

without killing the pathogen are of great significance in preventing resistance development. The findings of this study support this perspective.

3.4. Anti-Biofilm Activity of *Bacillus* Supernatants Against *P. aeruginosa*

Three different *Bacillus* spp. isolates (G20, G30, G33) were tested for their anti-biofilm effects against *P. aeruginosa*. In positive control wells containing only *P. aeruginosa* without the addition of QQ supernatants (i.e., without AHL-lactonase enzyme), the highest absorbance values were recorded. This confirmed that *P. aeruginosa* is capable of forming robust biofilms in the absence of lactonase activity.

In contrast, wells treated with the supernatants from isolates G20, G30, and G33, which contain AHL-lactonase enzyme, exhibited varying degrees of biofilm inhibition.

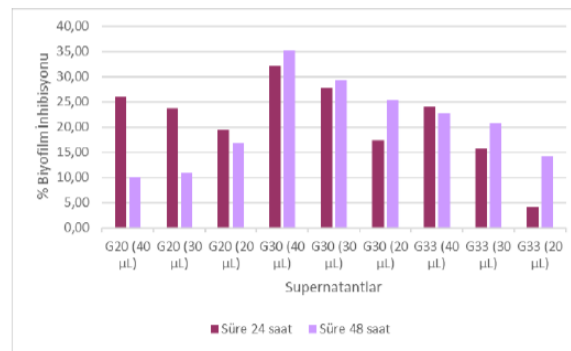


Figure 3.4. *P. aeruginosa* biofilm inhibition (%)

At the 24-hour mark, the lowest biofilm inhibition was observed in the well treated with 20 µL G33 supernatant (%4.16), whereas the highest inhibition was observed in the well treated with 40 µL G30 supernatant (%32). This indicates that G30 displayed the strongest QQ activity against *P. aeruginosa* biofilm at 24 hours. At 48 hours, the lowest biofilm inhibition was found in the well treated with 40 µL G20 supernatant (%10.16).

Overall, the results demonstrated that *Bacillus* supernatants inhibit biofilm formation by *P. aeruginosa* to varying extents. When compared to the control, all QQ supernatant treatments significantly reduced biofilm formation without affecting bacterial growth. As illustrated in the visual data, the highest biofilm inhibition (~%35.2) was achieved by the G30 isolate. A total of three QQ isolates—G30, G20, and G33—were able to inhibit biofilm formation by *P. aeruginosa* by more than 20%.

4.CONCLUSION

- In recent years, approaches targeting the suppression of virulence factors, rather than the direct elimination of antimicrobial-resistant pathogens, have gained increasing

attention. In this regard, inhibition of the QS system of the pathogenic *P. aeruginosa* represents an alternative strategy in the fight against antimicrobial resistance. Due to its ability to produce large amounts of enzymes and biopolymers, and its status as a probiotic organism generally recognized as safe (GRAS) by the FDA, *Bacillus* species are considered promising candidates in antimicrobial resistance research (Kalia et al., 2008; Singh et al., 2009).

- Even partial inhibition of biofilm formation is regarded as an alternative approach in combating pathogenic microorganisms. Accordingly, the G30 isolate, which demonstrated a high capacity for biofilm inhibition, is considered to possess notable potential for therapeutic applications against *P. aeruginosa*.
- Interfering with QS systems is considered an innovative strategy for the development of alternative antimicrobial agents aimed at preventing or mitigating bacterial infections. In this study, bacteria exhibiting quorum quenching (QQ) activity were identified and shown to be suitable candidates for anti-quorum sensing applications. Furthermore, our findings provide additional evidence that *Bacillus* species capable of degrading AHL molecules may also offer potential for degrading β -lactam antibiotics.

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GSE21942 VERİ SETİNE DAYALI BİYOİNFORMATİK ANALİZ: MULTİPL SKLEROZDA DİFERANSİYEL EKSPRESE OLAN MİKRORNA'LARIN TANIMLANMASI VE FONKSİYONEL ANOTASYONU

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ÖZET

Multipl Skleroz (MS), merkezi sinir sisteminde kronik enflamasyon ve miyelin hasarıyla seyreden otoimmün bir hastalıktır. Son çalışmalar, mikroRNA'ların (miRNA) Multipl Skleroz patogenezinde düzenleyici rol oynadığını göstermektedir. Bu çalışmada, Multipl Skleroz'da diferansiyel eksprese olan miRNA'ların belirlenmesi amacıyla GSE21942 veri seti (12 MS hastası, 15 sağlıklı kontrol; periferik mononükleer hücrelerinden elde edilen mikroarray datası) çeşitli biyoinformatik analizlere tabi tutulmuştur. Veri normalizasyonu ve istatistiksel analizler R programlama dili (GEOquery ve Limma paketleri) kullanılarak gerçekleştirilmiş, anlamlılık eşikleri düzeltilmiş $p \leq 0.05$ ve mutlak $\log_2$ kat değişimi ≥ 1 olarak belirlenmiştir. Analizler sonucunda, MS hastalarında üç artmış (miR-612, miR-6883-3p, miR-4738-3p) ve iki azalmış ekspresyon gösteren (miR-4680-3p, miR-7113-3p) miRNA tanımlanmıştır. Hedef gen tahminleri miRWalk ve TargetScan veri tabanlarının kesişim analiziyle yapılmıştır. Bu genlerin *nöronal apoptotik süreçler*, *glial hücre aktivasyonu* ve *immün yanıt* gibi kritik süreçlerde rol aldığı gösterilmiştir. Fonksiyonel anotasyon analizleri (GO, KEGG ve ClueGO), hedef genlerin özellikle *nörotrofin sinyali* ve *demir bağımlı hücre ölümü* gibi Multipl Skleroz'da rol oynayabilecek yollarda yoğunlaştığını ortaya koymuştur. Biyolojik prosesler Cytoscape yazılımıyla görselleştirilmiştir. Elde edilen bulgular, bu miRNA'ların Multipl Skleroz patogenezindeki olası rollerine değinmekle beraber, tanısal biyobelirteç ve terapötik hedef olarak kullanılma potansiyellerine işaret etmektedir. Çalışma, Multipl Skleroz'un moleküler mekanizmalarının anlaşılmasına katkı sağlamakta ve gelecekteki deneysel çalışmalar için yol gösterici olabilecek veriler sunmaktadır.

Anahtar Kelimeler: Multipl Skleroz, mikroRNA'lar, biyoinformatik, GSE21942, diferansiyel ekspresyon, biyobelirteç, immün yanıt.

IDENTIFICATION AND FUNCTIONAL ANNOTATION OF DIFFERENTIALLY EXPRESSED MICRO RNAS IN MULTIPLE SCLEROSIS: A BIOINFORMATICS ANALYSIS BASED ON GSE21942 DATASET

ABSTRACT

Multiple Sclerosis (MS) is a chronic autoimmune disorder characterized by neuroinflammation and demyelination in the central nervous system. Emerging evidence highlights the regulatory role of microRNAs (miRNAs) in MS pathogenesis. This study aimed to identify differentially expressed miRNAs in MS through comprehensive bioinformatics analysis of the GSE21942 dataset (12 MS patients, 15 healthy controls; PBMC samples). Data normalization and statistical analyses were performed using R programming language (GEOquery and Limma packages), with significance thresholds set at adjusted $p \leq 0.05$ and absolute $\log_2$ fold change ≥ 1 . Our analysis revealed three significantly upregulated (miR-612, miR-6883-3p, miR-4738-3p) and two downregulated (miR-4680-3p, miR-7113-3p) miRNAs in MS patients. Target gene prediction was conducted by intersecting miRWalk and TargetScan databases, demonstrating these genes' involvement in critical processes including neuron apoptotic process, glial cell activation, and immune responses. Functional annotation analyses (GO, KEGG, and ClueGO) revealed that the target genes are particularly enriched in pathways that may play a role in multiple sclerosis (MS), such as neurotrophin signaling and iron-dependent cell death. Biological processes were visualized using Cytoscape software.

The findings suggest that these miRNAs may serve as both diagnostic biomarkers and therapeutic targets in MS. Our study adds to the research on epigenetic regulation in MS and supports the development of miRNA-based diagnosis and treatment.

Keywords: Multiple Sclerosis, microRNAs, bioinformatics, GSE21942, differential expression, biomarker, immune response.

EVALUATING CARAWAY ESSENTIAL OIL AS A NATURAL ANTIMICROBIAL IN LOW-SODIUM CHEESE BRINE

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ABSTRACT

The increasing demand for naturally preserved foods has prompted the exploration of plant-derived antimicrobials as alternatives to synthetic preservatives, particularly in sodium-reduced products. This study investigates the application of caraway (*Carum carvi* L.) essential oil (EO), characterized by high carvone and limonene content, as a natural preservative in low-salt brine used for storing white brined cheese. The antimicrobial efficacy of the EO was evaluated against *Escherichia coli* and *Staphylococcus aureus* under varying conditions, including different storage temperatures and time intervals. Minimum inhibitory concentrations were identified at 0.12% (v/v) for *E. coli* and 0.25% (v/v) for *S. aureus*. Notably, the essential oil exhibited sustained bactericidal activity over a seven-day period without compromising the organoleptic integrity of the cheese, as confirmed through expert sensory analysis. Additionally, network-based bioinformatics analysis suggested that carvone and limonene target bacterial quorum sensing and DNA replication pathways, offering mechanistic insight into their antimicrobial action. These findings underscore the potential of caraway EO to contribute to safer, sodium-reduced dairy products and support its practical use in post-preservative brine formulations within the cheese industry.

Keywords: white brined cheese, caraway essential oil, antimicrobial, preservatives

ASSESSMENT OF THE ANTIMICROBIAL INTERACTION BETWEEN LAVENDER ESSENTIAL OIL AND A SIMPLE QUATERNARY COMPOUND AGAINST CLINICAL MICROORGANISMS

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ABSTRACT

The ongoing challenge of microbial resistance and the growing interest in plant-based antimicrobials underscore the need for innovative combinations of natural and conventional agents. This study evaluates the antimicrobial activity of lavender (*Lavandula angustifolia*) essential oil in combination with a structurally simple quaternary compound against a selection of clinically relevant microorganisms. The in vitro antimicrobial effect was tested using a broth microdilution method against *Escherichia coli* ATCC 25922, *Staphylococcus aureus* ATCC 29213, *Klebsiella pneumoniae* ATCC 13883, *Pseudomonas aeruginosa* ATCC 27853, *Bacillus subtilis* ATCC 6633, *Streptococcus pyogenes* ATCC 12384, and *Candida albicans* ATCC 10231. Minimum inhibitory concentrations (MICs) and minimum bactericidal/fungicidal concentrations (MBCs) were determined after aerobic incubation.

The lavender oil alone exhibited the strongest activity against *E. coli* (MIC/MBC = 0.31%). However, when combined with the quaternary agent, antimicrobial efficacy diminished notably for most strains, particularly for *E. coli*, where MIC and MBC increased 16-fold (5%), indicating antagonistic interaction. Indifferent effects were observed against *B. subtilis* and *P. aeruginosa*. In contrast, the combination demonstrated a synergistic effect against *C. albicans*, which was resistant to the oil alone but susceptible in the combined formulation (MIC/MBC = 10%).

These findings illustrate the complexity of interactions between natural products and quaternary compounds. While antagonism may limit effectiveness in some bacterial targets, synergistic antifungal outcomes suggest potential applications for mucosal antiseptics and biocidal formulations. Further studies should explore structurally advanced quaternary compounds to optimize synergy with essential oils.

Keywords: Lavender essential oil, antimicrobial synergy, MIC, MBC, fungal inhibition, quaternary compound interaction, natural biocides

MEDICINAL PLANTS AS ANTIBACTERIAL AGENTS: EXPLORING NATURAL THERAPY IN THE ERA OF ANTIBIOTIC RESISTANCE

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ABSTRACT

The rapid emergence and global spread of antimicrobial resistance (AMR) pose a significant threat to public health, reducing the efficacy of existing antibiotics and complicating the treatment of common infections. Conventional antibiotics are increasingly becoming ineffective against multidrug-resistant (MDR) pathogens, necessitating the exploration of alternative therapeutic options. Medicinal plants, long utilized in traditional healthcare systems, are a rich source of bioactive compounds with promising antibacterial potential. The justification for medicinal plant use lies in their structural diversity, ecological availability, cost-effectiveness, and reduced likelihood of inducing resistance. This review explores the antibacterial properties of medicinal plants, highlighting their potential role as alternative or complementary therapies in the fight against AMR. Key classes of phytochemicals such as flavonoids, alkaloids, terpenoids, and phenolic exhibit diverse mechanisms of antibacterial action, including cell wall disruption, inhibition of nucleic acid synthesis, and efflux pump suppression. The review also discusses various *in vitro* techniques used to assess the antibacterial efficacy of plant extracts. Furthermore, synergistic effects between plant-derived compounds and conventional antibiotics open new avenues for combination therapies. However, challenges remain in terms of standardization, dosage regulation, toxicity profiling, and clinical validation. This review advocates for intensified research into plant-based antimicrobials as a sustainable and culturally relevant approach to mitigating the AMR crisis, particularly in low- and middle-income countries where plant medicine remains accessible and affordable.

Keywords: Antimicrobial resistance, Medicinal plants, Phytochemicals, Antibacterial activity, Alternative therapy, Traditional medicine

UTILIZATION OF BROWN RICE AND EGGSHELL POWDER TO IMPROVE THE NUTRITIONAL AND SENSORIAL PROPERTIES OF CUPCAKES

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ABSTRACT

The main objective of the research exploration is to evaluate the brown rice flour and eggshell powder for their nutritional profile as well as to compare the cupcake developed with different concentrations (0%, 5%, 10%, 15%, and 20%) of brown rice flour and eggshell powder for their functional, physiochemical and sensorial characteristics. For this purpose, In 1st phase, brown rice flour and eggshell powder were carried out for their proximate analysis and mineral contents according to their respective methods. In 2nd Phase, Brown rice flour, and eggshell powder made cupcakes were stored for 28 days in a zip bag and tested after every 7th days. Moreover, in the last phase, physical parameters, proximate analysis, texture, color, and sensorial analysis was explored according to their respective methods. The results depicted that moisture content in the brown rice flour and eggshell powder were 6.88 ± 0.013 and 1.18 ± 0.11 respectively. Whereas in the T2 the moisture content was 14.4%. While in the T2 contains 7.89% fiber content. Ash content observed in the T2 was 0.74 ± 0.001 . The present study's findings indicated that the cupcake hardness in the brown rice flour fortified with eggshell powder cupcake 4.99. The present study's findings indicated that the overall acceptability in the brown rice cupcakes ranged from 6.9 ± 0.64 to 8.09 ± 0.39 . The cupcake prepared with brown rice flour with the supplementation of eggshell powder (40:30:30) showing a more good attributes and sensorial properties. Among all the four treatments, T2 consider the best treatment because of it nutritional, physiochemical and sensorial properties.

Keywords: Eggshell; Brown rice; Cupcake; Nutritional profile

CRISPR AND GENETIC THERAPIES: A FUTURE CURE FOR CELIAC DISEASE?

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Abstract

Celiac disease (CD) is an autoimmune disorder triggered by the ingestion of gluten in genetically predisposed individuals, primarily those with HLA-DQ2 or HLA-DQ8 haplotypes. While the gluten-free diet remains the only effective management strategy, it poses significant challenges related to adherence, nutritional adequacy, and quality of life. Recent advances in gene-editing technologies, particularly CRISPR-Cas systems, offer promising avenues toward more definitive therapeutic strategies. CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) enables precise targeting and modification of genomic sequences and may be used to disrupt key genes involved in the pathogenesis of celiac disease, including those encoding for immune-modulating HLA molecules or tissue transglutaminase.

This paper explores current preclinical studies applying CRISPR to modify immune responses, silence gliadin-reactive T cells, and engineer gluten-degrading enzymes or gut epithelial tolerance. Additionally, we discuss the feasibility, safety, and ethical implications of CRISPR-based interventions in human subjects, highlighting the potential for both somatic and germline editing. Though still in experimental stages, these interventions represent a paradigm shift from symptom management to disease modification or even cure. Integrating genetic therapies with immunological tolerance strategies could revolutionize celiac disease treatment, making gluten-free diets obsolete in the future.

Keywords: Celiac disease, CRISPR, gene therapy, HLA-DQ2, gluten intolerance, autoimmune disorders, genetic editing, transglutaminase, gluten-free diet, precision medicine.

1. Introduction

Celiac disease (CD) is a chronic, immune-mediated enteropathy precipitated by the ingestion of gluten—a composite of storage proteins found in wheat (gliadin and glutenin), barley (hordein), and rye (secalin)—in genetically predisposed individuals. The disease is characterized by an inappropriate adaptive immune response that leads to chronic intestinal inflammation, crypt hyperplasia, and villous atrophy in the small intestine, resulting in nutrient malabsorption and a wide spectrum of gastrointestinal and extraintestinal symptoms.

Globally, CD affects approximately 1% of the population, though it remains underdiagnosed in many regions due to variability in clinical presentation, limited awareness, and lack of access to accurate diagnostics. Clinical manifestations may range from classic gastrointestinal symptoms—such as chronic diarrhea, bloating, abdominal pain, and weight loss—to non-gastrointestinal features including anemia, dermatitis herpetiformis, osteoporosis, infertility, neurological disturbances, and growth retardation in children. Increasingly, cases are being identified in asymptomatic individuals through serological screening and genetic testing, highlighting the importance of early detection.

The genetic predisposition to celiac disease is strongly associated with the presence of specific human leukocyte antigen (HLA) class II genes—HLA-DQ2 (encoded by *DQA105:01* and *DQB102:01* alleles) and HLA-DQ8 (encoded by *DQA103* and *DQB103:02*). Around 95% of CD patients carry HLA-DQ2, while most of the remaining carry HLA-DQ8. These molecules present gluten-derived peptides to CD4⁺ T lymphocytes, triggering an inflammatory cascade that damages intestinal mucosa. However, these alleles are necessary but not sufficient; approximately 30-40% of the general population carry them without ever developing CD, indicating that non-HLA genes, environmental triggers, epigenetic changes, and intestinal microbiota also play a critical role in disease pathogenesis.

Despite advances in understanding the immunopathology and genetics of CD, the current standard of care remains a strict lifelong gluten-free diet (GFD). Adherence to this diet can be challenging due to:

- Widespread presence of gluten in processed foods
- Risk of cross-contamination
- Nutritional imbalances
- Limited availability and higher cost of gluten-free alternatives
- Psychological and social burdens

Even with strict adherence, up to 30% of patients report persistent symptoms or mucosal damage, and some develop refractory celiac disease, which may progress to serious complications like enteropathy-associated T-cell lymphoma (EATL) or small intestinal adenocarcinoma. These limitations underscore the pressing need for innovative, curative, or at least disease-modifying therapies.

In recent years, gene-editing technologies, particularly the CRISPR-Cas (Clustered Regularly Interspaced Short Palindromic Repeats – CRISPR-associated) system, have emerged as revolutionary tools in biomedical research. Initially discovered as part of the bacterial adaptive

immune system, the CRISPR-Cas9 system enables highly specific and efficient editing of genomic DNA. It allows for insertion, deletion, or correction of genes at precise loci, offering tremendous potential for monogenic and polygenic diseases, including autoimmune disorders like CD.

In the context of celiac disease, CRISPR holds the potential to:

- Modify or silence genes encoding immunogenic HLA-DQ molecules
- Interrupt the T-cell mediated immune response to gluten
- Enhance the intestinal barrier or regulatory immune pathways
- Engineer gluten-detoxifying enzymes in probiotic strains or host tissues

The application of CRISPR to CD not only represents a paradigm shift from dietary management to precision medicine, but also raises important questions regarding feasibility, safety, delivery methods, long-term efficacy, and ethical implications—especially when considering germline interventions.

This paper aims to explore these frontiers, offering a comprehensive review of the pathophysiology of celiac disease, limitations of current therapies, and the emerging role of CRISPR-based interventions, while also critically evaluating the associated challenges, preclinical evidence, and ethical considerations.

2. Pathophysiology of Celiac Disease

Celiac disease (CD) is a complex autoimmune disorder that arises from a dysregulated immune response to dietary gluten in genetically susceptible individuals. The disease primarily targets the small intestinal mucosa, resulting in a cascade of immunological events that culminate in inflammation, tissue remodeling, and nutrient malabsorption.

At the heart of CD pathophysiology is the adaptive immune response to gluten peptides, particularly gliadin, one of the primary protein components of gluten. Upon ingestion, gluten is partially digested in the gastrointestinal tract, but several immunogenic peptides—especially 33-mer gliadin peptides—remain resistant to complete proteolysis. These peptides cross the intestinal epithelium via transcellular and paracellular routes, the latter often facilitated by increased intestinal permeability linked to zonulin upregulation.

Once in the lamina propria, these peptides undergo a critical modification mediated by the enzyme tissue transglutaminase (tTG). tTG catalyzes the deamidation of specific glutamine residues in gliadin, converting them into negatively charged glutamic acid residues. This biochemical change increases the affinity of gliadin peptides for the HLA-DQ2 and HLA-DQ8

molecules, which are expressed on antigen-presenting cells (APCs) such as dendritic cells, macrophages, and B cells.

The HLA-gliadin-tTG complex is then presented to CD4⁺ T helper cells in the gut-associated lymphoid tissue (GALT). This presentation triggers:

- Clonal expansion of gliadin-reactive CD4⁺ T cells
- Secretion of pro-inflammatory cytokines (e.g., IFN- γ , IL-21, TNF- α)
- Recruitment and activation of intraepithelial lymphocytes (IELs), particularly CD8⁺ T cells
- Apoptosis of enterocytes and villous atrophy
- Hyperplasia of crypt cells and chronic inflammation of the intestinal mucosa

This immune-mediated tissue damage leads to hallmark histological findings, including flattening of intestinal villi, crypt elongation, and lymphocytic infiltration, all of which impair nutrient absorption and contribute to the clinical manifestations of CD.

Beyond the classical T-cell mediated response, other arms of the immune system also participate:

- Autoantibodies against tTG, endomysium (EMA), and deamidated gliadin peptides (DGP) are produced, serving as key serological markers for diagnosis.
- B cells, stimulated by T cells and cytokines, secrete these autoantibodies, although their direct pathogenic role remains unclear.
- Innate immune responses, including the action of IL-15, play a role in activating IELs and promoting epithelial damage independently of antigen presentation.

Genetically, the disease has a strong HLA association, with about 90–95% of CD patients carrying HLA-DQ2 (DQA105:01, DQB102:01) and the remainder usually expressing HLA-DQ8 (DQA103, DQB103:02). These molecules are essential for binding deamidated gluten peptides and presenting them to CD4⁺ T cells. However, possession of these alleles is not deterministic—approximately 30–40% of the general population carries HLA-DQ2/DQ8, but only a small fraction develops CD. This indicates that while HLA-DQ2/DQ8 is necessary, it is not sufficient for disease manifestation.

Additional contributing factors include:

- Non-HLA genetic loci, such as *IL2*, *IL21*, *SH2B3*, *TAGAP*, and others identified through genome-wide association studies (GWAS)
- Environmental triggers, such as gastrointestinal infections, early gluten introduction, mode of delivery at birth (e.g., C-section), and antibiotic use
- Epigenetic mechanisms, including DNA methylation and histone modification
- Gut microbiota dysbiosis, which may influence immune tolerance and gut permeability

The pathogenesis of celiac disease is a multifactorial process involving a tightly orchestrated interplay between dietary antigens, genetic predisposition, immune dysregulation, and environmental influences. Understanding these mechanisms provides a foundational basis for developing targeted interventions—such as CRISPR-based gene editing—to disrupt specific steps in this pathological cascade and move toward disease-modifying therapies.

3. Limitations of the Gluten-Free Diet

A strict gluten-free diet (GFD) remains the cornerstone and currently the only widely accepted treatment for celiac disease (CD). By eliminating wheat, barley, and rye from the diet, most patients experience symptom relief, mucosal healing, and a reduction in serological markers of autoimmunity. However, despite its effectiveness in managing symptoms, the gluten-free diet is not a cure, and it comes with a wide array of limitations that significantly affect patient well-being, dietary freedom, and long-term health.

3.1 Incomplete Symptom Resolution and Refractory Disease

While the majority of patients respond to a GFD, up to 30% report persistent symptoms such as abdominal discomfort, fatigue, or nutrient malabsorption even after strict adherence. This could be due to:

- Inadvertent gluten exposure, which is common in processed foods and cross-contaminated environments
- Overlapping gastrointestinal disorders, such as IBS
- Non-responsive or refractory celiac disease (RCD), a rare but serious condition in which intestinal damage persists despite a GFD

Refractory CD, especially Type II, carries an increased risk of complications such as ulcerative jejunitis, intestinal strictures, and enteropathy-associated T-cell lymphoma (EATL), highlighting the insufficiency of dietary control in severe cases.

3.2 Nutritional Deficiencies

A gluten-free diet, particularly when not carefully planned, may lead to micronutrient and macronutrient deficiencies, including:

- Iron, calcium, and vitamin D, contributing to anemia and bone health issues
- Folate, vitamin B12, and fiber, essential for energy metabolism and gastrointestinal health
- Zinc and magnesium, critical for immune and enzymatic functions

Moreover, many gluten-free commercial products are low in fiber and protein, and high in sugar, saturated fats, and glycemic index, increasing the risk of metabolic syndrome, obesity, and cardiovascular disease in long-term adherence.

3.3 Risk of Cross-Contamination

Due to the ubiquity of gluten in the food supply and food processing environments, even highly vigilant patients face risks of accidental gluten ingestion. Shared kitchen utensils, contaminated cutting boards, or restaurant-prepared meals can introduce trace amounts of gluten that are enough to trigger immune responses in highly sensitive individuals.

3.4 Social and Psychological Burden

Adherence to a GFD imposes significant social limitations, often leading to feelings of isolation or exclusion in social settings, travel, work, and school. Individuals must frequently:

- Decline invitations to events where safe food options are unavailable
- Rely on packed meals or restrictive choices at restaurants
- Constantly scrutinize ingredient labels and manufacturing processes

These experiences can lead to increased anxiety, social withdrawal, and reduced quality of life, particularly among adolescents and young adults who are highly vulnerable to peer dynamics and societal pressures.

3.5 Economic Constraints

Gluten-free products are significantly more expensive than their gluten-containing counterparts—often by 200–300%. This poses an economic burden, especially for families with multiple affected members or those living in low-income regions. Access to reliable gluten-free food options is also limited in rural areas or developing countries, where awareness and product availability remain low.

3.6 Compliance Challenges

Maintaining a GFD requires lifelong discipline, vigilance, and education. Studies show that only 42% to 91% of diagnosed patients fully adhere to the diet, depending on age, socio-economic status, and healthcare access. Common barriers include:

- Lack of understanding about hidden sources of gluten
- Difficulty interpreting food labels
- Peer pressure in social settings
- Limited dietitian support

These challenges further reinforce the need for alternative or adjunctive therapies that reduce dependence on diet alone.

Although the gluten-free diet remains the gold standard for managing celiac disease, it is not a definitive solution. The persistence of symptoms in a significant subset of patients, combined with nutritional, psychological, social, and financial limitations, calls into question the long-term sustainability and adequacy of this approach. There is a growing recognition in the medical community of the need to move beyond dietary control and toward curative or disease-modifying interventions. Emerging biotechnologies, such as CRISPR-based genetic therapies, offer promising avenues to address the root causes of CD and potentially eliminate the need for lifelong dietary restrictions.

4. CRISPR-Cas Systems: Mechanism and Promise

The CRISPR-Cas system (Clustered Regularly Interspaced Short Palindromic Repeats and CRISPR-associated proteins) represents a groundbreaking advancement in the field of genetic engineering and precision medicine. Originally discovered as an adaptive immune mechanism in bacteria and archaea, the CRISPR system protects microbial genomes from foreign genetic elements, such as viruses and plasmids, by recognizing and cleaving specific DNA sequences. This natural defense mechanism has since been adapted into a powerful tool for targeted gene editing in eukaryotic cells, revolutionizing biomedical research and therapy development.

4.1 The CRISPR-Cas9 Mechanism

At the core of this technology is the CRISPR-Cas9 system, composed of two primary components:

1. **Cas9 endonuclease** – a DNA-cutting enzyme that introduces double-strand breaks (DSBs) at targeted genomic sites.

2. **Guide RNA (gRNA)** – a synthetic RNA molecule that directs Cas9 to the specific DNA sequence to be edited by complementary base pairing.

Once introduced into a cell, the gRNA binds to its matching DNA sequence (known as the protospacer) adjacent to a PAM (Protospacer Adjacent Motif) site. Cas9 then cleaves both DNA strands, generating a double-strand break at the targeted locus. This break activates the cell's endogenous DNA repair machinery, leading to one of two possible repair pathways:

- **Non-Homologous End Joining (NHEJ):** An error-prone repair mechanism that rejoins the DNA ends but often introduces small insertions or deletions (indels), which can disrupt gene function—ideal for gene knockouts.
- **Homology-Directed Repair (HDR):** A more precise, template-dependent process that can introduce specific DNA sequences or corrections when a donor template is provided—ideal for gene replacement or correction.

This programmable and sequence-specific capability makes CRISPR-Cas9 a versatile platform for:

- Gene knockout
- Gene insertion or correction
- Gene silencing or activation
- Epigenetic modulation
- Base editing and prime editing

4.2 Evolution of CRISPR Systems

Although Cas9 from *Streptococcus pyogenes* is the most widely used CRISPR enzyme, ongoing innovations have led to the development of other CRISPR-associated proteins such as:

- **Cas12a (Cpf1)** – allows staggered DNA cuts and uses different PAM sequences.
- **Cas13** – targets RNA instead of DNA, useful for transcriptome editing and antiviral strategies.
- **Base editors and prime editors** – allow single nucleotide changes without double-strand breaks, reducing the risk of off-target effects and unwanted mutations.

These innovations offer greater flexibility, precision, and safety for clinical applications, including those targeting complex diseases like celiac disease.

4.3 CRISPR's Promise in Human Health and Autoimmune Diseases

The utility of CRISPR-Cas systems has extended well beyond laboratory models into clinical applications. It has been successfully applied in monogenic disorders such as:

- Sickle cell disease
- β -thalassemia
- Leber congenital amaurosis

Moreover, CRISPR is increasingly being investigated in complex polygenic and autoimmune diseases, where multiple genes and immune pathways are dysregulated. In such contexts, CRISPR can:

- Disrupt or correct disease-driving alleles
- Modulate immune responses
- Create regulatory cell types or tolerogenic environments

Given the genetic basis and immune dysregulation seen in celiac disease, the use of CRISPR offers a promising strategy to:

- Modify or silence key immune-related genes (e.g., *HLA-DQ2/DQ8*)
- Target T-cell receptors specific to gliadin
- Engineer tolerance mechanisms or gluten-detoxifying enzymes

5. CRISPR and Celiac Disease: A Logical Intersection

Celiac disease, though multifactorial, presents with well-characterized genetic and immunological hallmarks. Its strong HLA association, well-defined antigens (gliadin peptides), and localized pathology (intestinal mucosa) make it a compelling candidate for gene-editing interventions. CRISPR enables researchers to pinpoint and intervene at various levels of the disease cascade—from antigen presentation to immune effector function—opening doors to therapies that could move beyond symptom control to true disease modification or even cure.

The CRISPR-Cas system stands as a paradigm-shifting innovation in molecular biology and therapeutic development. Its unprecedented precision, flexibility, and scalability make it an ideal platform for addressing both genetic predisposition and immune dysfunction in celiac disease. As delivery systems improve and ethical frameworks evolve, CRISPR may soon become a central tool in the quest for a curative approach to celiac disease, challenging the current dependence on lifelong dietary restrictions.

CRISPR-Cas gene editing offers several innovative therapeutic possibilities for celiac disease (CD), targeting key immunological and molecular events in its pathogenesis. Unlike the gluten-free diet, which only mitigates exposure to the trigger, CRISPR holds the potential to intervene at the genetic and immunological root of the disease. These strategies, though still largely experimental, represent a significant step toward transforming CD from a managed condition to a potentially curable one.

5.1 Editing HLA-DQ Genes

One of the most promising and direct targets of CRISPR in CD is the modification of HLA-DQ2 and HLA-DQ8 alleles, which are essential for presenting deamidated gliadin peptides to CD4⁺ T cells. By disrupting or altering the expression of these alleles:

- Antigen presentation to T cells could be inhibited, preventing immune activation.
- Autoimmune response may be halted at its initiation point.

However, HLA molecules are integral to normal immune surveillance, especially in defending the host against pathogens and presenting a wide array of foreign antigens. Complete knockout of HLA-DQ molecules could:

- Lead to global immune dysfunction.
- Increase susceptibility to infections and other immune-related diseases.
- Disrupt the balance of immune self-tolerance and surveillance.

To address this, allele-specific silencing or partial modulation rather than complete deletion is being explored. Targeting regulatory regions (promoters/enhancers) to downregulate expression selectively in intestinal epithelial cells may offer a safer alternative.

5.2 Silencing Gliadin-Reactive T Cells

Another critical intervention point lies in inhibiting or deleting gliadin-specific T-cell receptors (TCRs). These T cells, once activated by HLA-gliadin complexes, orchestrate the inflammatory response in CD. Using CRISPR-Cas:

- Specific TCR genes (e.g., *TRAV* and *TRBV* segments) responsible for recognizing gliadin can be knocked out or silenced.
- Clonal expansion of pathogenic T cells can be disrupted, reducing inflammation and mucosal damage.

This approach preserves the broader immune system functionality by only targeting the autoreactive T-cell subsets responsible for disease. Delivery of such therapy could involve ex vivo editing of patient-derived T cells followed by autologous reinfusion, a strategy already being used in CAR-T cell therapies for cancer and under investigation for autoimmune diseases.

5.3 Engineering Gluten-Degrading Enzymes

A non-immunosuppressive strategy involves detoxifying gluten before it can provoke an immune response. Using CRISPR, scientists are engineering:

- Probiotic bacteria (e.g., *Lactobacillus*, *Bifidobacterium*) to express gluten-degrading proteases.
- Intestinal epithelial cells or stem cells secrete enzymes such as prolyl endopeptidases or EP-B2, which can cleave immunogenic gliadin peptides into non-reactive fragments.

These engineered microbes or cells could be administered orally, creating a localized, gut-level defense against gluten toxicity. Such strategies aim to reduce the immunogenic load in the small intestine, making the environment safer for individuals with CD, especially in cases of accidental gluten exposure.

5.4 Promoting Immune Tolerance

Restoring immune balance rather than suppressing it entirely is a central goal in autoimmunity. CRISPR-based interventions may be used to upregulate tolerogenic molecules in intestinal cells, such as:

- **Interleukin-10 (IL-10)** – an anti-inflammatory cytokine that inhibits T-cell activation.
- **Transforming Growth Factor Beta (TGF- β)** – promotes differentiation of regulatory T cells (Tregs) and suppresses effector responses.

By engineering gut epithelial cells or dendritic cells to overexpress these molecules:

- A tolerogenic environment can be established in the gut mucosa.
- The immune system may become desensitized to gluten, reducing or eliminating the need for strict dietary restrictions.

Additionally, CRISPR-based epigenome editing tools may be used to reprogram immune memory, silencing genes responsible for chronic immune activation against gluten.

6. Preclinical Evidence and Trials

Although CRISPR-based therapies for celiac disease (CD) are still in their early stages, preclinical research has yielded promising results. Most investigations to date have been conducted in in vitro cell culture systems and murine (mouse) models, which have demonstrated the potential of CRISPR to modulate immune pathways central to CD pathogenesis. Studies involving CRISPR-mediated knockout of gliadin-reactive T-cell receptors or modulation of HLA expression have shown a significant reduction in inflammatory cytokine release and improved intestinal histology in animal models. Additionally, experiments aimed at engineering gluten-degrading enzymes in gut microbiota using CRISPR have shown success in detoxifying immunogenic peptides before they can trigger an immune response. While these findings are not yet ready for direct clinical application in CD, they provide crucial proof-of-concept evidence supporting the feasibility of gene-editing strategies. Furthermore, the success of ongoing clinical trials using CRISPR-Cas9 in related autoimmune and monogenic conditions, such as sickle cell disease, β -thalassemia, and type 1 diabetes, underscores the safety and therapeutic potential of this technology in humans. These advances pave the way for future clinical translation of CRISPR-based therapies in celiac disease, offering hope for more targeted, durable, and curative interventions.

7. Ethical and Safety Considerations

As CRISPR-Cas technologies move closer to clinical application, particularly in the context of complex diseases like celiac disease (CD), careful consideration of the ethical and safety implications is paramount. While the therapeutic promise of gene editing is undeniable, the potential risks—both known and unforeseen—necessitate rigorous oversight, transparent dialogue, and responsible implementation.

One of the fundamental distinctions in gene-editing ethics lies between somatic and germline editing. Somatic gene editing, which targets non-reproductive cells, affects only the treated individual and is generally considered ethically permissible, especially when aimed at treating or curing serious diseases. In the case of CD, somatic interventions—such as editing T cells, intestinal epithelial cells, or gut microbiota—are more feasible and ethically justifiable, provided they demonstrate safety and efficacy.

In contrast, germline editing, which alters the DNA of gametes or embryos, poses far greater ethical and societal challenges. Such modifications are heritable and could be passed on to future generations, raising profound concerns about:

- Unintended long-term effects, including off-target mutations or epigenetic disruptions

- Irreversible changes to the human gene pool
- Inequitable access, potentially widening health disparities
- The ethical acceptability of altering genetic traits, especially in conditions where non-genetic interventions (like diet) are available

The issue of off-target effects—where CRISPR may inadvertently modify genes other than the intended target—remains a critical safety concern. Even small errors in editing could lead to oncogenesis, immune dysfunction, or other unpredictable complications. Thus, improving the specificity, fidelity, and delivery mechanisms of CRISPR systems is essential before widespread human use.

To ensure ethical integrity, robust regulatory frameworks must be established and enforced. These should include:

- Comprehensive risk assessment protocols during preclinical and clinical stages
- Long-term post-treatment monitoring to track delayed adverse effects
- Stringent oversight by ethical review boards and regulatory agencies
- Ongoing public engagement to align scientific advances with societal values

Additionally, informed consent must be thoroughly implemented, ensuring that patients understand the experimental nature of gene-editing interventions, the risks involved, and alternative treatment options. This is especially crucial in vulnerable populations such as children or those with limited access to healthcare education.

Transparency in research, equitable access to emerging therapies, and international cooperation in establishing global bioethical standards will be vital to prevent misuse or unethical applications of CRISPR. Lessons from past controversies, such as unauthorized embryo editing, highlight the urgency of preemptive governance and public accountability.

While CRISPR presents a transformative tool for the treatment of celiac disease and other immune-mediated disorders, its application must proceed with caution, responsibility, and an unwavering commitment to ethical principles. Only by balancing innovation with prudence can we harness the full potential of gene-editing technologies while safeguarding individual rights and public trust.

8. Challenges and Future Directions

While CRISPR-based therapy holds transformative promise for the treatment of celiac disease (CD), its path to clinical realization is fraught with technical, biological, logistical, and socio-

economic challenges. Addressing these hurdles is essential to ensure both the efficacy and safety of gene-editing interventions, as well as their equitable access and long-term success.

8.1 Efficient Delivery to Intestinal Cells

A major bottleneck in the application of CRISPR for CD is the targeted delivery of gene-editing tools to the intestinal mucosa. The gastrointestinal tract presents several physiological barriers, including acidic pH, digestive enzymes, and a protective mucus layer, which complicate delivery to enterocytes and immune cells within the gut-associated lymphoid tissue (GALT). Achieving precise and efficient editing in these tissues requires the development of:

- Advanced delivery platforms such as viral vectors (e.g., adeno-associated viruses, lentiviruses) with gut-specific tropism
- Non-viral systems like lipid nanoparticles, polymer-based carriers, or exosomes engineered for intestinal targeting
- Oral delivery methods capable of protecting CRISPR components through the upper GI tract and releasing them at the small intestine

Progress in delivery technologies is not only essential for therapeutic efficacy but also for minimizing systemic exposure and associated side effects.

8.2 Avoiding Off-Target Mutations

CRISPR's precision is one of its greatest strengths, but off-target editing—unintentional modifications at genomic sites resembling the target sequence—remains a critical safety concern. Such errors can potentially lead to oncogenesis, immune dysfunction, or genetic instability. Current strategies to improve specificity include:

- Engineering high-fidelity Cas9 variants (e.g., SpCas9-HF1, eCas9, HypaCas9)
- Employing shorter guide RNAs with enhanced discrimination
- Utilizing alternative systems like CRISPR-Cas12 or base editors, which reduce the risk of double-strand breaks

Future research must continue to prioritize rigorous genome-wide screening for off-target effects, especially in preclinical and early human trials.

8.3 Maintaining Immune Homeostasis

Any therapeutic approach that modifies immune-related genes, such as HLA-DQ alleles or gliadin-specific T-cell receptors, must be carefully balanced to avoid global immunosuppression. Since HLA molecules are critical for pathogen recognition and immune

surveillance, altering their function could increase vulnerability to infections or malignancies. Similarly, silencing T-cell populations without compromising overall immune competence remains a delicate task.

Thus, immune-targeted CRISPR therapies must be highly specific, ideally designed to preserve immune diversity and self-tolerance while eliminating only disease-specific reactivity. Preclinical models and systems immunology approaches will be vital for anticipating and mitigating such risks.

8.4 Cost, Scalability, and Accessibility

Gene-editing therapies, particularly those involving personalized or autologous treatments, are currently expensive and complex to manufacture. This limits their feasibility in low-resource settings and raises concerns about healthcare inequality. Celiac disease is a global condition, and any future cure must be scalable, cost-effective, and widely accessible.

To address these challenges, future strategies could explore:

- In vivo editing approaches that bypass the need for cell extraction and reinfusion
- Standardized allogeneic therapies with universal compatibility
- Integration with local healthcare systems and diet-based screening programs

International collaboration and open-access platforms for CRISPR innovation can further promote affordability and ethical dissemination of these therapies.

8.5 Future Research Priorities

To move CRISPR therapy for CD from bench to bedside, future research must focus on:

- Optimizing delivery systems with tissue-specific targeting
- Improving editing precision through novel enzymes and guide RNA designs
- Conducting long-term safety and efficacy studies in preclinical models
- Designing and implementing early-phase clinical trials for somatic interventions
- Understanding disease heterogeneity, including gene-environment interactions and microbiome dynamics, to tailor individualized treatment strategies

Multidisciplinary efforts, integrating genomics, immunology, bioengineering, and clinical research, will be critical to overcoming these barriers.

9. Conclusion

Celiac disease, once viewed solely as a lifelong dietary condition, is now emerging as a candidate for genetic and immunological intervention, thanks to the remarkable advancements in CRISPR-Cas gene-editing technologies. The limitations of the gluten-free diet—including persistent symptoms, nutritional deficiencies, psychological burden, and inconsistent adherence—underscore the urgent need for curative, rather than palliative, approaches. CRISPR-based therapies represent a paradigm shift, offering the possibility to intervene directly at the genetic and cellular origins of the disease, rather than merely mitigating its external triggers.

From the targeted editing of HLA-DQ2 and DQ8 alleles, which are central to antigen presentation, to the silencing of gliadin-reactive T cells, the applications of CRISPR in CD have demonstrated strong preclinical promise. Additionally, the engineering of gluten-degrading enzymes and the promotion of immune tolerance via regulatory cytokines offer novel, non-immunosuppressive avenues to manage or even eliminate the pathogenic immune response. Together, these approaches suggest a future in which the immune system can be retrained or reprogrammed to coexist with gluten, rather than attacking it.

Despite being in the experimental and translational research phase, CRISPR therapies are already redefining the boundaries of possibility in autoimmune disease management. However, the path forward requires caution and care. Critical challenges—ranging from precise delivery to off-target effects, immune modulation, long-term safety, ethical governance, and equitable access—must be systematically addressed through interdisciplinary collaboration, robust clinical trials, and adherence to bioethical principles.

In essence, CRISPR and related gene-editing tools hold the potential not only to transform the treatment landscape for celiac disease, but also to serve as a blueprint for tackling other autoimmune and genetically mediated disorders. With sustained research, technological refinement, and responsible implementation, the gluten-free diet—a mainstay of CD management for decades—may one day become a historical footnote rather than a lifelong necessity. The horizon now holds the promise of a world where celiac disease is not simply managed, but understood, modified, and ultimately cured at its genetic core.

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İKLİM DEĞİŞİKLİĞİ VE GIDA GÜVENLİĞİ İLİŞKİSİ**Emir ÜŞENMEZSOYLU**

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İklim değişikliğinin küresel gıda güvenliği bileşenleri üzerindeki olumsuz etkileri, mevcut yüzyılın en büyük tehditlerinden biridir ve bunların hafifletilmesi, giderek artan nüfusun gelecekteki gıda taleplerini karşılamak için elzemdir. İklim değişikliği, düzensiz yağışlar, kuraklık gibi aşırı hava olayları, sanayileşmenin etkisi ile sera gazlarının atmosfere salınımı (CO₂, CH₄, N₂O, HFCs, PFCs, SF₆, (NF₃)³), artan gıda fiyatları ve bozulan gıda kalitesi gibi bir dizi mekanizma yoluyla küresel gıda sistemini bozar. Bu olayları gıda güvenliğini düzeltme açısından yapılabilecek işlemler ekim tarihlerini iyi ayarlamak, etkili sulama ve gübreleme, kısa süreli olsa da iklim değişikliğine karşı etkin yöntemler oluşturmuştur. Dünya nüfusunun artış hızı nedeniyle sonraki nesillere gıda erişimi, enerji tüketimindeki yükseliş, tarımsal ilaçlarının kullanımındaki yükseliş, bulaşıcı hastalıkların yayılmaları doğa olayları ile insan faaliyetlerinin olumsuzlukları ve buna eşlik eden susuzluk küresel olarak gıda güvenliğine tehdit oluşturmuştur. Bu çalışma ile, gıda güvenli açısından gıdaya erişebilirlik adı altında iklim değişikliğinin gıda güvenliğine etkileri üzerine insan sağlığının korunması, gıdada sürekliliğin devamı için pestisitler, mikroplastikler, ağır metaller, zararlı alglerin çoğalması, parazitler ve patojenler başlıkları altında genel bilgiler verilmiş olup ilerleyen çalışmalar, araştırmalar ve bilgiler sunulmuştur. En önemli kriter insan sağlığı olup, sağlığın korunabilmesi için gıdanın besleyici, temiz, güvenli, gelecekte sürdürülebilir olmakla birlikte besin değeri yüksek gıdalar üretmek gerekir. Bu unsurların sağlanamaması halinde sağlığın korunabilmesi pek mümkün olmayacaktır.

Anahtar kelimeler: İklim değişikliği, gıda güvenliği, sürdürülebilirlik, sağlık.

ABSTRACT

The negative effects of climate change on global food security components are one of the greatest threats of the current century, and their mitigation is essential to meet the future food demands of the growing population. Climate change disrupts the global food system through a series of mechanisms, such as irregular rainfall, extreme weather events such as drought, the

release of greenhouse gases (CO₂, CH₄, N₂O, HFCs, PFCs, SF₆, (NF₃)₃) into the atmosphere due to the effects of industrialization, increasing food prices and deteriorating food quality. The actions that can be taken to correct these events in terms of food security are to adjust planting dates well, effective irrigation and fertilization, and effective methods against climate change, albeit short-term. Due to the rapid increase in the world population, access to food for future generations, the increase in energy consumption, the increase in the use of agricultural drugs, the spread of infectious diseases, the negative effects of natural events and human activities, and the accompanying drought have posed a threat to food security globally. In this study, under the name of food accessibility in terms of food safety, general information was provided under the titles of protection of human health on the effects of climate change on food safety, pesticides, microplastics, heavy metals, proliferation of harmful algae, parasites and pathogens for the continuation of food continuity, and advanced studies, research and information were presented. The most important criterion is human health, and in order to protect health, food must be nutritious, clean, safe, sustainable in the future and high nutritional value food must be produced. If these elements cannot be provided, it will not be possible to protect health.

Keywords: Climate change, food safety, sustainability, health.

GİRİŞ

İklim değişikliği ile atmosferdeki sera gazlarının birikmesi nedeniyle sanayileşmenin de etkisiyle yaklaşık 1850 yılından bu yana küresel sıcaklıklar artmaktadır (Al ve ark., 2008). Bunun başlıca nedenleri, artan enerji talebini karşılamak için fosil yakıtların yakılması ve artan gıda talebini karşılamak için modern ve ilaçlı tarımın yaygınlaştırılması, buna sıklıkla ormanların yok olması da etki etmektedir. Küresel ısınma süreci hiçbir azalma belirtisi göstermemekte ve hava koşullarında uzun vadeli değişikliklere yol açmaktadır (Al ve ark., 2008).

Bu değişikliklerin gıda güvenliğine ciddi etkileri olmaktadır. Gıda bulunabilirliği, gıdaya erişilebilirlik, gıdadan yararlanma gibi faktörlerde sıkıntılar meydana gelmektedir. Etkileri küresel gıda piyasalarında mahsullerin yetersiz kaldığı, verimin düştüğü, tedarik zincirlerini kesintiye uğrattığı için bu da piyasa fiyatlarının artmasına sebep olduğundan, insan sağlığı tehlikeye girmektedir (Al ve ark., 2008). Dünyanın mevcut başlıca gıdaları, insanların diyetlerinde ihtiyaç duydukları kalorileri, proteinleri, yağları ve besinleri sağlamakta yetersiz kalmaktadır. Politik ve ekonomik istikrarsızlığın ek stresleri göz önüne alındığında, yeni, yerel olarak geliştirilen ve uyarlanmış gıdalara ihtiyaç duyulduğu anlaşılmaktadır (Cheeseman, 2016).

Dünya nüfusu hızla büyümeye devam etmekte olup yaklaşık olarak 2023'te 8 milyara ulaşmaktadır. Birleşmiş Milletler (BM) 10 milyar sınırına 2058'de, maksimum 10,4 milyara ise 2080'lerde ulaşılacağını öngörülmektedir (Brakman, 2025). İklim değişikliği üzerinde küresel gıda güvenliği hedefini yerine getirmekte büyük zorluklar yaşanmaya devam etmektedir. Bu özellikle dünyanın en kalabalık ülkeleri ve kara alanı bakımından büyük olan ülkeler için daha tehlikeli olmaktadır (Ye ve ark., 2013). Küresel ısınmanın gıda güvenliği açısından verimliliğinin korunması için termal strese dayanıklı çeşitler kullanmak, ekim tarihlerini ayarlamak, su tasarrufu ve yönetim uygulamalarını iyileştirmek, etkili sulama ve gübre yönetimi kullanmak, mahsulleri çeşitlendirmek ürün verimliliği ve kalitesi üzerinde de etkili rol oynamaktadır (Mall ve ark., 2017).

Bu çalışmada; bilimsel araştırmaların, verilerin yorumlanması altında iklim değişikliğinin öncelikle gıda güvenliğine, insan sağlığına ve gıdanın sürdürülebilirliği üzerindeki etkilerini araştırmak amaçlanmaktadır.

İKLİM DEĞİŞİKLİĞİNİN GIDA GÜVENLİĞİNE ETKİLERİ

Sıcaklıkların anlık alçalıp yükselmesi ile yağışların gecikme sürelerine, miktarlarının azlığına bağlı olarak doğamızda yetişen gıdaların tehlikeye girdiği görülmektedir. Sadece gıdalara değil, gıdaların sürdürülebilirliği açısından toprağa mineral, vitamin vb. gıdayı doğrudan etkileyecek unsurlara da sebep olmaktadır. İklim değişikliğinin gıda güvenliği üzerine tehlikeleri bulunmaktadır. Bu tehlikeler arasında gıda kaynaklı parazit ve patojenler, zararlı alglerin çoğalması, pestisitler, mikroplastikler, ağır metaller bu sınıfa girmektedir. Bu bağlamlar ile gıda güvenliği yöneticileri ve düzenleyicilerin değişen üretim sisteminin gıda güvenliği risklerini nasıl etkileyebileceği konusunda daha dikkatli olmaları ve uygun kontrolleri sağlamaları gerekmektedir (Mukherjee ve ark., 2021).

Gıda kaynaklı parazit ve patojenler

Yükselen sıcaklıklar, nem ve değişen yağış düzenleri patojenik kontaminasyonunun artmasına yol açmaktadır. Bulaşıcı hastalıkların yaklaşık dörtte üçünün iklim değişikliğinden etkilendiği gözlemlenmektedir (Awad ve ark., 2024). Gıda kaynaklı hastalıklara bakteri, mantar, parazit ve virüs gibi patojenler neden olmakla birlikte, enfeksiyon veya zehirlenme hastalıkları olarak kategorize edilmektedir. Bu patojenler ve parazitler çapraz bulaşıya neden olmaktadır. Bu konuda sadece iklimin değil tüketiciler olarak ürünün muhafazası ve muhafaza sıcaklıkları, marinyasyonu, pişme süreleri, kullanılan ekipmanların temizliği de önem taşımaktadır. *Escherichia coli*, *Listeria monocytogenes*, *Salmonella* veya *Shigella* türleri, Adenovirüs ve *Cryptosporidium*, gıda ürünlerini bir bulaşma aracı olarak kullanan iyi bilinen patojenlerdir. Bu nedenle, gıda kaynaklı olaylar halk sağlığı için bir sorun olmaya devam ederken, bilim insanları

patojenlerin tespiti için yenilikçi tekniklere özel önem vermektedir. Bu alternatif yöntemlerin gıda endüstrisinde uygulanması, gıda güvenliği konusunda hızlı ve doğru sonuçlar sağlayabilmektedir (Dimitrakopoulou ve ark., 2024).

Zararlı alglerin çoğalması

Çeşitli su ekosistemlerinde, tatlı su nehirlerinde, göllerinde, kutup bölgelerinde, kıyı suları ve açık okyanuslar dahil olmak üzere buralarda planktonların hızlı şekilde çoğalması olarak tanımlanmaktadır (Schleyer ve Vardi, 2020). Bu tarz ortamlarda alglerin çoğalması için gerekli koşul, büyümeyi sağlayan sıcaklıkların oluşması önem taşımaktadır (Gobler, 2020). Öncelikle iklim değişikliğinin etkisini, bazı zararlı alglerin oluşumuna katkıda bulunduğu yapılan çalışmalarla karşımıza çıkmaktadır. Bazı alg türlerinin önümüzdeki 30-60 yıl arasında fazlasıyla artması tahmin edilmektedir. Bu artışla beraber insanlar tarafından sıkça tüketilen balık ve kabuklu deniz gıdalarında birikim yapıp toksik etki göstermektedir.

Pestisitlerin Önemi

Pestisitler, böcek zararlıları ve hastalıklar için mücadelede kullanılan kimyasal ilaçlar olup tarım ve halk sağlığı sektörlerinde bu zararlıları kontrol etmek için sıklıkla kullanılmaktadır. (Palikhe, 2007). Özellikle uygulama sıklığı, etkinliği, taşınması, hareketi, bozulma süreçleri ve çevredeki kalıcılığı, sıcaklık artışları, yüksek CO2 konsantrasyonları ve yağış düzeni gibi iklimle ilgili faktörlerden etkilenmektedir (Zidan ve ark., 2025). Pestisitlerin içinde sentetik pestisitler önemli rol oynamaktadır. Bunun da örneği olarak en çok kullanılan böcek ilacı (DDT'nin) tanıtılmasıyla başlamaktadır. Şimdi 7,8 milyarı aşkın nüfusa gıda sağlamak için 1055'ten fazla farklı pestisit mahsul tarlalarındaki zararlılarla ve hastalıklarla mücadele etmek üzere kullanılmaktadır (Choudhury ve Saha., 2020). Artan sıcaklıkların daha fazla pestisit buharlaşmasına yol açması ve daha fazla pestisit hedeften alanlara ulaşmak yerine havaya karışması anlamına gelmektedir (El-Şeyh ve ark., 2025). Ancak iklim değişikliği ile pestisit kullanımı ne kadar artsa bile bazen bu küresel sıcaklık değişimleri çevredeki pestisitlerin bozulmasına da sebep olmaktadır (Barwant ve ark., 2025).

Mikroplastikler

Plastik atıklar çevreye bırakıldığında, birtakım fotodegradasyon parçalanma yoluyla, mekanik etki, çevresel aşınma veya mikrobiyal bozunma yoluyla mikroplastiklere dönüşebilmektedir. Çevresel plastik, makroplastik veya mikroplastik olarak sınıflandırılabilir. Mikroplastikler, türlerine, şekillerine, boyutlarına ve bileşimlerine bağlı olarak çevre ve ekoloji üzerinde farklı toksik seviyeler oluşturmaktadır. Daha küçük boyutlu mikroplastikler, sucul organizmalar ve bitkiler tarafından alınmaya daha duyarlı oldukları için genel olarak daha toksik olmaktadır. Bu

çevresel plastiklerin bozulma sebepleri mekanik, termal, kimyasal ve artan fotodegradasyon olarak sıralanabilmektedir (Haque ve Fan., 2023).

Ağır metaller

Çevredeki ağır metallere maruz kalma, son yüzyıldaki endüstriyel faaliyetlerin artmasının bir sonucu olarak önemli ölçüde artmaktadır. İnsan zehirlenmelerine en sık neden olan ağır metaller cıva, kurşun, krom, kadmiyum ve arsenik olarak sıralanabilmektedir (Alzain, 2023). Ağır metallerin atmosferde taşınmasında ve birikmesinde, rüzgârın hızı ve yönü, kullanılan kimyasalın bileşimi, yoğunlukları, yağmur gibi olaylara bağlı olmaktadır (Cimboláková ve ark., 2019). Bitkiler ağır metalleri topraktan aldığı için küresel ısınma ile toprağın sıcaklıklarında yükselmeler meydana geldiğinden dolayı ağır metalin gıdaya daha hızlı geçmesini sağlamaktadır.

SONUÇ

İklim değişikliğinin gıda güvenliğine farklı yollardan etki ettiğini, bu etkilerin ileri zamanda insanların doğal ve sağlıklı gıdayı bulmasında zorluk yaşayacaklarının sinyallerini vermektedir. Bu çalışmanın önemi gıda güvenliği ile ilgili olmasına rağmen küresel ısınma ekolojik düzeni de bozacağından sadece insanın tüketeceği gıda değil dolaylı yoldan hayvanları da etkilemektedir. Hava koşulları bitki örtüsü ve suyu olumsuz etkilediğinden otçul popülasyonu azaltmakta ve doğa dengesinde bozulmalar meydana gelmektedir. Gelecek yıllarda insanlar havaya zararlı gaz salınımlarını, su kaynaklarını, gıdalara uygulanan koruma amaçlı ilaçları ve toprakta kalıcı etki bırakan ağır metallerin salınımını azalttığı durumda önemli ölçüde ormanlar, hava koşulları kendini toplayacaktır. Bu unsurlara dikkat edilmeği takdirde doğanın düzeninin bozulma hızı geri toplanmasından çok daha hızlı etki gösterecektir.

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YAPAY KAYNAKLARLA ÜRETİLEN PEYNİR ALTI SUYU VE KAZEİN İLE HAYVANSAL SÜT TOZU ELDESİ

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ÖZET

Geleneksel süt üretimi, yüksek kaynak tüketimi, çevresel etkiler ve etik kaygılar nedeniyle sürdürülebilir alternatifler geliştirilmesini zorunlu kılmaktadır. İklim değişikliği, su kaynaklarının azalması ve artan küresel nüfus gibi faktörler, süt endüstrisinde yenilikçi çözümler arayışını hızlandırmıştır. Bu bağlamda, biyoteknoloji alanındaki gelişmeler, hassas fermantasyon ve hücre tabanlı biyoteknoloji teknikleri ile süt proteinlerinin hayvansal kaynaklara bağlı kalmadan üretimini mümkün kılmıştır. Hassas fermantasyon, genetik olarak mühendislik uygulanmış mikroorganizmalar aracılığıyla süt proteini üretimini sağlayan bir yöntemdir. Bu süreçte mikroorganizmalar belirli genetik düzenlemelerle hedef proteinleri sentezleyerek, doğal süte yakın bileşenler oluştururlar. Hücre tabanlı biyoteknoloji ise memeli hücreleri kullanılarak süt proteinlerinin laboratuvar ortamında doğrudan üretimini mümkün kılar. Her iki yöntem, süt proteini üretiminde verimliliği ve sürdürülebilirliği artırarak endüstriyel ölçekte uygulanabilir çözümler sunmaktadır. Bunun yanı sıra, üretilen süt proteinlerinin endüstriyel işlenmesi protein izolasyonu, kurutma teknikleri ve formülasyon süreçleriyle optimize edilmektedir. Bu teknikler, ürünün stabilitesini artırarak, besin değerini korumakta ve tüketiciye ulaşan nihai ürünün kalite standartlarını belirlemektedir. Özellikle kurutma ve karıştırma süreçleri, süt proteinlerinin dayanıklılığını artırarak uzun raf ömrü sağlamakta, bu da ticari uygulanabilirliği desteklemektedir. Yapay süt proteini üretimi, geleneksel süt endüstrisine alternatif olarak çevresel ve ekonomik açıdan önemli avantajlar sunmaktadır. Bu yenilikçi biyoteknoloji tekniklerinin geliştirilmesi, süt üretiminin gelecekte daha sürdürülebilir ve etik açıdan kabul edilebilir bir noktaya evrilmesini sağlayacaktır. Araştırma ve geliştirme çalışmaları ilerledikçe, bu teknolojilerin ticari yaygınlığı artacak ve küresel gıda sisteminde daha büyük bir rol oynayacaktır.

Anahtar kelimeler: Kazein, peynir altı suyu, hayvansal süt tozu, hassas fermantasyon, hücre tabanlı biyoteknoloji

OBTAINING ANIMAL MILK POWDER FROM WHEY AND CASEIN PRODUCED FROM ARTIFICIAL SOURCES

ABSTRACT

Traditional milk production necessitates the development of sustainable alternatives due to high resource consumption, environmental impacts and ethical concerns. Factors such as climate change, depletion of water resources and increasing global population have accelerated the search for innovative solutions in the dairy industry. In this context, developments in the field of biotechnology have made it possible to produce milk proteins without relying on animal sources with precision fermentation and cell-based biotechnology techniques. Precision fermentation is a method that enables milk protein production through genetically engineered microorganisms. In this process, microorganisms synthesize target proteins with specific genetic arrangements, creating components close to natural milk. Cell-based biotechnology, on the other hand, enables the direct production of milk proteins in a laboratory environment using mammalian cells. Both methods offer industrially applicable solutions by increasing efficiency and sustainability in milk protein production. In addition, industrial processing of produced milk proteins is optimized with protein isolation, drying techniques and formulation processes. These techniques increase the stability of the product, preserve its nutritional value and determine the quality standards of the final product reaching the consumer. In particular, drying and mixing processes increase the durability of milk proteins and provide long shelf life, which supports commercial viability. Artificial milk protein production offers significant environmental and economic advantages as an alternative to the traditional dairy industry. The development of these innovative biotechnology techniques will enable milk production to evolve to a more sustainable and ethically acceptable point in the future. As research and development studies progress, the commercial prevalence of these technologies will increase and play a greater role in the global food system.

Keywords: Casein, whey, animal milk powder, precision fermentation, cell-based biotechnology

GİRİŞ

Gıda üretimi, insanlık tarihi boyunca sürekli evrim geçirmiş ve zamanla daha verimli, sürdürülebilir ve etik yöntemlere doğru yönelmiştir. Geleneksel süt üretimi, yüzyıllardır beslenmenin temel taşlarından biri olmasına rağmen, günümüzde çevresel etkileri, yüksek kaynak tüketimi ve hayvan refahına dair etik kaygılar nedeniyle yeniden değerlendirilmektedir. Özellikle iklim değişikliği, su kaynaklarının azalması ve artan nüfus gibi küresel faktörler, süt endüstrisinde daha sürdürülebilir alternatifler geliştirilmesini zorunlu kılmaktadır. Bu

bağlamda, biyoteknoloji alanındaki ilerlemeler, süt ve süt ürünlerini hayvansal kaynaklara bağlı kalmadan üretmeyi mümkün kılan yeni teknolojileri ortaya çıkarmıştır. Hassas fermantasyon ve hücre tabanlı biyoteknoloji, bu dönüşümün merkezinde yer alarak, süt proteinlerinin geleneksel yöntemlere gerek kalmadan laboratuvar ortamında üretilmesini sağlamaktadır. Yapay süt proteini üretimi, yalnızca çevresel faydalar sağlamakla kalmaz, aynı zamanda besinsel açıdan hayvansal süte oldukça yakın bileşenler oluşturmayı da mümkün kılar (Özcan ve Harputlugil, 2021).

HASSAS FERMANTASYON

Mikroorganizmaların genetik mühendislik yoluyla belirli proteinleri, enzimleri ve diğer biyomolekülleri üretmesini sağlayan bir biyoteknoloji yöntemidir. Bu süreçte, mikroorganizmaların genetik kodlarına belirli proteinleri sentezlemeye yönelik modifikasyonlar eklenir ve fermantasyon yoluyla saflaştırılmış ürünler elde edilir. Süt proteini üretimi için en sık kullanılan proteinler kazein ve peynir altı suyu olup, bu bileşenler sentetik olarak üretildiğinde hem besin değeri hem de işlevsellik açısından geleneksel süte oldukça yakın özellikler taşır (Priyadharsini ve ark., 2023).

HÜCRE TABANLI BİYOTEKNOLOJİ

Biyofarmasötik sektöründe de hızla büyüyen bir alan olup hücresel tarım, monoklonal antikolar, glikoproteinler ve diğer terapötik ürünlerin üretiminde önemlidir. Bu süreçler için, hücrelerin optimal şekilde büyümesini ve hedef ürünlerin verimli bir şekilde elde edilmesini sağlayan hassas fermantasyon, etkin hasat ve saflaştırma sistemleri gereklidir. Aynı zamanda, hücrelerin etkin bir şekilde işlenmesini sağlayan hijyenik ekipmanların kullanımı ve kontaminasyon riskinin tamamen ortadan kaldırılması, üretim süreçlerinin başarısı için kritik öneme sahiptir (Aquino ve ark., 2022).

PROTEİN İZOLASYONU

Ürünün besinsel, fonksiyonel ve endüstriyel değerini doğrudan etkileyen bir aşamadır. Yapay süt proteini üretiminde, mikrobiyal fermantasyon, rekombinant DNA teknolojisi veya hücresel tarım gibi biyoteknolojik yöntemler kullanılarak hedef proteinler sentezlenir. Ancak bu proteinler biyokütle içerisinde ham halde bulunur ve doğrudan kullanılamaz. Bu noktada, izolasyon süreci devreye girerek süt proteinlerinin ayrıştırılması ve saflaştırılması sağlanır (Houdebine, 2004).

İlk aşamada, süt proteinleri üreten mikroorganizmalar belirli biyoteknolojik süreçlere tabi tutulur. Hücrelerin lizisi ile proteinler serbest hale getirilir ve filtrasyon ya da çöktürme işlemleriyle istenmeyen bileşenler uzaklaştırılır. Elde edilen ham proteinler daha sonra ultrafiltrasyon, iyon değişim kromatografisi ve hidrofobik etkileşim teknikleri gibi yöntemlerle

saflaştırılarak süt proteini kalitesine uygun hale getirilir. Bu süreç, biyoyararlanımı optimize etmek ve fonksiyonel özellikleri iyileştirmek açısından büyük önem taşır. Endüstriyel ve besinsel açıdan değerlendirildiğinde, iyi optimize edilmiş bir izolasyon süreci, yapay süt tozunun protein içeriğinin stabilitesini artırır ve besinsel kaliteyi koruyarak doğal süt proteiniyle kıyaslanabilir bir ürün ortaya çıkmasını sağlar. Ticari sürdürülebilirlik açısından maliyet ve üretim süreçlerinin dengelenmesi de önemli bir faktördür (Moraes ve Tavares, 2019).

BİTKİSEL SÜT, KAZEİN VE PEYNİR ALTI SUYUNUN KURUTULMASI

Yapay süt tozu üretiminde kurutma işlemi, besin kaybını en aza indirmek ve ürünün raf ömrünü uzatmak için kritik bir adımdır. Bu süreçte hem süt hem de proteinlerin nem içeriği azaltılarak mikrobiyal bozulma önlenir ve besinsel stabilite korunur. Ancak, yanlış kurutma teknikleri protein denatürasyonuna ve besin kaybına yol açabileceğinden, optimum kurutma koşullarının belirlenmesi büyük önem taşır. Kazein ve peynir altı suyu proteini, farklı kurutma teknikleri gerektirir. Kazein genellikle sprej kurutma yöntemiyle toz haline getirilir. Bu süreçte, sıvı kazein çözeltisi yüksek sıcaklıkta atomize edilerek hızlı bir şekilde kurutulur. Peynir altı suyu proteini ise liofilizasyon (dondurarak kurutma) veya sprej kurutma ile işlenebilir. Liofilizasyon, protein yapısını koruyarak besin kaybını minimuma indirir, ancak endüstriyel ölçekte maliyetli olabilir (Harizi ve ark., 2023).

Bitkisel süt ise genellikle sprej kurutma yöntemiyle toz haline getirilir. Bu süreçte sıvı süt ince damlacıklar halinde püskürtülerek sıcak hava ile temas eder ve hızla kurutulur. Hızlı su buharlaşması sayesinde besin bileşenleri korunur ve stabilizatörler eklenerek süt tozunun çözünürlüğü artırılır. Besin kaybını en aza indirmek için düşük sıcaklıkta kurutma tercih edilmeli, mikroenkapsülasyon ile proteinlerin oksidatif bozulması önlenmeli ve nem kontrolü sağlanarak ürünün raf ömrü artırılmalıdır (Yadav ve Mishra, 2024).

KURUTULAN SÜT TOZLARININ KARIŞTIRILMASI

Kurutma işlemi tamamlandıktan sonra, elde edilen kazein, peynir altı suyu proteini ve bitkisel süt tozu belirlenen oranlarda karıştırılarak tüketilebilir hale getirilir. Bu aşamada, bileşenlerin homojen bir şekilde dağılımını sağlamak için özel karıştırma teknikleri uygulanır. Tozların birbirine tam olarak entegre olması, ürünün çözünürlüğünü ve duyu özelliklerini doğrudan etkilediğinden, karıştırma sürecinde partikül boyutu ve nem dengesi dikkatle kontrol edilir. Karışımın stabilitesini artırmak için anti-topaklanma ajanları eklenerek tozun akışkanlığı korunur. Ayrıca, ürünün raf ömrünü uzatmak ve besin değerini korumak amacıyla oksidasyonu önleyici bileşenler kullanılabilir. Bu aşamada, süt tozunun paketlenmesi büyük önem taşır. Nem ve ışık geçirmeyen özel ambalajlar kullanılarak ürünün uzun süre boyunca tazeliğini koruması sağlanır (Apsarina ve ark., 2020).

Paketleme sonrası, ürün kalite kontrol testlerinden geçirilir. Çözünürlük, besin içeriği ve mikrobiyal stabilite analiz edilerek tüketiciye güvenli bir ürün sunulması sağlanır. Son olarak, lojistik süreçler devreye girer ve ürünler depolama koşullarına uygun şekilde raflara ulaştırılır. Bu süreç boyunca sıcaklık ve nem kontrolü sağlanarak ürünün fizikokimyasal özelliklerinin korunması hedeflenir. Böylece, yapay süt tozu tüketiciye ulaşana kadar besin değerini ve fonksiyonel özelliklerini koruyarak güvenli bir şekilde raflara yerleştirilmiş olur (Clarke ve ark., 2021).

SONUÇ

Geleneksel süt üretim yöntemleri, çevresel sürdürülebilirlik ve etik kaygılar nedeniyle yeniden değerlendirilmektedir. Hassas fermentasyon ve hücre tabanlı biyoteknoloji, hayvansal kaynaklara bağımlılığı azaltarak süt proteini üretiminde yeni bir çağ başlatmaktadır. Bu yöntemler, yüksek besin değerine sahip süt proteinlerini endüstriyel ölçekte üretmeyi mümkün kılarken, doğal süt ürünlerine yakın bir kaliteyi koruma avantajı sunmaktadır.

Protein izolasyonu, kurutma ve karıştırma süreçleri gibi teknolojik ilerlemeler, yapay süt proteini üretiminin ticari uygulanabilirliğini artırmaktadır. Bu süreçler sayesinde, süt proteini üretimi daha verimli ve sürdürülebilir hale gelerek, küresel gıda sisteminde önemli bir dönüşüm sağlamaktadır. Ekonomik ve endüstriyel açıdan değerlendirildiğinde, bu teknolojiler süt endüstrisinde maliyet etkinliği sağlayarak sürdürülebilir ve yenilikçi bir model oluşturmaktadır. Tüketici taleplerine uyumlu olarak geliştirilmesi halinde, geleneksel süt ürünlerine alternatif olarak geniş çapta benimsenebilir.

Gelecek perspektifinde, biyoteknolojinin gıda üretimi üzerindeki etkisinin giderek artacağı öngörülmektedir. Hassas fermentasyon ve hücre tabanlı biyoteknoloji, yeni nesil süt ürünlerinin temelini oluşturacak ve gıda endüstrisinin dönüşümüne öncülük edecektir. Araştırma ve geliştirme faaliyetleri, süreçlerin daha da optimize edilmesini sağlarken, düzenleyici çerçevelerin uyumlanması ve tüketici eğilimlerinin şekillendirilmesi sürecin başarısını belirleyen unsurlar olacaktır.

Bu çalışma, alternatif süt proteini üretiminin bilimsel ve endüstriyel boyutlarını detaylandırarak, gelecekte sürdürülebilir süt üretimi için önemli bir referans oluşturmayı amaçlamaktadır.

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ALKOQOLSUZ İÇKİLƏRİN MÜXTƏLİF MARKALARININ SUYUN KEYFİYYƏT PARAMETRLƏRİNİN MÜQAYİSƏLİ TƏDQIQI

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ABSTRACT

A soft drink is a drink that contains no alcohol but is usually referred to as a sugary drink. We overwhelmingly order Soft drinks or Soda cans as a part of the meal. It's a proven fact, that today's youth mostly prefers Soft drinks or Soda cans to fresh Fruit juices. Soft Drinks Impact on Health is getting adverse day by day. To determine the harmful effects of soft drinks, various soft drink brands were collected and qualitative analysis was conducted. The analysis included different testing carried in chemistry lab viz. pH, Acidity, Dissolved Oxygen, Chlorides, Sodium (Na) & Potassium (K) content, Electrical conductivity & Total Dissolved Solids (TDS). However, these nutrients are generally only lost in large amounts during high-intensity exercise for one hour or more. Sports drinks may be useful for people doing intense exercise for a long time, especially if they're sweating a lot. But for non-athletes, sports drinks are simply another sugary beverage. Most people should drink water, not sports drinks, during their workouts. Caffeine is found in drinks like coffee, some teas, energy drinks, and sodas. While you may urinate more after drinking a caffeinated drink, drinking these beverages does not cause you to lose more fluid than you consumed. However, caffeine can lead to headaches and trouble sleeping in some people.

Overall, water is your best bet to stay hydrated. It's caffeine-free, calorie-free, and readily available for most people. The test results revealed that most soft drinks exceed drinking water standards. Water is the main component of soft drinks, making up 85% of the product⁹⁵ and acting as a carrier for the ingredients. Hence soft drinks are not beneficial for health. Drinking soft drinks regularly really is slow poisoning. The over-consumption of sugar sweetened soft drinks is associated with obesity, diabetes, dental caries, kidney stones and low nutrient levels.

The aim of this study was to make others to be aware about bad effects of soft drinks on human health to people specially to youths. The most important information is the role of water in drinks and its usage methods.

Keywords: Soft drinks, Health hazards, water, ingredient, acidity.

COMPARATIVE STUDY OF WATER QUALITY PARAMETERS OF DIFFERENT BRANDS OF SOFT DRINKS

Xülasə

Alkoqolsuz içki tərkibində spirt olmayan, lakin adətən şəkərli içki adlandırılan içkidir. Biz yeməyin bir hissəsi kimi çoxlu sərinləşdirici içkilər və ya sodalı içkilər sifariş edirik. Bu sübut olunmuş faktdır ki, müasir gənclər daha çox sərinləşdirici içkilərə və ya qazlı içkilərə təzə meyvə şirələrinə üstünlük verirlər. Alkoqolsuz içkilərin sağlamlığa təsiri günü-gündən pisləşir. Alkoqolsuz içkilərin zərərli təsirlərini müəyyən etmək üçün müxtəlif sərinləşdirici içki markası toplanmış və keyfiyyət təhlili aparılmışdır. Təhlil kimya laboratoriyasında aparılan müxtəlif sınaqları, yəni. pH, Turşuluq, həll olunmuş oksigen, xloridlər, natrium (Na) və kalium (K) tərkibi, elektrik keçiriciliyi və ümumi həll olunmuş bərk maddələr (TDS). Bununla belə, bu qidalar ümumiyyətlə yalnız bir saat və ya daha çox yüksək intensivlikli məşq zamanı böyük miqdarda itirilir. İdman içkiləri uzun müddət intensiv məşq edən insanlar üçün faydalı ola bilər, xüsusən də çox tərləyirlərsə. Ancaq idmançı olmayanlar üçün idman içkiləri başqa bir şəkərli içkidir. Çox insan məşq zamanı idman içkiləri deyil, su içməlidir. Kofein qəhvə, bəzi çaylar, enerji içkiləri və qazlı içkilər kimi içkilərdə olur. Kofeinli içki içdikdən sonra daha çox idrar edə bilsəniz də, bu içkiləri içmək istehlak etdiyinizdən daha çox maye itirməyinizə səbəb olmur. Bununla belə, kofein bəzi insanlarda baş ağrısına və yuxu probleminə səbəb ola bilər.

Ümumiyyətlə, su nəmli qalmaq üçün ən yaxşı seçimdir. Kofeinsiz, kalorısızdır və əksər insanlar üçün hazırdır. Sınaqların nəticələrindən məlum olub ki, sərinləşdirici içkilərin əksəriyyəti içməli su standartlarını üstələyir. Su sərinləşdirici içkinin əsas komponenti kimi adətən məhsulun 85-95%-ni təşkil edir və digər inqrediyentlər üçün daşıyıcı kimi çıxış edir.

Buna görə də sərinləşdirici içkilər sağlamlıq üçün faydalı deyil. Müntəzəm olaraq sərinləşdirici içkilər içmək həqiqətən yavaş zəhərlənmədir. Şəkərli sərinləşdirici içkilərin həddindən artıq istehlakı piylənmə, şəkərli diabet, diş kariyes, böyrək daşları və aşağı qida səviyyəsi ilə əlaqələndirilir. Bu araşdırmanın məqsədi sərinləşdirici içkilərin insan sağlamlığına zərərli təsirləri barədə insanlara, xüsusən də gənclərə məlumat vermək idi. Ən vacib məlumat isə suların içkilərin tərkibində rolu, istifadə metodları izah olunur.

Açar sözlər : İçkilər, Sağlamlıq təhlükələri, su, element, turşuluq.

THE ROLE OF WATER IN FOOD PRODUCTS

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ABSTRACT

Food is an indispensable factor for humans and animals, because it provides the energy and substances necessary for developing the metabolic processes, which generate the body's growth. It is the source and regulator of exchange processes between the body and the environment. Since ancient times man has received the necessary nutrients from the environment but the operation and maintenance of the body physiology constantly needs energy. In this work we focus on the chemical composition of food, and more specifically, on the amount of water contained in food products (humidity), as a factor influencing the stability and quality of food products. Our goals in this article are: - To determine the role of water in food products; - To identify and define methods for determining the water content in food.

Water in food products. The human body processes chemicals contained in food products. Some foods consist of almost only one substance, but in general they consist of five main chemical groups: water, minerals, carbohydrates, lipids and proteins. Also, food products contain vitamins, pigments, acids, enzymes, tannins, essential oils, alkaloids, hormones, etc.

Not all foods have significant nutritional potential, but they in turn have taste, aromatic and other favorable properties that affect the nutritional process. The water used in food production must meet the same conditions and water quality. Water quantity and quality control determines a number of characteristics of food products, such as: freshness (meat, eggs, fish, produce, products, etc.), manufactured products (wine, milk, wine, produce drinks, natural juices, minced meat). methods of improving the quality. Products with a high water content spoil quickly, create conditions for the development of pathogens, and therefore require special low temperatures for their long-term storage. This section includes meat and fish from products exposed to the action of enzymes. A decrease in the water content of some products below the norm can lead to a decrease in the value of products such as fruits and vegetables.

Key words: food, humidity, quality, water, minerals.

QIDA MƏHSULLARINDA SUYUN ROLU

Xülasə

Qida insanlar və heyvanlar üçün əvəzolunmaz amildir, çünki o, orqanizmin böyüməsini yaradan metabolik proseslərin inkişafı üçün lazım olan enerji və maddələri təmin edir. Orqanizmlə ətraf mühit arasında mübadilə proseslərinin mənbəyi və tənzimləyicisidir. Qədim dövrlərdən bəri insan ətraf mühitdən lazımi qidaları almışdır, lakin bədən fiziologiyasının işləməsi və saxlanması daim enerjiyə ehtiyac duyur. Bu işdə biz qida məhsullarının sabitliyinə və keyfiyyətinə təsir edən amil kimi qidanın kimyəvi tərkibinə, daha dəqiq desək, qida məhsullarının tərkibində olan suyun miqdarına (rütubət) diqqət yetiririk. Bu məqalədə məqsədlərimiz bunlardır: - Qida məhsullarında suyun rolunun müəyyən edilməsi; - Qidada suyun tərkibini təyin etmək üçün üsulların müəyyən edilməsi və təyin edilməsi. Qida məhsullarında su. İnsan orqanizmi qida məhsullarının tərkibində olan kimyəvi maddələri emal edir. Bəzi qidalar demək olar ki, yalnız bir maddədən ibarətdir, lakin ümumiyyətlə beş əsas kimyəvi qrupdan ibarətdir: su, minerallar, karbohidratlar, lipidlər və zülallar. Həmçinin qida məhsullarının tərkibində vitaminlər, piqmentlər, turşular, fermentlər, aşıləyıcı maddələr, efir yağları, alkaloidlər, hormonlar və s. var. Bütün qidalar əhəmiyyətli qida potensialına malik deyil, lakin öz növbəsində qidalanma prosesinə təsir edən dad, aromatik və digər əlverişli xüsusiyyətlərə malikdir. Qida istehsalında istifadə olunan su eyni şərtlərə və suyun keyfiyyətinə cavab verməlidir. Suyun kəmiyyətinə və keyfiyyətinə nəzarət qida məhsullarının bir sıra xüsusiyyətlərini müəyyənləşdirir, məsələn: təzəlik (ət, yumurta, balıq, məhsul, məhsul və s.), istehsal olunan məhsullar (şərab, şərab, məhsul içkilər, təbii şirələr, qiymə). Üsulların keyfiyyətinin yüksəldilməsi. Tərkibində yüksək səviyyədə su olan məhsullar tez xarab olur, patogenin inkişafı üçün şərait yaradır və buna görə onların uzun müddət saxlanması xüsusi aşağı temperatur tələb edir. Bu bölməyə fermentlərin təsirinə məruz qalan məhsullardan ət və balıqlar daxildir. Bəzi məhsulların tərkibindəki suyun normadan aşağı düşməsi meyvə və tərəvəz kimi məhsulların dəyərinin aşağı düşməsinə səbəb ola bilər.

Açar sözlər: qida, rütubət, keyfiyyət, su, minerallar.

CONCEPTUAL ISSUES IN FACILITATING ACCESS TO FINANCE FOR AGRICULTURAL PRODUCERS

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Abstract

The article investigated ways to facilitate agricultural producers' access to finance. The efficiency of agricultural production depends on its financial position and the degree of utilization of financial resources, as well as the efficiency of the use of these resources. Financial relations related to the creation and use of money at the level of enterprises in agriculture condition the efficiency of economic activity at various levels.

The need to facilitate access to finance for those working in agriculture is conditioned, first of all, by the strategic importance of this sphere from the point of view of ensuring food security of the country. Facilitating access to finance for those working in the agricultural sector plays an important role in sustainable rural development. Therefore, the search for new ways in the strategic management of financial provision of the regions continues. The main resource in agriculture is land, which cannot be increased even if the population increases. At the same time, note that the nature and efficiency of land use relations is a decisive factor determining the degree of access to financial resources.

Currently, agricultural producers' access to finance is strongly related to the size of their operations. In most cases, there is a correlation between the size of production enterprises and their access to finance. Therefore, the role of cooperation factor in facilitating producers' access to finance cannot be ignored in Azerbaijan. Land and financial relations in agriculture complement each other in terms of development criteria. With a high probability it can have a positive impact on access to finance for the subjects of production. Regardless of the level of liberalism of the economy and the nature of the financial control mechanism, the priorities of the state's financial policy should be taken into account at any level of the economy. The agricultural sector is considered a high-risk sector, so it is necessary to minimize, neutralize risks, its management, which includes distribution and a number of other issues.

The role of insurance as a guarantee system is increasing in terms of ensuring harmony and stability of this activity. One of the important points for agricultural producers in the conditions of developed market relations is that insurance funds are not only a reliable guarantee system, but also can play the role of one of the important sources of long-term investments.

The objective basis for the formation and development of the insurance market is the public demand for insurance protection. The opportunities of digital technologies for the development

of insurance in the agricultural sector are also wide. This covers a wide range: from creating and updating the necessary information base to solving the issues of creating insurance funds.

Keywords: agricultural producers, finance, production, agriculture, financial resources, risk, insurance.

КОНЦЕПТУАЛЬНЫЕ ВОПРОСЫ ОБЛЕГЧЕНИЯ ДОСТУПА СЕЛЬСКОХОЗЯЙСТВЕННЫХ ПРОИЗВОДИТЕЛЕЙ К ФИНАНСАМ

Аннотация

В статье были исследованы пути облегчения доступа сельскохозяйственных производителей к финансам. Эффективность сельскохозяйственного производства зависит от его финансового положения и степени использования финансовых ресурсов, а также эффективности использования этих ресурсов. Финансовые отношения, связанные с созданием и использованием денежных средств на уровне предприятий в сельском хозяйстве, обуславливают эффективность экономической деятельности на различных уровнях.

Роль сельского хозяйства и продовольственной безопасности в жизни общества имеет решающее значение на всех этапах развития. Сельское хозяйство, как и любой сектор экономики, напрямую зависит от ресурсов. Как и во всех других сферах экономической деятельности, эффективность сельскохозяйственного производства зависит от его финансового положения и степени использования финансовых ресурсов, а также эффективности использования этих ресурсов. Финансовые отношения, связанные с созданием и использованием денежных средств на уровне предприятий в сельском хозяйстве, обуславливают эффективность экономической деятельности на различных уровнях. Нормальное функционирование финансовой системы как совокупности взаимодействующих индивидуальных решений этих отношений является решающим фактором устойчивости экономики в этой области. Являясь хозяйствующим субъектом, производственное предприятие определяет свою финансовую политику, располагая специальными финансовыми ресурсами (6). Эта политика предусматривает следующее: обеспечение финансовой устойчивости и оптимизацию структуры капитала для этой цели, увеличение прибыли, обеспечение прозрачности финансово-хозяйственной деятельности, повышение инвестиционной привлекательности внутри

Необходимость облегчения доступа к финансам для работающих в сельском хозяйстве обусловлена, прежде всего, стратегическим значением этой сферы с точки зрения обеспечения продовольственной безопасности страны. Облегчение доступа к

финансированию для тех, кто работает в сельскохозяйственном секторе, играет важную роль в устойчивом развитии сельских территорий. Поэтому поиск новых путей в стратегическом управлении финансовым обеспечением регионов продолжается. Основным ресурсом в сельском хозяйстве является земля, увеличить которую невозможно даже при увеличении численности населения. В то же время обратите внимание, что характер и эффективность отношений землепользования является решающим фактором, определяющим степень доступа к финансовым ресурсам.

В настоящее время доступ сельскохозяйственных производителей к финансированию в значительной степени связан с масштабами их деятельности. В большинстве случаев наблюдается корреляционная зависимость между размерами производственных предприятий и их доступом к финансам. Поэтому в Азербайджане нельзя игнорировать роль фактора сотрудничества в облегчении доступа производителей к финансированию. Земельные и финансовые отношения в сельском хозяйстве дополняют друг друга по критериям развития. С высокой вероятностью это может оказать положительное влияние на доступ к финансам субъектов производства. Независимо от уровня либерализма экономики и характера механизма финансового контроля приоритеты финансовой политики государства должны учитываться на любом уровне экономики. Сельскохозяйственный сектор считается сектором высокого риска, поэтому необходимо минимизировать, нейтрализовать риски, ее управление, включающее в себя распределение и ряд других вопросов.

Роль страхования как гарантийной системы возрастает с точки зрения обеспечения гармонии и стабильности этой деятельности. Одним из важных моментов для сельскохозяйственных товаропроизводителей в условиях развитых рыночных отношений является то, что страховые фонды не только являются надежной гарантийной системой, но и могут играть роль одного из важных источников долгосрочных инвестиций.

Объективной основой формирования и развития страхового рынка является общественный запрос на страховую защиту. Широки также возможности цифровых технологий для развития страхования в аграрном секторе. Это охватывает широкий спектр: от создания и обновления необходимой информационной базы до решения вопросов создания страховых фондов.

Ключевые слова: сельскохозяйственные производители, финансы, производство, сельское хозяйство, финансовые ресурсы, риск, страхование.

Значение аграрного сектора и обеспечения продовольственной безопасности в функционировании общества является ключевым на всех этапах его социально-экономического развития. Сельскохозяйственное производство, как важная составная часть экономической системы, демонстрирует высокую степень зависимости от наличия и рационального использования ресурсной базы. Подобно иным видам хозяйственной деятельности, результативность аграрного производства во многом определяется его финансовым состоянием и степенью эффективности привлечения и использования финансовых ресурсов. Финансово-экономические отношения, формирующиеся в процессе создания и распределения денежных средств на уровне аграрных субъектов, оказывают непосредственное влияние на общий уровень экономической устойчивости и эффективности в данной отрасли. Сбалансированное функционирование финансовой системы как совокупности институциональных решений и механизмов в рамках аграрного сектора выступает решающим условием устойчивого развития экономики в целом.

Как хозяйствующий субъект, сельскохозяйственное предприятие самостоятельно формирует и реализует собственную финансовую политику, основываясь на наличии и использовании специфических финансовых ресурсов (6). Основной задачей такой политики является обеспечение финансовой устойчивости, оптимизация структуры капитала, рост рентабельности, повышение прозрачности хозяйственной деятельности, а также укрепление инвестиционной привлекательности предприятия. Наряду с этим важное значение приобретает внедрение эффективных инструментов и методов мобилизации финансовых ресурсов.

Финансовая стратегия аграрного предприятия, представляющая собой совокупность управленческих решений, направленных на формирование, распределение и использование финансовых потоков, определяет динамику его развития. Уровень реализации этой стратегии оказывает прямое влияние на позиционирование субъекта в структуре финансового рынка в условиях институционализированных рыночных отношений. Упрощение процедур доступа к финансовым источникам для аграрных товаропроизводителей обусловлено стратегическим значением сельского хозяйства в контексте обеспечения продовольственной независимости страны (15, с.199-205). Одновременно с этим следует отметить, что аграрный сектор, как правило, находится в менее конкурентных условиях по сравнению с другими отраслями, особенно в аспекте привлечения финансовых ресурсов.

Среди факторов, обуславливающих ограниченный доступ аграрного сектора к финансовым ресурсам, можно выделить следующие обстоятельства: сравнительно низкий уровень рентабельности сельскохозяйственного производства, замедленный оборот денежных средств, высокая степень зависимости от природно-климатических условий, а также низкая кредитоспособность субъектов агробизнеса, в большинстве случаев не располагающих кредитной историей (13, с.366-369). Кроме того, наблюдается ценовой дисбаланс, не в пользу сельского хозяйства, что негативно отражается на доходности отрасли. Также характерной чертой является слабая мотивация к кооперации и интеграции среди аграрных производителей, что ограничивает масштабы их деятельности и возможности для коллективного доступа к финансам. Важно отметить, что фермерские хозяйства преимущественно представлены в виде малых предприятий, что снижает интерес со стороны коммерческих банков, поскольку работа с мелкими клиентами требует значительных транзакционных и административных затрат, связанных с мониторингом и обеспечением исполнения условий кредитных соглашений.

Упрощение доступа к финансовым ресурсам для субъектов сельскохозяйственной деятельности рассматривается как важнейшее условие устойчивого развития сельских территорий. В этом контексте продолжается поиск новых подходов к стратегическому управлению системой финансового обеспечения регионов. Воздействие природно-климатических факторов усиливает уровень неопределённости в краткосрочной и среднесрочной перспективе, что существенно затрудняет проведение точных прогнозов и планирования производственных результатов. В связи с этим представляется оправданным и широко распространённым мнение о том, что сельское производство находится в прямой зависимости от природных условий. Даже в странах с высокоразвитой аграрной культурой и внедрёнными интенсивными технологиями невозможно обеспечить предсказуемость результатов с достаточной степенью точности (14, с. 17).

Указанные обстоятельства, независимо от уровня экономического развития государства, обуславливают необходимость разработки и реализации мер государственного регулирования, включая механизмы поддержки, направленные на облегчение доступа аграрных производителей к финансированию. Эти меры приобретают универсальный характер и реализуются практически во всех странах, стремящихся обеспечить продовольственную безопасность и устойчивость аграрного сектора.

В Азербайджанской Республике, обладающей благоприятным природно-климатическим потенциалом, устойчивыми традициями в сфере сельского хозяйства и реальными возможностями по обеспечению продовольственной безопасности на национальном уровне, аграрному сектору систематически уделяется особое внимание. Начиная с периода руководства национальным лидером Гейдаром Алиевым, развитие аграрной отрасли рассматривалось как приоритетное направление государственной политики, получившее комплексную поддержку и институциональное обоснование.

На современном этапе развитие инновационной модели сельского хозяйства объявлено одним из ключевых направлений, а вопросы финансового обеспечения аграрного сектора остаются в центре государственной повестки. В частности, в третьей стратегической цели Стратегической дорожной карты по производству и переработке сельскохозяйственной продукции в Азербайджане, утверждённой Указом Президента от 6 декабря 2016 года, обозначено, что достижение конкурентоспособности аграрного сектора возможно за счёт повышения доступности финансовых ресурсов для производителей. Для этого необходимо провести оценку рисков в аграрной сфере и модернизировать действующие механизмы по их минимизации и нейтрализации (7, с. 35-44).

В рамках обозначенной цели определены три приоритетных направления. Первое из них охватывает комплекс мер по совершенствованию финансового механизма в аграрной сфере. Вторым приоритетом акцентируется внимание на развитии системы аграрного страхования в стране. Третьим направлением предполагается реализацию инструментов, стимулирующих как внутренние, так и внешние инвестиции в сельскохозяйственное производство.

Прежде чем приступить к анализу совершенствования финансовых механизмов, представляется необходимым определить сущностное содержание самого понятия «финансовый механизм». Согласно экономической науке, финансовый механизм представляет собой совокупность организационно-правовых форм и методов управления, предназначенных для эффективного функционирования процессов формирования, распределения и использования финансовых ресурсов (4, с. 224).

В контексте сельскохозяйственного производства финансовый механизм включает в себя систему финансовых инструментов, методов, регламентирующих нормативов и информационно-аналитических компонентов, обеспечивающих поддержание и развитие производственного процесса. Однако в существующем виде этот механизм не в полной мере соответствует требованиям динамично развивающегося аграрного сектора. Такая

ситуация обусловлена не только особенностями самой отрасли, но и ограничениями применяемых инструментов регулирования. Финансовые методы, правовые и информационные составляющие действующего механизма нередко вступают в противоречие с актуальными мерами государственной поддержки и не успевают адаптироваться к изменениям методологического характера (3, с.82).

Одним из факторов, усугубляющих данную проблему, является применение режима налоговых каникул для сельскохозяйственных производителей. В условиях действия налоговых льгот учётная и отчётная деятельность предприятий аграрного сектора зачастую осуществляется в неполном объёме, что препятствует интеграции прогрессивных элементов национальной налоговой системы. Следовательно, вне зависимости от форм собственности и моделей управления, обеспечение комплексного и последовательного использования всех возможных источников финансирования, их устойчивое наращивание и целевое применение должны рассматриваться в качестве одной из основополагающих задач государственной экономической политики (11, с. 149).

Продление налоговых каникул, имеющее системный характер и действующее в течение последних двух десятилетий, стало важным стимулом для активизации предпринимательской деятельности в аграрной сфере. Эти меры государственного стимулирования значительно улучшили финансовое положение сельскохозяйственных производителей, усилив их инвестиционные возможности и снизив административные барьеры.

Современные условия развития страны не допускают игнорирования ни одного из ключевых экономических, социальных и правовых аспектов, связанных с функционированием аграрного сектора (2). В первую очередь это касается земельных отношений, поскольку земля выступает базовым и невосполнимым ресурсом сельского хозяйства. При этом структура и эффективность системы землепользования оказывает прямое влияние на возможности доступа к финансовым ресурсам. Наличие несформированного полноценного рынка земли существенно тормозит развитие институциональных механизмов финансового обеспечения и затрудняет нормализацию экономических взаимоотношений между субъектами аграрного производства.

Проведённые в Азербайджане земельные реформы стали основой для построения цивилизованного рынка земли и придали системность земельным отношениям. Однако сохраняющееся расхождение между фактической и рыночной стоимостью земельных участков продолжает сдерживать формирование эффективного механизма залогового

кредитования. В условиях, когда производственные мощности сельхозпредприятий ограничены по масштабу, уровень их финансовой доступности напрямую коррелирует с размерами хозяйств. Таким образом, значимость кооперации и объединения усилий мелких производителей возрастает. Закон Азербайджанской Республики «О сельскохозяйственной кооперации», принятый 14 июня 2016 года, направлен на институционализацию этих процессов и включает положения, касающиеся расширения доступа аграрных субъектов к финансированию (1).

Результаты аграрной земельной реформы продемонстрировали эффективность перехода к рыночной модели и создание предпосылок для эволюции земельных отношений. Однако проблемы остаются: различия между оценочной и рыночной стоимостью активов, недостатки в правовой базе залогового кредитования, слабая интеграция рынков земли и финансовых инструментов требуют комплексного пересмотра действующих механизмов. В частности, необходима адаптация банковских процедур к аграрной специфике, модернизация системы залога и активизация взаимодействия между рынками земли и ценных бумаг. Земельные и финансовые отношения в сельском хозяйстве следует рассматривать как взаимодополняющие в аспекте стимулирования экономического роста (8, с. 15).

Таким образом, независимо от уровня экономической либерализации, принципы государственной финансовой политики должны соблюдаться на всех уровнях управления. Финансовый контроль, являясь основным элементом в системе управления государственными финансами, служит инструментом обеспечения финансовой безопасности, стабильности и реализации стратегических приоритетов. Его значение возрастает в условиях активного товарно-денежного оборота и необходимости координации экономической политики.

Интенсивная модель развития сельского хозяйства обуславливает реализацию комплекса задач, направленных на рост конкурентоспособности отрасли. Ключевыми направлениями в этом контексте выступают: повышение эффективности использования основных и оборотных фондов, внедрение технологических инноваций, совершенствование организации труда и производственного процесса, а также оптимизация управленческих решений (6, с. 160).

Уровень доступа к финансированию во многом зависит от способности сельскохозяйственного предприятия эффективно контролировать и минимизировать свои издержки. Чем ниже себестоимость сельхозпродукции, тем выше финансовая устойчивость хозяйствующего субъекта и шире возможности для расширения

производственной базы. Анализ корреляции между масштабами производства и динамикой затрат приобретает особую значимость с точки зрения стратегического управления ресурсами. В частности, при расширении объемов производства наблюдается снижение удельных затрат на единицу продукции, что обусловлено эффектом масштаба и повышением эффективности использования переменных факторов (5, с. 179).

Сельское хозяйство традиционно рассматривается как высоко рисковая сфера, что требует формирования устойчивой системы управления рисками, включая механизмы перераспределения и нейтрализации неблагоприятных факторов. Одной из ключевых гарантий таких механизмов выступает страхование, однако уровень охвата аграрного сектора страховыми услугами остаётся низким. Причины кроются в недостатке доверия к страховым компаниям, ограниченном ассортименте продуктов, слабом финансовом состоянии страховых организаций в регионах, а также отсутствии конкуренции и недостаточной информационно-консультационной поддержки для сельхозпроизводителей (12, с.27-28).

При этом страховые фонды, наряду с функцией гарантии, могут служить источником долгосрочных инвестиционных ресурсов. Однако полноценное функционирование страхового рынка возможно лишь при наличии устойчивого общественного спроса на страховую защиту, который, в свою очередь, коррелирует с доступом к финансированию. Взаимосвязь этих факторов требует более глубокого изучения в рамках научных исследований и практической реализации финансовых стратегий.

Финансовая стратегия предприятия должна учитывать риски, связанные с инфляцией, выплатами и иными непредвиденными обстоятельствами. Она обязана соответствовать производственным целям и корректироваться по мере необходимости. Хотя полная предсказуемость событий в аграрной сфере недостижима, чрезмерно частая корректировка стратегии доступа к финансам может подорвать устойчивость системы (10, с.150).

Высокая зависимость от климатических условий и неопределённость окружающей среды делают фактор риска центральным элементом стратегического планирования. При этом доступ к финансированию во многом определяется интересом кредитных учреждений к работе с аграрным сектором. В настоящее время среди ключевых ограничений – несовершенство залогового обеспечения, не учитывающего особенности сельских хозяйств. Также следует отметить значительные транзакционные издержки, возникающие при получении кредитов.

Цифровизация становится новым этапом в повышении финансовой доступности для сельхозпроизводителей. Развитие электронных платежных систем, внедрение цифровых платформ и финансовых посредников на базе искусственного интеллекта и анализа больших данных формируют новый вектор агрофинансирования (9, с. 180). Эти технологии создают предпосылки для оптимизации процедур доступа к страхованию, автоматизации формирования страховых фондов и повышения инвестиционной привлекательности сектора.

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HER SAĞLIKLI HAYVANDA SAĞLIKLI BİR UTERUS BEKLENMELİ MİDİR?**Enes ÇERÇİ**

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ORCID: 0000-0003-4500-1958**ÖZET**

Kısırlaştırılmamış carnivorlarda uterin enfeksiyonlar yaygın olarak görülmektedir. Bu enfeksiyonlar genellikle uterusun bir ya da her iki kornusunda farklı özelliklere sahip sıvı birikimi ile karakterizedir. Sıvı birikiminin ilk evresi hidrometradır. Hidrometra, enfeksiyöz ve inflamatuvar olmayan, berrak ve steril bir sıvının uterin lümende birikmesiyle oluşan bir uterus patolojisidir. Genellikle progesteron hormonu kaynaklıdır ve transabdominal ultrasonografi, vajinal sitoloji ile hemogram ve biyokimya analizleriyle tanı konulabilir. Hidrometra tüm türlerde gözlemlenebilmekle birlikte, kedilerde nadir olarak görülmektedir. Hidrometra üç evrede gelişebilir: hidrometra, mukometra ve piyometra. İlk iki evrede hayvanda herhangi bir klinik belirti görülmez ve evcil hayvan sahipleri bu durumu fark edemeyebilir. Bu olgu sunumunda, kliniğimize kısırlaştırma amacıyla getirilen 7 aylık bir dişi kedi değerlendirilmiştir. Kedinin rutin genel muayenesi yapılmış, hemogram değerleri ölçülmüş ve genel sağlık durumunda herhangi bir bozukluk saptanmamıştır. Ultrasonografik inceleme sonucunda, vesica urinerianın ventralinde uterus görüntülenmiş ve uterusta anekoik bir sıvı tespit edilmiştir. Ultrasonografi sırasında gebelik olasılığı değerlendirilmiş ancak fetüse rastlanmamıştır. Vajinal akıntının olmaması ve hastanın genel durumunun iyi olması nedeniyle cerrahi müdahaleye karar verilmiştir. Bu amaçla hastaya ovariohisterektomi operasyonu planlanmıştır. Genel anestezi için Domitor (medetomidin hidroklorür, 80 µg/kg i.m.) ve Keta-control (ketamin hidroklorür, 5–7,5 mg/kg i.m.) kullanılmıştır. Cerrahi girişim olarak median laparotomi tercih edilmiştir. Her iki uterus kornusunun da sıvı ile dolu olduğu gözlenmiştir. Bu sıvıdan örnek alınarak mikrobiyolojik inceleme yapılmıştır. İnceleme sonucunda olgunun hidrometra olduğu belirlenmiştir. Mikrobiyolojik ajan olarak *Escherichia coli* üremesi saptanmıştır. Hidrometra ve mukometra olgularında erken tanı, piyometra gelişiminin önlenmesi açısından kritik öneme sahiptir.

Anahtar Kelimeler: Hidrometra, Mukometra, Uterin Enfeksiyonlar, Kısırlaştırma, Dişi Kedi

SHOULD A HEALTHY UTERUS BE EXPECTED IN EVERY HEALTHY ANIMAL?**ABSTRACT**

Uterine infections are common in unspayed carnivores. These infections are usually characterised by fluid accumulation in the uterus or its cornu (unilateral/bilateral) of different character. The first stage of fluid accumulation is hydrometra. Hydrometra is a uterine pathology caused by the accumulation of a non-infectious, non-inflammatory, clear, and sterile fluid in the uterine lumen. The hormone progesterone usually causes Hydrometra and can be diagnosed by transabdominal ultrasonography, vaginal cytology and haemogram-biochemistry analysis. Cases of hydrometra can be observed in all species, but are rarely seen in cats. Hydrometra can occur in 3 stages: hydrometra, mucometra, and pyometra. In the first two stages, there are no clinical signs in the animal, and pet owners may not realise that there is a medical problem. In this case report, a 7-month-old cat was brought to our clinic with a request for spaying. The routine general examination of the cat was performed, and haemogram values were measured. No general condition disorder was observed. Ultrasonography revealed a uterus ventral to the vesica urinaria. The uterus was found to be filled with an anechoic fluid. During ultrasonographic examination, the patient was examined for pregnancy, and no fetus was seen. Since there was no vaginal discharge and the general condition of the patient was good, it was decided to perform surgical treatment. For this purpose, the patient underwent ovariohysterectomy. Domitor (medetomidine hydrochloride 80 µg/kg im) and keta-control (ketamine hydrochloride 5-7,5 mg/kg im) were administered for general anesthesia. Median line laparotomy was preferred. It was observed that both cornu uteri were filled with fluid. A sample was taken from the fluid, and a microbiological examination was performed. As a result of this examination, hydrometra was diagnosed. When the microbiological agent was isolated, *E. coli* growth was detected. Early diagnosis of hydrometra and mucometra is essential for preventing pyometra.

Keywords: Hydrometra, Mucometra, Uterine Infections, Spaying, Queen

CAUSE OF DYSTOCIA IN A MALAKLI BITCH: ADENOCARCINOMA**Enes ÇERÇİ**

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ORCID: 0000-0003-4500-1958**ABSTRACT**

A 2-year-old female dog weighing 38 kg was brought to the Obstetrics and Gynecology Clinic of Veterinary Medicine with complaints of difficult delivery, as labor had not occurred 24 hours after the onset of bloody vaginal discharge. During the clinical examination, vaginal bloody discharge continued, and no fetus was detected in the birth canal during the vaginal examination. Ultrasonography revealed the presence of the fetus; however, no heartbeat was detected. In the absence of a heartbeat, medical treatment was initiated. For this purpose, a single injection of oxytocin was administered, and after waiting for 30 minutes, since labor did not occur, a cesarean section was performed. During the surgical preparation, a neoplasm was detected in the left fifth mammary gland of the dog. The surgical intervention was performed via the median line, and the uterus was removed. Two fetuses were detected in the right uterine horn and uterine corpus. The fetuses were removed through an incision made in the uterine corpus. Size differences were observed between the fetuses. After the fetuses were removed, two masses measuring 5x5 cm in size, resembling cauliflower with a stalk, were detected in the caudal portion of the uterine corpus, near the cervix uteri. It was concluded that delivery had not occurred due to the location of the masses. Due to significant tissue loss from the uterus during mass removal, an ovariohysterectomy (OHE) was performed. An OHE was performed, followed by a local mastectomy. A histopathological examination of the removed tissues was conducted. Adenocarcinoma was diagnosed in both the mammary gland and uterine tumors. Adenocarcinomas are neoplasms that are more commonly seen in mammary tissue in carnivores and are rare in uterine tissue. This case is unique in terms of its frequency of occurrence, as the animal was female and the masses were removed from the uterus.

Keywords: Dystocia, Adenocarcinoma, Mammary Tumor, Neoplasm, Bitch

INTRODUCTION

Dystocia, or difficult labor, is a common and urgent obstetric condition in small animals—particularly dogs and cats—where the fetus is unable to pass through the birth canal. Both maternal and fetal factors (e.g., oversized fetus, malposition) play a role in the etiology (Anadol, 2007; Gendler et al., 2007; Traas, 2008; Dejneka et al., 2020; Scully, 2024).

High-risk breeds include brachycephalic and toy breeds; in some breeds, the incidence of dystocia can range from less than 5% to as high as 95%. Recent studies have found higher rates of dystocia in dogs aged 1–3 years, in primiparous individuals, in small breeds, and in those carrying 2–5 puppies (O'Neill et al., 2017; Dejneka Long et al., 2022).

Additionally, although tumor growth in the genital system of dogs is not common, it may exhibit symptoms such as hormonal disorders. Tumors that develop in the uterus are extremely rare and account for only 0.3–0.4% of all tumors (Percival et al., 2018; Almeida et al., 2023). Uterine tumors are typically diagnosed in the later stages of life. Symptoms are often vague, making diagnosis challenging (Troisi et al., 2023).

This case report will evaluate the prevention of birth in a female dog of the Malaklı breed due to uterine adenocarcinoma.

Materyal and Metot

Case Description:

A 2-year-old female dog weighing 38 kg was brought to the Obstetrics and Gynecology Clinic of Veterinary Medicine with complaints of difficult delivery, as labor had not occurred 24 hours after the onset of bloody vaginal discharge. During the clinical examination, vaginal bloody discharge continued, and no fetus was detected in the birth canal during the vaginal examination. Ultrasonography revealed the presence of the fetus; however, no heartbeat was detected. In the absence of a heartbeat, medical treatment was initiated. For this purpose, a single injection of oxytocin (Teknovet, 5 IU, im) was administered, and after waiting for 30 minutes, since labor did not occur, a cesarean section was performed. During the surgical preparation, a neoplasm was detected in the left fifth mammary gland of the dog.

Blood sample was collected bitch prior to application, and hemogram (Mindray 2008Vet) and biochemical (MNChip, Pointcare V3) analyses were performed.

Gas anesthesia protocol was used for general anesthesia. The protocol included anesthetic agents Propofol (1%, 6 mg/kg IV) and Sevoflurane (Sevorane liquid 250 ml, AMS Junior 620 V automatic ventilation device, and Shei brand Sevoflurane vaporizer). The surgical site was incised along the midline. Local mastectomy after spaying were performed.

The tissue samples were preserved in 10% formalin for a period of 48 hours. The tissue processing procedure was conducted in accordance with established protocols, employing a Leica TP1020 tissue processing system. This system utilizes a series of graded alcohols, xylene, xylene-paraffin, and paraffin, culminating in paraffin embedding. Tissue sections measuring 4 μ m in thickness were obtained from the paraffin blocks and stained with Hematoxylin-Eosin (HxE). Following the staining process, the preparations were examined under an Olympus BX51 light microscope, and photographs were taken using an Olympus DP12 camera (Tokyo, Japan).

RESULTS

Hematological Evaluation:

Leukocytosis and neutrophilia indicate a possible ongoing inflammatory, infectious, or stress-induced response. The decreased lymphocyte percentage is consistent with a stress leukogram. Additionally, mild macrocytosis may reflect regenerative anemia, early reticulocytosis, or imbalances in vitamin B12 or folate. Other erythrocyte indices, including RBC, HGB, HCT, MCH, and MCHC, remain within normal ranges, effectively ruling out anemia. Platelet count (PLT) and mean platelet volume (MPV) are also within reference limits, suggesting normal thrombopoiesis. Although the eosinophil percentage (Eos%) appears elevated, the absence of a defined reference range precludes a definitive interpretation; however, it may suggest an allergic or parasitic etiology (see Table1).

Table 1. Hematologic results (Mindray 2008Vet).

Parameter	Result	Reference Range	Unit
WBC	18.6	6.0–17.0	$\times 10^9/L$
Lymph#	2.2	0.8–5.1	$\times 10^9/L$
Mon#	0.6	0.0–1.8	$\times 10^9/L$
Gran#	15.8	4.0–12.6	$\times 10^9/L$
Lymph%	11.8	12.0–30.0	%
Mon%	3	2.0–9.0	%
Gran%	85.2	60.0–83.0	%
RBC	6.46	5.50–8.50	$\times 10^{12}/L$
HGB	15.3	11.0–19.0	g/dL
HCT	47.8	39.0–56.0	%
MCV	74	62.0–72.0	fL
MCH	23.6	20.0–25.0	pg
MCHC	32	30.0–38.0	g/dL
RDW	14.2	11.0–15.5	%
PLT	286	117–460	$\times 10^9/L$
MPV	8.7	7.0–12.9	fL
PDW	16	-	-
PCT	0.248	-	%
Eos%	8.5	-	%

Biochemical Evaluation:

Most of the biochemical parameters are within normal physiological limits, reflecting overall systemic stability. However, the glucose (GLU) level is slightly below the reference range, which may indicate mild hypoglycemia. This finding could be attributed to factors such as fasting, hepatic dysfunction, insulinoma, or systemic inflammatory conditions, including sepsis. Liver and pancreatic enzyme activities (ALT, ALP, and AMY) are within reference intervals, suggesting the absence of acute hepatocellular injury or exocrine pancreatic dysfunction. Moreover, serum cholesterol, calcium, phosphorus, and electrolyte concentrations (Na^+ , K^+) are consistent with normal metabolic and renal function. The total bile acids (TBA) concentration is also within acceptable limits, supporting the presence of adequate hepatic functional reserve (Table2).

Table 2. Biochemical results (MNChip, PointcareV3).

Parameter	Result	Reference Range	Unit
TP	6.6	5.2–8.2	g/dL
ALB	3.1	2.2–4.4	g/dL
GLO	3.5	2.3–5.2	g/dL
A/G	0.9	-	-
TBIL	0.25	0.1–0.9	mg/dL
ALT	22	10–140	U/L
ALP	28	20–150	U/L
AMY	1858	400–3500	U/L
CHOL	233	110–320	mg/dL
GLU	62	70–143	mg/dL
CRE	0.35	0.3–0.7	mg/dL
BUN	8.15	0.7–32	mg/dL
BUN/CRE	23	-	-
Ca	10	7.9–11.8	mg/dL
P	3.75	2.5–6.8	mg/dL
K+	5.6	3.7–5.8	mmol/L
Na	153	138–160	mmol/L
Na/K	27	-	-
TBA	2.64	0–20	μmol/L

Surgical Intervention and Histopathological Evaluation:

The surgical intervention was performed via the median line, and the uterus was removed. Two fetuses were detected in the right uterine horn and uterine corpus. The fetuses were removed through an incision made in the uterine corpus. Size differences were observed between the fetuses. After the fetuses were removed, two masses measuring 5x5 cm in size, resembling cauliflower with a stalk, were detected in the caudal portion of the uterine corpus, near the cervix uteri. It was concluded that delivery had not occurred due to the location of the masses. Due to significant tissue loss from the uterus during mass removal, an ovariohysterectomy (OHE) was performed. An OHE was performed, followed by a local mastectomy.

The masses that were removed during the operation were then subjected to histopathological evaluation. The mass contained cystic areas measuring 6x8x4 cm, along with necrotic areas measuring 5x5x3 cm, macroscopically (Table 3). Microscopic analysis of cells from the tumor

exhibited several cyst-like areas resembling cystic morphology. Glandular tissue cells show abnormal characteristics, such as anisocytosis, anisonucleosis and pleomorphism. Also, there was a pink-colored fluid full of protein in the gland (Table 4).

Table 3. Macroscopic Appearance of Tumor Masses: A: 6x8x4 cm, B: 5x5x3 cm masses.

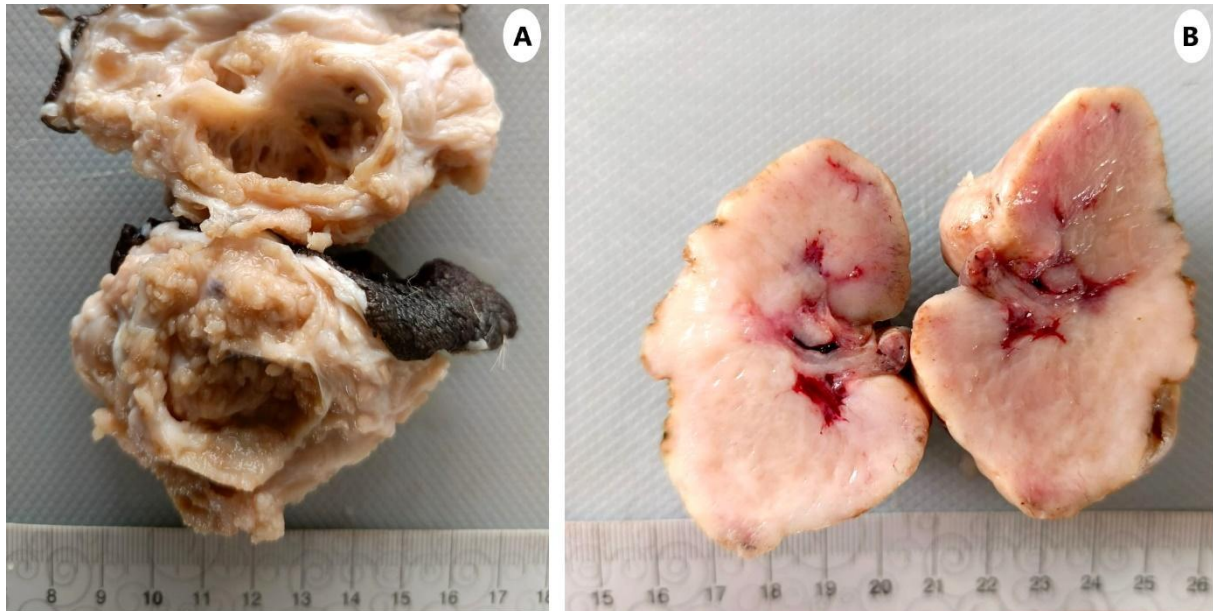
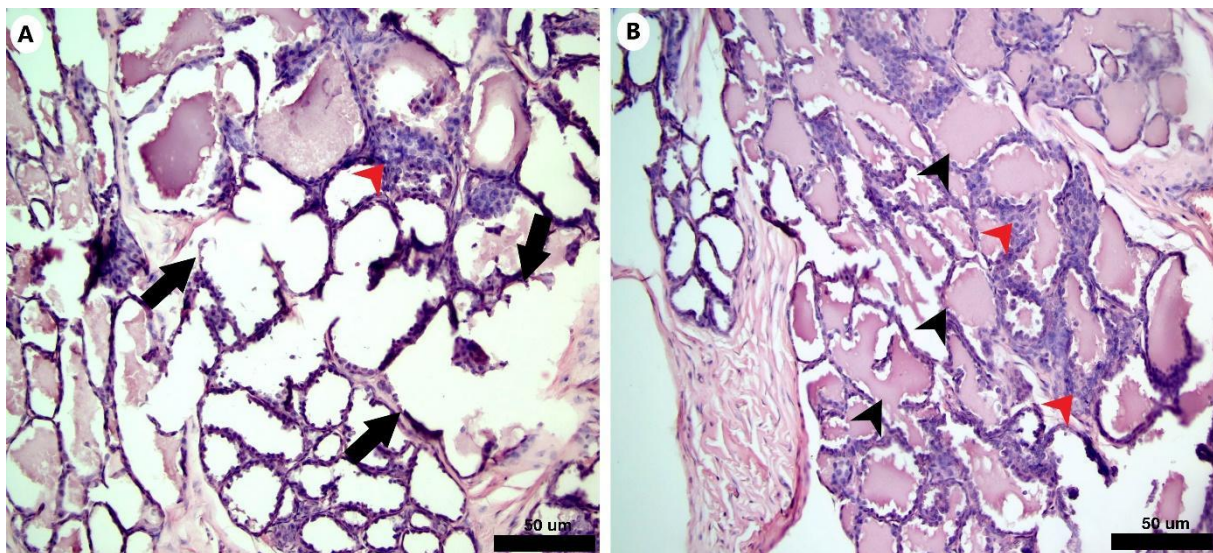


Table 4. Histopathological findings. A: Cystic structures (black arrow), protein-rich fluid (red arrow tip), HE, x40, B: Atypical cells (black arrow tip), protein-rich fluid (red arrow tip), HE, x40.



DISCUSSION

Ultrasonography played a critical role in the diagnosis of the case, as it enabled the assessment of fetal vital signs. Due to the absence of fetal heartbeat on ultrasound, the expected delivery process could not be initiated, and the administration of oxytocin was unsuccessful. In this case, an emergency cesarean section was performed, and due to the presence of masses in the uterus,

an ovariohysterectomy was performed. This case demonstrates that neoplasms can cause dystocia and that the causes should not be limited to classical maternal-fetal factors alone. In the management of dystocia, it is recommended to first apply medical approaches (oxytocin, calcium, etc.) followed by surgical intervention (cesarean section) if necessary (Anadol, 2007; Gendler et al., 2007; Long et al., 2022; Scully, 2024). In the presented case, a similar algorithm was followed; however, due to tumor obstruction in the birth canal, delivery could not be achieved, making surgical intervention necessary.

Adenocarcinomas most often occur in the mammary tissue of cats, dogs and horses; however, these tumours can occur in any glandular tissue (Erer and Kiran 2009). Though this presentation's mass is in a site that does not often exhibit this feature, the observation is consistent with what is published on the topic. Adenocarcinomas are named resembling the type of glandular tissue created by the cells that gave rise to them such as papillary cystic, papillary cystic, follicular, tubular and trabecular (Erer and Kiran 2009). In this occasion, the cystic nature of the cells from which the tumor arises confirms the diagnosis of a cystic adenocarcinoma. Normally adenocarcinomas are ill-defined by the presence of gland-like structures secreting various secretory products (Meuten 2020). The diagnosis is supported by the presence of secretory products which is indicated by homogeneous pink-colored protein-rich fluid in the above case. The cause of uterine adenocarcinoma, a rare female dog neoplasm, is unknown (Murphy et al. 1994). This case is unusual due to the sex of the animal and the location of the masses in the uterus.

CONCLUSION

Dystocia is a common condition with a broad etiological spectrum. This presentation is rare and clinically significant as it demonstrates that uterine adenocarcinoma can cause dystocia. Veterinarians should consider the possibility of neoplastic obstruction, particularly in cases of prolonged labor and lack of progress during physical examination. In such cases, early diagnosis and appropriate surgical intervention are critical for both maternal survival and preventing birth complications.

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AZƏRBAYCAN ƏDƏBİYYATININ QORUNMASI VƏ TƏBLİĞİNDƏ HEYDƏR ƏLİYEVİN ROLU**SƏFƏROVA Aynur Elşən qızı**

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Məqalədə Ümummilli Lider Heydər Əliyevin Azərbaycan ədəbiyyatına və milli-mənəvi dəyərlərə münasibəti, bu sahəyə göstərdiyi qayğı və həyata keçirdiyi siyasət geniş şəkildə təhlil edilir. Qeyd olunur ki, Azərbaycan ədəbiyyatı tarix boyu xalqın milli kimliyinin daşıyıcısı və mənəvi yaddaşının ifadəsi olmuşdur. Bu baxımdan, müstəqillik dövründə ədəbiyyatın milli identiklik və mədəni özünüdərk istiqamətindəki rolu daha da artmışdır.

Heydər Əliyevin rəhbərliyi dövründə ədəbiyyat və mədəniyyət sahələrinə dövlət səviyyəsində yüksək diqqət göstərilmiş, klassik və çağdaş ədib və sənətkarların yaradıcılığına qiymət verilmişdir. Onun təşəbbüsü ilə bir çox görkəmli ədəbiyyat və mədəniyyət xadimlərinin yubileyləri keçirilmiş, irsləri elmi və ideoloji cəhətdən təhlil olunaraq geniş şəkildə təbliğ edilmişdir. Bu kontekstdə Nizami Gəncəvi, Füzuli, Nəsimi, Hüseyn Cavid, M.P.Vaqif kimi klassiklərin irsinə göstərilən diqqət ön plana çıxır.

Məqalədə vurğulanır ki, Heydər Əliyev ədəbiyyata yalnız estetik deyil, həm də ideoloji və mənəvi dəyər kimi yanaşırdı. O, yazıçı və şairləri milli ideologiyanın formalaşmasında, cəmiyyətin mənəvi dirçəlişində mühüm rol oynayan şəxsiyyətlər kimi qiymətləndirirdi. Onun siyasi iradəsi nəticəsində bir sıra muzey və xatirə evləri yaradılmış, repressiya qurbanlarının – xüsusən Hüseyn Cavidin – xatirəsinin əbədləşdirilməsi istiqamətində mühüm addımlar atılmışdır.

Heydər Əliyevin milli-mənəvi irsə kompleks yanaşması Elmlər Akademiyasının fəaliyyətində də özünü göstərmişdir. Bu dövrdə ədəbiyyatşünaslıq, dilçilik, folklorşünaslıq və mədəniyyət tarixi kimi sahələrin inkişafı üçün geniş elmi və maddi imkanlar yaradılmışdır. Akademiyanın potensialı Azərbaycan ədəbiyyatının klassik və çağdaş nümayəndələrinin irsinin araşdırılmasına və təbliğinə yönəldilmişdir.

Sonda vurğulanır ki, Heydər Əliyevin ədəbiyyat siyasəti milli kimliyin qorunması, milli-mənəvi dəyərlərin yaşadılması və gələcək nəsillərə ötürülməsi baxımından strateji əhəmiyyət kəsb edir. Onun bu sahədəki fəaliyyəti müasir dövrdə də öz aktuallığını qoruyur və davam etdirilir. Bu kontekstdə "Kitabi-Dədə Qorqud" dastanının 1300 illik yubileyinin 1998-ci ildə UNESCO səviyyəsində qeyd olunması, Azərbaycanın zəngin ədəbi-mədəni irsinin dünya miqyasında tanınması istiqamətində atılan mühüm addımlardan biri kimi xüsusi qeyd olunur.

Açar sözlər. Heydər Əliyev, Azərbaycan mədəniyyəti, ədəbiyyat, ədəbi irs, mədəniyyət siyasəti.

Giriş

Azərbaycan ədəbiyyatı əsrlər boyu xalqımızın mənəvi sərvəti, milli kimliyinin ifadəsi olmuşdur. Bu zəngin irsin qorunması və gələcək nəsillərə ötürülməsi tarixin müxtəlif mərhələlərində diqqət mərkəzində olmuş, müəyyən dövrlərdə sistemli və ardıcıl şəkildə dövlət siyasətinə çevrilmişdir. XX əsrin sonlarında Azərbaycanın müstəqillik qazanması ilə ədəbiyyatın milli identiklik və mənəvi dəyərlərin bərpası istiqamətindəki rolu bir daha ön plana çıxmışdır.

Ulu öndər Heydər Əliyev Azərbaycan dövlətçiliyinin möhkəmləndirilməsi ilə yanaşı, mədəniyyətin, xüsusilə də ədəbiyyatın inkişafı və təbliğini prioritet sahələrdən biri kimi müəyyənləşdirmişdir. Onun rəhbərliyi dövründə ədəbiyyat yalnız yaradıcılıq müstəvisi kimi deyil, eyni zamanda milli yaddaşın qorunması vasitəsi kimi də dəyərləndirilmişdir. Bu yanaşma, bir tərəfdən, yazıçı və şairlərin fəaliyyətinə dövlət səviyyəsində dəstək göstərilməsini təmin etmiş, digər tərəfdən isə ədəbiyyatın təbliğinə yönəlmiş genişmiqyaslı layihələrin həyata keçirilməsinə zəmin yaratmışdır.

Heydər Əliyev və milli-mənəvi dəyərlər. Azərbaycan xalqının əsrlərlə formalaşmış milli-mənəvi dəyərləri onun kimliyinin ayrılmaz tərkib hissəsidir. Bu dəyərlərin qorunması və inkişaf etdirilməsi isə yalnız fərdi təşəbbüslərlə deyil, sistemli dövlət siyasəti ilə mümkün olmuşdur. Ulu Öndər Heydər Əliyev milli dəyərləri xalqın ideoloji dayağı, mənəvi sütunu kimi qiymətləndirmiş və bu sahəyə xüsusi önəm vermişdir.

Ümummilli Liderin siyasi hakimiyyətinin ilk mərhələsində – 1969-cu il noyabrın 2-də Bakı Dövlət Universitetinin 50 illik yubileyində iştirakı zamanı Azərbaycan dilində etdiyi çıxış xalqımızın mənəvi təkamülündə mühüm rol oynamış bu ali təhsil müəssisəsinin alim və müəllimlərinə göstərdiyi xüsusi diqqət və ehtiramın bariz ifadəsi idi. Bunun nəticəsində tezliklə universitetdə yaradılan 4 cildlik "Müasir Azərbaycan dili" dərsliyi Dövlət Mükafatına layiq görüldü. [Qarayeva, 2019: s.8].

Heydər Əliyev dəfələrlə vurğulamışdır ki, xalqı tanıdan, onu dünyaya tanıdan ən önəmli amillərdən biri onun mədəniyyəti və ədəbiyyatıdır. Onun fikrincə, ədəbiyyat yalnız estetik deyil, həm də ictimai-fəlsəfi və tarixi mahiyyət daşıyır. Bu baxışdan çıxış edən Ulu Öndər, ədəbiyyat adamlarının yaradıcılığına yüksək qiymət vermiş, onları milli düşüncənin daşıyıcıları və gələcək nəsillər üçün nümunəvi şəxsiyyətlər kimi təqdim etmişdir.

Onun rəhbərliyi ilə ədəbiyyat və mədəniyyət sahəsində çalışan ziyalılar dövlət səviyyəsində təltif olunmuş, yaradıcılıq mühitinin genişlənməsi üçün lazımi imkanlar yaradılmışdır. Heydər

Əliyev üçün milli-mənəvi dəyərlər sadəcə keçmişin mirası deyil, həm də gələcəyə aparan yol xəritəsi idi. O, bu dəyərləri yaşatmaqla cəmiyyətin mənəvi dirçəlişini təmin etməyi qarşıya məqsəd qoymuşdu.

Xüsusilə qeyd etmək lazımdır ki, Heydər Əliyevin nitqlərində və çıxışlarında tez-tez Azərbaycan ədəbiyyatının klassik və müasir nümayəndələrinə istinad etməsi, onların fikir və yaradıcılıq dünyasını yüksək qiymətləndirməsi, milli irsə bağlılığının bariz ifadəsidir. O, Nizami, Füzuli, Nəsimi kimi böyük söz ustadlarının irsini təkcə elmi-ədəbi baxımdan deyil, milli ideologiyanın tərkib hissəsi kimi dəyərləndirmişdir.

Ümummilli Lider Heydər Əliyevin dahi Nizami Gəncəvi irsinə sonsuz məhəbbəti onun milli-mənəvi dəyərlərə əsaslanan ideoloji baxışlarının tərkib hissəsi idi. SSRİ dövründə milli ideoloji məhdudiyyətlərin mövcud olmasına baxmayaraq, Nizaminin 840 illik yubileyinin keçirilməsi Ulu Öndərin xalq qarşısındakı mühüm xidmətlərindən biri olmuşdur. 1993-cü ildə yubileyin qeyd olunması zamanı Heydər Əliyev bu addımı belə əsaslandırmışdı: “Nizami Gəncəvi elə bir şəxsiyyətdir ki, onun yubileyi hər il keçirilə bilər” [Azertac, 2023].

1970–1973-cü illərdə İmadəddin Nəsiminin 600 illik yubileyinin keçirilməsi ilə bağlı görülmə tədbirlər Ulu Öndər Heydər Əliyevin şəxsi təşəbbüs və siyasi iradəsinin nəticəsi idi. Onun Moskvaya ünvanladığı rəsmi müraciət nəticəsində yubileyin SSRİ və beynəlxalq səviyyədə qeyd olunması təmin edilmiş, bu münasibətlə tədbirlər planı hazırlanmış, xarici nümayəndələrin iştirakı ilə beynəlxalq yubiley keçirilmişdir.

Nəsiminin məzarının bərpası məqsədilə alimlər Suriya ezam olunmuş, beynəlxalq portret müsabiqəsi elan edilmiş, əsərləri bir sıra xarici dillərə tərcümə olunmuşdur. YUNESKO-nun rəsmi orqanlarında Nəsimi irsi geniş işıqlandırılmışdır. Azərbaycan mədəniyyətinin dünyada tanınması baxımından bu yubiley mühüm əhəmiyyət kəsb etmişdir [Əhmədova, 2013, s.].

Dahi Məhəmməd Füzulinin anadan olmasının 500 illiyi münasibətilə keçirilən yubiley tədbirlərinə hazırlıq çərçivəsində, 1 avqust 1994-cü ildə keçirilən Təşkilat Komitəsinin iclasında Ulu Öndər Heydər Əliyevin səsləndirdiyi fikirlər milli-mənəvi özünüdərk və xalqın tanınması istiqamətindəki əsas hədəfləri əks etdirirdi. O bildirirdi: “Bu yubileyi keçirərkən biz xalqımızın özünü tanımasını təmin edəcəyik... Xalq gərək daim öz kökünü xatırlasın, tarixini öyrənsin, milli mədəniyyətindən, elmindən heç vaxt ayrılmasın”. Bu sözlər yubileyin yalnız bir mədəni hadisə deyil, həm də vətənpərvərlik və milli kimlik şüurunun möhkəmləndirilməsi baxımından böyük əhəmiyyət daşıdığını göstərirdi [Həbibbəyli, 2023].

Ədəbiyyat xadimlərinin xatirə muzeylərinin yaradılması məsələsi də prezident Heydər Əliyevin fəaliyyətində mühüm yer tutmuşdur. Məhz onun şəxsi təşəbbüsü ilə Bakı şəhərində Azərbaycan mədəniyyəti və ədəbiyyatının tanınmış nümayəndələri – Üzeyir Hacıbəyli, Səməd

Vurğun, Cəfər Cabbarlı, Nəriman Nərimanov, Bülbül, Cəlil Məmmədquluzadə, Niyazi kimi sənətkarların, Naxçıvanda Hüseyn Cavidin, Tbilisidə isə M.F.Axundzadənin xatirə muzeyləri yaradılmışdır. Heydər Əliyev M.F.Axundov adına Azərbaycan Dövlət Kitabxanasının fəaliyyəti ilə də xüsusi maraqlanmış, dəfələrlə kitabxananı ziyarət etmiş və şəxsi kitabxanasından 300-dən artıq qiymətli nəşri bu mədəniyyət ocağına hədiyyə etmişdir.

XX əsrin 70-ci illərində və müstəqillik dövründə Heydər Əliyevin rəhbərliyi ilə Naxçıvan Muxtar Respublikasında bir sıra muzeylərin yaradılması ədəbiyyat və mədəniyyətə töhfə kimi qiymətləndirilə bilər. Bu illərdə tarix-diyarşünaslıq muzeyləri, M.S.Ordubadi, A.Y.Məmmədəliyev, H.Cavid, C.Məmmədquluzadə, C.Naxçıvanski, Cəlilkənd və Nehrəmdə ev-xatirə muzeyləri, eləcə də H.Əliyev və B.Kəngərli muzeyləri, Naxçıvan Dövlət Xalça Muzeyi, Açıq Səma Altında Muzey, Naxçıvan Dövlət Rəsm Qalereyası, Rəssamlar Birliyinin sərgi salonu və "Xatirə muzeyləri" fəaliyyətə başlamışdır [Kəngərli, 2006: s.5].

Heydər Əliyev Azərbaycan ədəbiyyatına dərin bağlılığı və xüsusi qayğısı ilə seçilirdi. O, milli-mənəvi dəyərlərimizi daim diqqət mərkəzində saxlayır, ədəbiyyatın qorunması və dünyada tanınması istiqamətində mühüm işlər görürdü. Onun təşəbbüsü ilə repressiya qurbanlarından biri olan Hüseyn Cavidin nəşi doğma yurdu Naxçıvana gətirildi, Şuşada M.P.Vaqifin məqbərəsi ucaldıldı. Bu kimi təşəbbüslər Ulu Öndərin Azərbaycan ədəbiyyatına verdiyi böyük töhfələrin bariz nümunəsidir [Turan, 2022].

Ulu Öndər Heydər Əliyevin 1993-cü ildə yenidən hakimiyyətə qayıdışı, 1970–1980-ci illərdə əsas qoyulan mədəni siyasətin davam etdirilməsinə və milli-mədəni irsin, o cümlədən ədəbi şəxsiyyətlərin xatirəsinin qorunub yaşadılmasına yeni nəfəs verdi. Elə həmin ildə onun təşəbbüsü ilə erməni vandalizminə məruz qalmış Xurşidbanu Natəvan kimi görkəmli ədəbiyyat və mədəniyyət xadimlərinin güllələnmiş heykəlləri üçüncü tərəf vasitəsilə Bakıya gətirilərək Milli İncəsənət Muzeyinin həyatında yerləşdirildi. Bu addım təkcə mədəni yaddaşın deyil, həm də ədəbi irsin qorunması yönündə atılmış mühüm addım kimi qiymətləndirilməlidir [Sayadoğlu, 2012: s.3.].

Mədəni irsin qorunub saxlanması və təbliği sahəsində Ulu Öndərin əvəzsiz xidmətlərindən biri də Azərbaycanın görkəmli tarixi şəxsiyyətlərinin, mədəniyyət və incəsənət xadimlərinin yubiley tədbirlərinin YUNESKO səviyyəsində qeyd olunması idi. İmadəddin Nəsiminin 600 illiyi, Məhəmməd Füzulinin 500 illiyi, "Kitabi-Dədə Qorqud" dastanının 1300 illiyi, Müslüm Maqomayev, Cəfər Cabbarlı, M.S.Ordubadi, Aşıq Ələsgər və digər ədəbiyyat və incəsənət nümayəndələrinin yubileyləri yüksək səviyyədə qeyd edildi. Nizami Gəncəvinin dünyada Azərbaycan şairi kimi qəbul edilməsi də məhz Ulu Öndərin sayəsində oldu. Əliyev, 2014: s. 11].

2000-ci ilin aprel ayında "Kitabi-Dədə Qorqud" dastanının 1300 illik yubileyinin 1998-ci ildə Parisdə – YUNESKO-nun iqamətgahında yüksək səviyyədə qeyd olunması da böyük bir ədəbi hadisə kimi Azərbaycanın zəngin ədəbi-mədəni irsinin dünya miqyasında tanınması istiqamətində atılan mühüm addımlardan biri kimi xüsusi qeyd olunur [Abbasov, 2011: s.164].

Azərbaycan ədəbiyyatının qorunması istiqamətində görülən işlər. Heydər Əliyevin rəhbərliyi dövründə Azərbaycan SSR Elmlər Akademiyasının 25 illik yubileyinin keçirilməsi haqqında 1969-cu il 30 dekabr tarixli qərarı, respublikada elmin inkişafına göstərilən strateji diqqətin bariz nümunəsidir. Bu sənəddə Akademiyanın əsas vəzifələrindən biri kimi ölkənin təbii sərvətlərinin öyrənilməsi və onlardan səmərəli istifadə məsələsi önə çəkilsə də, əslində bu qərar milli-mənəvi sərvətimiz olan ədəbiyyat və mədəniyyətin də inkişafı üçün geniş imkanlar yaratmışdır [Həbibbəyli, 2023: s.3].

Heydər Əliyevin milli-mədəni irsə yanaşması hər zaman kompleks xarakter daşıyır, təkcə maddi sərvətlərin deyil, həm də mənəvi dəyərlərin, o cümlədən ədəbiyyatın araşdırılması və təbliğini dövlət siyasətinin prioritet istiqamətinə çevirirdi. Elmlər Akademiyasının elmi potensialı və intellektual resursları məhz bu dövrdən etibarən ədəbiyyatşünaslıq, dilçilik, folklorşünaslıq və mədəniyyət tarixi kimi sahələrin inkişafında mühüm rol oynamağa başlamışdır. Nəticədə, Azərbaycan ədəbiyyatının klassik və çağdaş nümayəndələrinin irsi daha dərinlənən araşdırılmış, onların əsərləri elmi əsaslarla nəşr olunmuş və təbliğ edilmişdir.

Onun təşəbbüsü ilə bir sıra klassik və çağdaş ədiblərin əsərləri yeni nəşr formatında çap olunaraq geniş oxucu kütləsinə çatdırılmışdır. Xüsusilə Nizami Gəncəvi, Məhəmməd Füzuli, İmadəddin Nəsimi, Mirzə Fətəli Axundzadə kimi ədəbiyyat korifeylərinin əsərlərinin elmi-tənqidi mətnləri əsasında nəşri və onların irsinin tədqiqinə dövlət səviyyəsində dəstək göstərilməsi bu istiqamətdə görülən ən mühüm tədbirlər sırasındadır.

Eyni zamanda, ədəbiyyatla bağlı fəaliyyət göstərən institut və təşkilatların — xüsusilə Azərbaycan Milli Elmlər Akademiyasının müvafiq şöbələrinin fəaliyyətinə diqqət artırılmış, müasir tələblərə cavab verən elmi-tədqiqat mühiti formalaşdırılmışdır. Ədəbi irsin qorunması məqsədilə arxivlərin bərpası, yazılı və şifahi irs nümunələrinin toplanması, sistemləşdirilməsi və nəşri istiqamətində layihələr reallaşdırılmışdır.

Heydər Əliyevin respublikada milli-mənəvi dəyərlərin qorunması və inkişafı istiqamətində həyata keçirdiyi məqsədyönlü siyasət, həmçinin humanitar elmlərə və ədəbiyyata göstərdiyi xüsusi qayğı, Azərbaycan elmi mühitində yeni elmi istiqamətlərin formalaşmasına şərait yaratmışdır. Bu dövrdə Elmlər Akademiyasının müxtəlif institutlarında fəaliyyət göstərən alimlər təkcə elmi proseslərin deyil, həm də milli ideoloji siyasətin fəal iştirakçılarına çevrilmişlər.

Xüsusilə, Nəriman Nərimanovun anadan olmasının 100 illik yubileyinin geniş miqyasda, yalnız yazıçı və dramaturq kimi deyil, eyni zamanda görkəmli dövlət xadimi səviyyəsində qeyd olunması, Bakıda onun əzəmətli heykəlinin ucaldılması bu baxımdan əlamətdar hadisə idi. Yubiley tədbirlərinə hazırlıqda Elmlər Akademiyasının elmi-tədqiqat institutlarının bir sıra tanınmış alimləri yaxından iştirak etmişlər.

Bu illərdə ölkədə formalaşan sağlam azərbaycançılıq mühiti və ümummillî ideyaların dövlət səviyyəsində dəstəklənməsi, Elmlər Akademiyasında humanitar və ictimai elmlər sahəsində bir sıra elmi məktəblərin yaranmasına səbəb olmuşdur. Akademik Firudin Köçərlinin fəlsəfə, akademik Məmməd Cəfər Cəfərovun ədəbiyyat nəzəriyyəsi, akademik Ziya Bünyadovun şərqşünaslıq və mətnşünaslıq, müxbir üzv Kərim Kərimovun sənətşünaslıq məktəbləri bu elmi yüksəlişin mühüm nümunələri olmuşdur. Eyni zamanda, dilçilik elminin inkişafı sahəsində də mühüm addımlar atılmışdır. 1978-ci ildə Azərbaycan dilinin respublika Konstitusiyasına dövlət dili kimi daxil edilməsi, məhz Heydər Əliyevin iradəsi və qətiyyəti nəticəsində mümkün olmuşdur. Bu qərar, dilçilik sahəsində sanballı tədqiqatların meydana çıxmasına zəmin yaratmışdır. Akademik Məmməd ağa Şirəliyevin rəhbərlik etdiyi dialektoloji məktəb, “Sovetskaya türkologiya” jurnalının Bakıda – Elmlər Akademiyasında nəşri, Azərbaycan Dövlət Universitetinin dilçi alimlərinə “Müasir Azərbaycan dili” dərslisinə görə Dövlət mükafatlarının verilməsi həmin dövrdə elmi-humanitar düşüncənin yüksəlişini təsdiqləyən faktlardır [Həbibbəyli, 2023: s.6].

Bu dövrdə ədəbi şəxsiyyətlərin yubileylərinin dövlət səviyyəsində keçirilməsi və onların ictimaiyyətə təqdimatı da ədəbiyyatın qorunmasına xidmət edən mühüm vasitələrdən biri olmuşdur. Azərbaycan Respublikası Prezidentinin müvafiq sərəncamları ilə bir sıra klassik yazıçı və şairlərin yubileyləri UNESCO miqyasında qeyd olunmuş, onların irsi beynəlxalq səviyyədə tanındılmışdır.

Heydər Əliyev bu sahədə təkcə maddi və inzibati vasitələrlə deyil, həm də ideoloji dəstək vasitəsilə ədəbiyyatın qorunmasına şərait yaratmışdır. Onun çıxışlarında “xalq ədəbiyyatını qorumaq, eyni zamanda gələcək nəsillərin mənəviyyatını qorumaq deməkdir” fikri, bu istiqamətdə aparılan işlərin ideya bazasını təşkil etmişdir.

Bundan əlavə, Heydər Əliyevin təşəbbüsü və dəstəyi ilə ədəbiyyatla bağlı fəaliyyət göstərən muzeylərin və mədəniyyət ocaqlarının qorunması və bərpası istiqamətində ciddi addımlar atılmışdır. Nizami Gəncəvi adına Milli Azərbaycan Ədəbiyyatı Muzeyi, Sabirin ev muzeyi kimi mədəniyyət müəssisələrinin fəaliyyəti yenidən qurulmuş, onların ekspozisiya və arxiv fondları genişləndirilmişdir. Bu mərkəzlər yalnız ədəbi irsin saxlanıldığı məkanlar deyil, eyni zamanda ədəbiyyatın təbliği və tədqiqi üçün əhəmiyyətli elmi və mədəni platformalara çevrilmişdir.

Heydər Əliyevin rəhbərliyi ilə atılan bu sistemli və məqsədyönlü addımlar nəticəsində klassik ədəbi irs həm qorunmuş, həm də gələcək nəsillərə ötürülməsi üçün zəmin yaradılmışdır. Bu siyasət ədəbiyyatın milli kimliyin formalaşmasındakı rolunu gücləndirməklə yanaşı, onu müasir cəmiyyətin inkişafına xidmət edən canlı ideoloji amilə çevirmişdir.

Ədəbiyyat yalnız yazılı irsin qorunması ilə deyil, həm də onun cəmiyyətə düzgün və məqsədyönlü şəkildə çatdırılması ilə yaşar və inkişaf edir. Ulu Öndər Heydər Əliyev bu prinsipə əsaslanaraq ədəbiyyatın təbliği sahəsində ardıcıl və məqsədyönlü siyasət yürütmüşdür. Onun təşəbbüsü ilə ədəbiyyatın geniş ictimaiyyət arasında yayılması, yazıçı və şairlərin fəaliyyəti üçün əlverişli şəraitin yaradılması istiqamətində mühüm addımlar atılmışdır.

1934-cü ildən fəaliyyət göstərən Azərbaycan Yazıçılar Birliyi (AYB) ölkənin ədəbi həyatında mühüm rol oynayıb. Bu quruma dövlətin, xüsusilə də Ümummilli Lider Heydər Əliyevin qayğısı xüsusi əhəmiyyət daşıyır. Heydər Əliyev AYB-nin qurultaylarında daim iştirak etmiş, yazıçılarla sıx əlaqədə olmuşdur. Onun dövründə Şüvəlandakı Səməd Vurğun adına Yaradıcılıq Evi açılmışdır. Ümummilli Lider 1981-ci ildə keçirilən VII qurultayda da geniş çıxış edərək yazıçıların mövqeyini önə çəkmişdir.

Müstəqilliyin ilk illərində AYB çətinliklər yaşasa da, məhz Ulu Öndərin dəstəyi ilə fəaliyyətini davam etdirmişdir. 1997-ci ildə keçirilən X qurultay AYB-nin müstəqillik dövründəki ilk qurultayı idi. Yazıçı Anarın sözlərinə görə, AYB-nin ilk fəxri üzvü də məhz Heydər Əliyev olmuşdur. Onun dəstəyi ilə AYB və ədəbi orqanlar dövlət büdcəsinə daxil edilib. Bu, ədəbiyyatın və ədəbi dilin qorunmasına ciddi töhfələr vermişdir [Sarıyeva, 2015: s.15.]. Heydər Əliyev gənc ədiblərə də xüsusi qayğı göstərmiş, onların yaradıcılıq təşəbbüslərinin dəstəklənməsi üçün müxtəlif proqram və layihələrin icrasına şərait yaratmışdır.

Ədəbiyyatın cəmiyyətə yaxınlaşdırılmasının daha bir mühüm vasitəsi “Kitab bayramları”, “Ədəbiyyat günləri” və müxtəlif mövzulu ədəbi tədbirlərin keçirilməsi olmuşdur. Bu tədbirlər sayəsində ədəbiyyat yalnız bir qrup ziyalının işi olaraq qalmamış, ictimai həyatın canlı və təsiredici bir hissəsinə çevrilmişdir. Kitab sərgiləri, poeziya gecələri, oxucu-yazar görüşləri və məktəblərdə təşkil olunan ədəbi müsabiqələr bu istiqamətdə atılan addımların praktik təzahürləridir.

Nəticə

Heydər Əliyevin ədəbiyyat sahəsində həyata keçirdiyi uzaqgörən və sistemli siyasət bu gün də öz aktuallığını qoruyur. Onun təşəbbüsləri nəticəsində formalaşan ədəbi-mədəni mühit yalnız XX əsrin sonlarında deyil, XXI əsrin ilk onilliklərində də Azərbaycan ədəbiyyatının inkişafına güclü təsir göstərmişdir. Ədəbiyyatın qorunması, təbliği və gənc nəsə ötürülməsi

istiqlamətində müəyyənləşdirilmiş strateji xətt bu gün ölkəmizin mədəni həyatında əsas istiqamətlərdən biri olaraq qalır.

Bu siyasət Prezident İlham Əliyev və Heydər Əliyev Fondunun prezidenti Mehriban Əliyeva tərəfindən uğurla davam etdirilir. Mədəni irsimizin qorunması və dünyaya tanıtılması istiqamətində həyata keçirilən layihələr, klassik və müasir yazıçıların fəaliyyətinin dəstəklənməsi, həmçinin müxtəlif ədəbi festivallar və beynəlxalq tədbirlərin təşkili bu siyasətin davamlı xarakter daşdığını sübut edir. Xüsusilə Heydər Əliyev Fondunun ədəbiyyatın inkişafına yönəlmiş təşəbbüsləri – kitab layihələri, tərcümə proqramları, ədəbi müsabiqələr – bu istiqamətdə ardıcıl fəaliyyətin nümunəsidir.

Heydər Əliyevin milli ədəbiyyatın qorunması və inkişafına yönəlmiş fəaliyyəti Azərbaycan mədəniyyətində ideoloji əsas və strateji yanaşma yaratmışdır. Bu siyasət nəticəsində ədəbiyyat yalnız mədəniyyət sahəsinin bir istiqaməti kimi deyil, həm də milli identikliyin, vətənpərvərlik ruhunun və ümumbəşəri dəyərlərə bağlılığın daşıyıcısı kimi önə çıxmışdır.

Beləliklə, Ulu Öndər Heydər Əliyevin ədəbiyyat siyasəti bu gün də yaşayan, inkişaf edən və gələcək nəsillərə örnək olacaq bir ideoloji və mədəni sistemdir. Onun qoyduğu təməl üzərində inkişaf edən Azərbaycan ədəbiyyatı, milli və beynəlxalq müstəvidə öz sözünü deməyə davam edir.

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HEYDAR ALIYEV'S ROLE IN THE PROTECTION AND PROMOTION OF AZERBAIJANI LITERATURE

Summary

The article extensively analyzes the attitude of the national leader Heydar Aliyev to Azerbaijani literature and national-spiritual values, the care he showed in this area and the policy he implemented. It is noted that Azerbaijani literature has been the bearer of the national identity of the people throughout history and an expression of their spiritual memory. In this regard, the role of literature in national identity and cultural self-awareness has increased even more during the period of independence.

During Heydar Aliyev's leadership, high attention was paid to the fields of literature and culture at the state level, and the creativity of classical and contemporary writers and artists was appreciated. On his initiative, the anniversaries of many prominent literary and cultural figures were held, and their heritage was analyzed scientifically and ideologically and widely promoted. In this context, the attention paid to the heritage of classics such as Nizami Ganjavi, Fuzuli, Nasimi, Huseyn Javid, M.P. Vagif comes to the fore.

The article emphasizes that Heydar Aliyev approached literature not only as an aesthetic, but also as an ideological and spiritual value. He assessed writers and poets as personalities who played an important role in the formation of national ideology and the spiritual revival of society. As a result of his political will, a number of museums and memorial houses were created, and important steps were taken to perpetuate the memory of the victims of repression - in particular, Huseyn Javid.

Heydar Aliyev's comprehensive approach to national and spiritual heritage was also manifested in the activities of the Academy of Sciences. During this period, extensive scientific and material opportunities were created for the development of such fields as literary criticism, linguistics, folklore studies and cultural history. The potential of the Academy was directed at the study and promotion of the heritage of classical and contemporary representatives of Azerbaijani literature.

In conclusion, it is emphasized that Heydar Aliyev's literary policy is of strategic importance in terms of preserving national identity, preserving national and spiritual values, and passing them on to future generations. His activities in this field maintain their relevance and are continued in the modern era. In this context, the celebration of the 1300th anniversary of the epic "Kitabi-Dede Gorgud" in 1998 at the UNESCO level is especially noted as one of the important steps taken towards the worldwide promotion of Azerbaijan's rich literary and cultural heritage.

Keywords: Heydar Aliyev, Azerbaijani culture, literature, literary heritage, cultural policy.

РОЛЬ ГЕЙДАРА АЛИЕВА В ЗАЩИТЕ И ПРОПАГАНДЕ АЗЕРБАЙДЖАНСКОЙ ЛИТЕРАТУРЫ

Резюме

В статье подробно анализируется отношение общенационального лидера Гейдара Алиева к азербайджанской литературе и национально-духовным ценностям, проявляемая им забота в этой области и проводимая им политика. Отмечается, что азербайджанская литература на протяжении всей истории была носителем национальной идентичности народа и выражением его духовной памяти. В связи с этим роль литературы в национальной идентичности и культурном самосознании еще больше возросла в период независимости.

В период руководства Гейдара Алиева на государственном уровне уделялось большое внимание сферам литературы и культуры, высоко ценилось творчество классиков и современных писателей и художников. По его инициативе были проведены юбилеи многих выдающихся деятелей литературы и культуры, научно и идеологически анализировалось и широко пропагандировалось их наследие. В этом контексте на первый план выходит внимание, уделяемое наследию таких классиков, как Низами Гянджеви, Физули, Насими, Гусейн Джавид, М.П. Вагиф.

В статье подчеркивается, что Гейдар Алиев подходил к литературе не только как к эстетической, но и как к идейно-духовной ценности. Он оценивал писателей и поэтов как личностей, сыгравших важную роль в формировании национальной идеологии и духовном возрождении общества. В результате его политической воли был создан ряд музеев и мемориальных домов, а также были предприняты важные шаги по увековечению памяти жертв репрессий, в частности, Гусейна Джавида.

Комплексный подход Гейдара Алиева к национальному и духовному наследию проявился и в деятельности Академии наук. В этот период были созданы широкие научные и материальные возможности для развития таких направлений, как литературоведение, языкознание, фольклористика и история культуры. Потенциал Академии был направлен на изучение и пропаганду наследия классиков и современных представителей азербайджанской литературы.

В заключение подчеркивается, что литературная политика Гейдара Алиева имеет стратегическое значение с точки зрения сохранения национальной идентичности, сохранения национально-духовных ценностей и передачи их будущим поколениям. Его деятельность в этой области сохраняет свою актуальность и продолжается в современную эпоху. В этом контексте особо отмечается празднование 1300-летия эпоса

«Китаби-Деде Горгуд» в 1998 году на уровне ЮНЕСКО как один из важных шагов, предпринятых в направлении всемирной пропаганды богатого литературного и культурного наследия Азербайджана.

Ключевые слова: Гейдар Алиев, азербайджанская культура, литература, литературное наследие, культурная политика.

YABANCI DİL OLARAK ALMANCA ÖĞRETİMİNDE NÖRODİDAKTİK YAKLAŞIMLAR: BEYİN TEMELLİ YÖNTEMLERLE DİL EDİNİMİNİ GELİŞTİRME

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ÖZET

Nörobilim ve pedagoji arasındaki gelişen sinerji, yabancı dil eğitiminde, özellikle de yabancı dil olarak Almanca öğretiminde önemli bir dönüm noktası teşkil etmektedir. Gelişmekte olan disiplinlerarası bir alan olan nörodidaktik, insan beyninin dilsel bilgiyi nasıl işlediği, depoladığı ve geri çağırdığına dair deneysel olarak desteklenmiş içgörüler sunmaktadır. Bu yaklaşım, bilişsel, duygusal ve sosyal öğrenme boyutlarıyla içsel olarak uyumlu öğretim metodolojilerini savunarak, daha derin ve kalıcı dil edinimini teşvik etmektedir. Özünde nörodidaktik, dil edinimi için kritik olan temel nörobiyolojik mekanizmaları ele alır. Buna çalışma belleği, uzun süreli bellek konsolidasyonu, dikkat düzenlemesi ve duygusal katılımın dinamik etkileşimi dahildir. Bu temellerden yola çıkarak, temel nörodidaktik prensipler ortaya çıkar: çeşitli nöral yolları harekete geçirmek için çok duyuşal girdiye duyulan ihtiyaç; anlamsal işlemeyi geliştirmek için öğrenmeyi anlamlı bağlamlar içinde bütünleştirme; dilbilgisi yapıları ve kelime bilgisi için örüntü tanımayı kolaylaştırma ve belleği optimize etmek için aralıklı tekrarın stratejik uygulaması. Almanca öğretimine uygulandığında, bu beyin temelli stratejiler çeşitli öğrenme bileşenlerini geliştirmek için pratik yollar sunar. Örneğin, çok duyuşal katılım ve bağlamsal öğrenme yoluyla kelime edinimi önemli ölçüde iyileştirilebilir; dilbilgisi açıklamaları, açık kalıplar ve görsellerle sunulduğunda daha erişilebilir hale gelir. Duygusal olarak güvenli ve sosyal olarak etkileşimli ortamlarda çerçevelenen konuşma pratiği, akıcı iletişim için hayati önem taşıyan nöral devreleri etkinleştirir. Ayrıca, içsel motivasyonu geliştiren ve bilişsel aşırı yüklenmeyi azaltan sınıf ortamları ve görevler tasarlamak çok önemlidir. Hikaye anlatımı, görsel yardımlar, müzik ve seçkin dijital uygulamalar gibi araçlar, bellek tutulmasını ve öğrenci katılımını önemli ölçüde desteklemektedir. Bir üniversite düzeyindeki Almanca kursundan alınan bir vaka çalışması, nörodidaktik yöntemlerin öğrenci sonuçları üzerindeki somut faydalarını daha da örneklendirmektedir. Öğretmen eğitimi ve adapte edilmiş müfredat geliştirme ihtiyacı gibi uygulama zorlukları mevcut olsa da, nörodidaktik çerçeve daha bütüncül, öğrenci merkezli bir dil öğretimi modelini desteklemektedir.

Bu sadece dilsel yeterliliği yükseltmekle kalmaz, aynı zamanda öğrencinin uzun vadeli bilişsel ve duygusal gelişimine de aktif olarak katkıda bulunur.

Anahtar Kelimeler: Nörodidaktik, beyin temelli öğrenme, yabancı dil olarak almanca, dil edinimi, bilişsel sinirbilim, yabancı dil öğretimi

NEURODIDACTIC APPROACHES TO TEACHING GERMAN AS A FOREIGN LANGUAGE: ENHANCING LANGUAGE ACQUISITION THROUGH BRAIN-BASED METHODS

ABSTRACT

The evolving synergy between neuroscience and pedagogy marks a pivotal shift in foreign language education, particularly for German as a foreign language. Neurodidactics, an emergent interdisciplinary field, offers empirically supported insights into how the human brain processes, retains, and retrieves linguistic data. This approach advocates for teaching methodologies intrinsically aligned with cognitive, emotional, and social learning facets, fostering more profound and lasting language acquisition. At its core, neurodidactics considers fundamental neurobiological mechanisms critical for language acquisition. This includes the dynamic interplay of working memory, long-term memory consolidation, attention regulation, and emotional engagement. From these foundations, key neurodidactic principles emerge: the necessity of multisensory input, integration of learning within meaningful contexts, facilitation of pattern recognition, and strategic application of spaced repetition. Applied to German language instruction, these brain-based strategies enhance various learning components. Vocabulary acquisition improves through multisensory engagement; grammar explanations become more accessible with clear patterns and visuals. Speaking practice, framed within emotionally safe and socially interactive environments, activates neural circuits vital for fluent communication. Designing classroom environments and tasks that cultivate intrinsic motivation and mitigate cognitive overload is paramount. Tools like storytelling, visual aids, music, and digital applications significantly bolster memory retention and learner engagement. A case study from a university-level German course further exemplifies the tangible benefits of neurodidactic methods on student outcomes. While implementation challenges exist, such as the need for specialized teacher training and adapted curriculum development, the neurodidactic framework champions a more holistic, learner-centric model.

This not only enhances linguistic competence but also actively contributes to students' long-term cognitive and emotional development.

Keywords: Neurodidactics, brain-based learning, German as a foreign language, language acquisition, cognitive neuroscience, foreign language teaching

1. INTRODUCTION

Recent advances in neuroscience have significantly influenced educational theory and practice, providing a deeper understanding of how the human brain processes, stores, and retrieves information. This growing body of research has led to the emergence of neurodidactics, an interdisciplinary approach that integrates cognitive neuroscience with pedagogical methodology. Neurodidactics aims to align teaching strategies with the brain's natural mechanisms of learning, thereby enhancing both the effectiveness and sustainability of instruction.

In the field of foreign language education, these developments are particularly relevant. Learning a new language requires the orchestration of multiple cognitive systems, including working memory, long-term memory, attentional control, and emotional regulation. Traditional methods of language instruction often fail to fully engage these systems in a coordinated way. By contrast, neurodidactic approaches are designed to activate and support the brain's learning architecture through multisensory input, contextualized content, emotional engagement, and repetition that is spaced over time.

German as a foreign language (Deutsch als Fremdsprache - DaF) poses specific linguistic and cognitive challenges for learners, such as complex syntax, grammatical gender, and inflectional morphology. These features can create cognitive overload if not presented in a brain-compatible manner. Applying neurodidactic principles in the DaF classroom can therefore improve not only linguistic competence, but also learner motivation, emotional safety, and retention.

This paper explores the theoretical foundations and practical applications of neurodidactic methods in the teaching of German at the university level. Drawing on recent neuroscientific findings, it identifies key strategies—such as pattern recognition, meaningful associations, and emotion-driven learning—that can enhance language acquisition. By demonstrating how these approaches can be integrated into real-world classroom practice, the paper advocates for a more holistic, learner-centered model of language instruction that promotes both academic success and long-term cognitive development.

2. Theoretical Foundations of Neurodidactics

Foreign language acquisition involves complex and dynamic cognitive processes that rely on the coordinated functioning of various brain systems. One of the fundamental components is working memory, a temporary storage system that manages incoming verbal and visual information. This capacity is particularly relevant in the context of language learning, where learners must simultaneously process auditory input (e.g., spoken words) and visual stimuli (e.g., written text or images). The integration of these modalities enables deeper comprehension and promotes the encoding of linguistic structures into long-term memory [7, p. 355]. For effective retention, however, language input must be transferred from working memory into long-term memory through processes of consolidation. One well-established principle in this regard is the spacing effect, which demonstrates that distributing learning sessions over time results in better long-term recall than massed practice. This approach is especially effective in vocabulary and grammar acquisition. Spaced repetition systems (SRS) — such as those used in digital language-learning tools — are grounded in this principle, offering learners optimized review intervals based on difficulty and forgetting rates [4, pp. 354–355; 6, pp. 3–6; 11, pp. 3988–3990].

Another critical factor is attention, which regulates the intake of information and determines the depth of cognitive processing. When learners are able to focus on meaningful content and relate it to prior knowledge, they form stronger semantic networks in the brain. This process — often referred to as deep encoding — enhances retention and facilitates recall far more effectively than rote memorization. Additionally, pattern recognition in linguistic input (e.g., grammatical rules, word formation) helps the brain organize information efficiently and supports faster retrieval [1, p. 2]. Emotional engagement plays an equally vital role in learning success. Neuroscientific findings have shown that positive emotional states — such as enjoyment, curiosity, and a sense of safety — stimulate brain regions associated with motivation, attention regulation, and memory consolidation [9, p. 5]. In learning environments where students feel secure, valued, and encouraged to participate actively, neural activity supports more sustainable and meaningful learning outcomes [8, pp. 7–9]. Therefore, fostering a classroom climate rich in social interaction, intrinsic motivation, and emotional support is not merely pedagogically desirable — it is neurologically essential. Together, these neurocognitive mechanisms form the core of neurodidactics, a field that seeks to translate insights from neuroscience into practical teaching strategies. A neurodidactic approach integrates multisensory input, emphasizes meaningful and relevant contexts, uses spaced reinforcement,

and prioritizes the emotional and motivational well-being of learners — all with the goal of optimizing how language is internalized and retrieved.

3. The Role of Emotions and Motivation in Neurodidactics in Teaching German as a Foreign Language

In recent years, the significance of emotional and motivational factors in foreign language acquisition has become increasingly evident within the framework of neurodidactics. The brain's capacity to learn and retain new information is profoundly influenced not only by cognitive mechanisms but also by the learner's affective state and motivational drive. This chapter explores how emotions and motivation interact with neurobiological processes to enhance or hinder the acquisition of German as a foreign language (GFL). Neuroscientific research has demonstrated that positive emotions, such as curiosity, enjoyment, and a sense of safety, activate neural circuits involving the limbic system and dopaminergic pathways, which are crucial for motivation and memory consolidation [9, pp. 102–104]. The release of neurotransmitters like dopamine enhances synaptic plasticity, facilitating the encoding and retrieval of linguistic material. Conversely, negative emotions, including anxiety and fear, can trigger the amygdala's stress response, which inhibits prefrontal cortex activity and impairs working memory function, thereby obstructing effective language processing [7, p. 87].

In the context of GFL teaching, fostering a positive emotional climate is essential for reducing the so-called "affective filter" — a concept originally introduced by Krashen, referring to emotional barriers that impede language acquisition [2, p. 88]. When learners feel safe and supported, they are more likely to take linguistic risks, participate actively, and engage deeply with the material. This emotional security encourages neuroplastic adaptation, enabling learners to form new neural connections more efficiently. Motivation also plays a pivotal role in sustaining the learning process over time. Intrinsic motivation—driven by personal interest and enjoyment of the language—has been linked to higher levels of attention and cognitive engagement, which correlate with improved learning outcomes [9, pp. 102–104]. Extrinsic motivation, while often less durable, can still contribute positively when combined with intrinsic factors, particularly through the use of meaningful rewards and social recognition within the classroom environment. Effective GFL instruction integrates strategies to enhance both emotional well-being and motivation. Techniques such as collaborative group work, constructive feedback, and the incorporation of culturally relevant content help create an emotionally supportive atmosphere that stimulates learners' engagement [8, pp. 12–15]. Furthermore, educators are encouraged to design activities that balance challenge and skill

level, promoting a state of flow—where learners are fully immersed and motivated, leading to optimal neurocognitive performance [3, pp. 210–212].

In sum, the intersection of emotions, motivation, and neurodidactic principles underscores the importance of a holistic approach to language teaching. By addressing the affective dimension alongside cognitive strategies, GFL educators can foster environments that not only facilitate linguistic competence but also nurture learners' psychological readiness to embrace the complexities of German language acquisition.

4. Practical Application of Neurodidactic Principles in German Language Instruction

The theoretical framework of neurodidactics finds its most compelling validation in real classroom practices, where abstract principles are translated into effective teaching strategies. A notable illustration of this can be found in the integration of neurodidactic methods into German language classes, as documented in a case study by Bizuleanu Conkan (2019), developed in collaboration with teacher training programs such as those run by the Goethe-Institut. In this case, instructors intentionally incorporated multimodal learning tasks, structured environments, and emotionally supportive settings into the curriculum for learners of German as a foreign language. One exemplary activity, “Klassenspaziergang” (classroom walk), required students to move around the room to interact with posters displaying discussion prompts. This activity activated spatial awareness, peer interaction, and embodied learning — leading to a noticeable improvement in lexical retention and motivation [2, pp. 417–418]. Furthermore, instructors applied cooperative listening and reading tasks, where learners co-constructed understanding through shared interpretation of texts and audio materials. These methods directly reflect neurodidactic principles such as meaningful learning through social collaboration and contextual engagement, instead of passive content delivery [2, p. 418].

Visual tools, storytelling, and music were also integrated not merely as add-ons but as core pedagogical instruments. For instance, narrative texts were embedded in grammar instruction, while songs introduced new lexical themes — enriching semantic encoding and facilitating emotional resonance in memory processes [2, p. 418]. What makes this approach particularly viable is its adaptability: it does not depend heavily on digital infrastructure but rather on pedagogical design, attentiveness to learners' emotional needs, and flexible use of physical space. Classrooms designed to minimize cognitive overload and foster engagement helped activate the neural mechanisms crucial for long-term learning [1, p. 5]. This real-world example underscores how neurodidactic strategies, when thoughtfully implemented, can significantly enhance the quality and effectiveness of German language education. It bridges scientific

insight with didactic creativity, proving that even modest interventions can yield meaningful educational outcomes.

5. Challenges and Implications for Teacher Training and Curriculum Development

While the integration of neurodidactic principles into the teaching of German as a foreign language offers promising results, it also brings a number of pedagogical and institutional challenges. Chief among them is the necessity of systematic teacher training that familiarizes educators with the cognitive and emotional underpinnings of language acquisition. Traditional teacher education programs often emphasize linguistic content and didactic methodology, but lack sufficient grounding in neuroscience-informed practices. To address this gap, training modules must be restructured to include basic neuropsychological concepts relevant to memory, attention, and motivation. Teachers should be equipped not only with theoretical knowledge, but also with practical tools to design multisensory, emotionally engaging, and learner-centered activities. A lack of such training risks superficial application of neurodidactic ideas—where techniques are imitated without a deep understanding of their rationale or neural mechanisms [1, pp. 4–5]. Another key challenge lies in curriculum flexibility. Many educational institutions operate within rigid frameworks, where syllabi are overloaded with content and time constraints leave little room for reflective, adaptive instruction. Neurodidactic approaches, by contrast, advocate for depth over breadth, favoring iterative learning and the cultivation of intrinsic motivation. This calls for a re-evaluation of assessment criteria as well. Instead of focusing primarily on discrete-point testing, curricula should integrate formative assessments that monitor emotional engagement, learner autonomy, and memory consolidation over time [8, p. 10].

Additionally, resource limitations—especially in underfunded schools—can hinder the adoption of neurodidactic tools such as visual aids, music integration, or storytelling materials. However, as demonstrated by Conkan’s case study [2, p. 418], effective neurodidactic implementation does not always require expensive infrastructure. Rather, it demands creative lesson planning, collaborative learning structures, and a supportive classroom atmosphere.

Finally, institutional acceptance of neurodidactic innovations may face resistance from traditionalist perspectives, particularly in systems where teaching has long been associated with authoritative knowledge transfer rather than learner activation. Overcoming this inertia requires ongoing research dissemination, pilot programs, and evidence-based advocacy that highlights the tangible cognitive and emotional benefits of these approaches. In summary, embracing neurodidactic strategies in language education is not merely a matter of adopting new

techniques; it requires a paradigm shift in how we train teachers, structure curricula, and define educational success.

CONCLUSIONS AND RECOMMENDATIONS

The integration of neurodidactic principles into the teaching of German as a foreign language presents a transformative opportunity to enhance language acquisition by aligning pedagogy with the brain's natural learning processes. This approach emphasizes multisensory input, meaningful context, spaced repetition, and emotional engagement, all of which contribute to deeper and more durable linguistic competence. The practical case discussed demonstrates that such methods are applicable and effective in real educational settings, improving student motivation, retention, and communicative skills. However, successful implementation depends on comprehensive teacher training programs that impart both theoretical understanding and practical skills grounded in neuroscience.

Curriculum design must become more flexible and learner-centered, allowing time for iterative learning and formative assessment that recognizes cognitive and emotional growth, not just discrete linguistic achievements. Furthermore, educators should be encouraged to creatively utilize available resources and foster supportive classroom environments to reduce cognitive overload and boost intrinsic motivation.

While challenges remain—including institutional inertia, resource constraints, and the need for ongoing research dissemination—the neurodidactic approach offers a holistic, scientifically informed pathway for modernizing foreign language education. By bridging neuroscience and didactics, it not only improves linguistic outcomes but also promotes learners' long-term cognitive and emotional development, ultimately supporting more effective and meaningful language learning experiences.

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POST-MÜHARİBƏ ƏDƏBİYYATINDA TRAVMATİK YADDAŞ VƏ ONUN POETİK REKONSTRUKSIYASI

VƏLİYEVA SEVDA ƏKRƏM

Odlar Yurdu Universiteti, Bakı, Azərbaycan

Xülasə

Müharibə dövrləri ədəbiyyat üçün sadəcə ilham mənbəyi deyil, eyni zamanda onun varlığını, istiqamətini və funksiyasını yenidən müəyyən edən çətin sınaq mərhələləridir. Müharibənin gətirdiyi fiziki və mənəvi dağıntılar, ictimai təbəqələşmələr və ideoloji qütbləşmələr ədəbiyyatın estetik funksiyasını ikinci plana keçirdərək onu daha çox sosial, ideoloji və psixoloji bir vasitəyə çevirir. Müharibə ədəbiyyatının əsas xüsusiyyəti onun bir çox hallarda fəvqəladə vəziyyətin dili kimi çıxış etməsidir. Ədəbiyyat bu mərhələdə həm propaganda aləti, həm də ictimai etirazın səsi, yaddaşın qoruyucusu, psixoloji sağalma vasitəsi rolunu oynayır. Müəlliflər ya cəbhə ruhunu yüksəltməyə çalışır, ya da insan itkilərini, vəhşilikləri və mənəvi parçalanmanı təsvir edərək travmaların sənədçisi funksiyasını yerinə yetirir. Bu dövrdə ədəbi formalar da dəyişikliklərə məruz qalır: nəsr daha lakonik, şeir daha emosional və təsiredici, simvolizm isə daha kəskin və ekspressiv olur. Azərbaycan ədəbiyyatında Qarabağ müharibəsi dövründə yazılmış əsərlər bu kontekstdə xüsusi əhəmiyyət kəsb edir. Bu əsərlərdə real hadisələrin sənədli təsviri ilə yanaşı, həm də mifləşdirmə, qəhrəmanlaşdırma və milli yaddaşın kodlaşdırılması kimi funksiyalar da nəzərə çarpır. Beləliklə, müharibə ədəbiyyatı yalnız sənət deyil, həm də bir tarixi ifadə, emosional arxiv və kollektiv yaddaşın kodlaşdırıcı aləti kimi çıxış edir. Ədəbiyyat bu dövrlərdə öz daxili strukturunu da yenidən quraraq həm forma, həm məzmun, həm də funksional baxımdan “çalxalanır”. Müharibə sonrası cəmiyyətlər yalnız iqtisadi və sosial baxımdan deyil, həm də psixoloji və mədəni baxımdan ciddi travmalar yaşayır. Bu travmaların ən dərin izlərini isə ədəbiyyatda müşahidə etmək mümkündür. Ədəbiyyat həm fərdi, həm də kollektiv yaddaşın daşıyıcısı və formalaşdırıcısı kimi çıxış edir. Bu tədqiqat post-müharibə ədəbiyyatında travmatik təcrübələrin hansı bədii vasitələrlə əks olunduğunu və onların necə poetik rekonstruksiya edildiyini araşdırır. Təhlil zamanı əsas diqqət Azərbaycan ədəbiyyatında Qarabağ müharibəsi kontekstində yazılmış şeir və hekayələrə yönəldilir. Bu əsərlərdə travmatik hadisələrin xatırlanması, təsviri və bəzən də transformasiyası ədəbi dillə kodlaşdırılmışdır. Simvolik obrazlar, qeyri-xətti zaman strukturları, parçalanmış mənsubiyyət hissi və emosional yüklü metaforalar vasitəsilə travma həm fərdi təcrübə, həm də kollektiv yaddaş kimi poetik mətnə təəcəssüm etdirilir. Tədqiqatda Dominick LaCapra və Cathy Caruth-un travma nəzəriyyələri, Assmannların yaddaş modelləri və Paul Ricoeur-un narrativ identiklik anlayışları nəzəri baza kimi istifadə olunmuşdur. Araşdırma göstərir ki, poetik rekonstruksiya yalnız travmanın ifadə vasitəsi deyil, eyni zamanda onun mənalandırılması və

sağaldılması prosesidir. Nəticə olaraq belə qənaətə gəlmək olar ki, post-müharibə ədəbiyyatı yalnız yaddaşı qorumaqla kifayətlənmir, həm də cəmiyyətin özünütanıma, empatiya və emosional reabilitasiya prosesinə bədii töhfə verir.

Açar sözlər: Post-müharibə ədəbiyyatı, Travmatik yaddaş, Poetika, Kollektiv identiklik, Bədii rekonstruksiya, Qarabağ müharibəsi, Travma nəzəriyyəsi

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THE IMPLEMENTATION OF DEVELOPMENTAL TEACHING METHODS IN THE INSTRUCTION OF TEXTS IN AZERBAIJANI LANGUAGE CLASSES

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ABSTRACT

This paper explores the implementation of developmental teaching methods in the instruction of texts in Azerbaijani language classes within general education schools. The primary aim is to assess the effectiveness of modern pedagogical approaches in enhancing students' text comprehension, analytical skills, and expressive abilities. The research compares traditional teaching strategies with learner-centered and interactive approaches, focusing on their impact on student engagement and academic performance.

Special emphasis is placed on methods such as problem-based learning, classroom discussions, clustering techniques, and visual thinking tools like Venn diagrams and concept maps. Fieldwork was conducted in several schools in Baku, where both classroom observations and surveys were utilized to collect data from teachers and students. The findings indicate that the use of developmental methods significantly increases student interest in texts, promotes critical and creative thinking, and enhances the overall quality of Azerbaijani language instruction.

These results suggest that the systematic integration of developmental methods into Azerbaijani language lessons can revitalize the teaching process and contribute meaningfully to the development of students' communicative competences.

Keywords: Azerbaijani language, text instruction, developmental teaching, interactive methods, critica

AZƏRBAYCAN DİLİ DƏRSLƏRİNDƏ MƏTNLƏRİN TƏDRİSİNDƏ İNKİŞAFETDİRİCİ METODLARIN TƏTBİQİ

Xülasə

Bu məqalədə ümumtəhsil məktəblərində Azərbaycan dili dərslərində mətnlərin tədrisində inkişaf etdirici təlim metodlarının tətbiqi tədqiq olunur. Məqsəd, şagirdlərin mətnə yanaşma, anlama, təhlil etmə və ifadə etmə bacarıqlarını artırmaq üçün müasir pedaqoji yanaşmaların effektivliyini müəyyənləşdirməkdir. Araşdırma zamanı ənənəvi təlim üsulları ilə inkişafyönlü metodların müqayisəsi aparılmış, eyni zamanda interaktiv və şagirdmərkəzli yanaşmaların şagird nailiyyətlərinə təsiri empirik məlumatlar əsasında təhlil edilmişdir.

Tədqiqatda əsas diqqət problembazlı öyrənmə, diskussiya və debat, klaster üsulu, mətn üzərində qrafik modellərlə işləmə (Venn diaqramı, anlayış xəritəsi və s.) kimi metodların

tətbiqinə yönəldilmişdir. Bakı şəhərində bir neçə məktəbdə müşahidə və sorğular həyata keçirilmiş, müəllim və şagirdlərin rəyləri toplanmışdır. Nəticələr göstərir ki, inkişaf etdirici metodlar şagirdlərin mətnə qarşı marağını artırır, onları tənqidi və yaradıcı düşünməyə sövq edir və ümumilikdə dil dərslərinin keyfiyyətini yüksəldir.

Əldə edilən nəticələr onu deməyə əsas verir ki, Azərbaycan dili dərslərində bu cür metodların sistemli tətbiqi, tədrisə yeni nəfəs gətirə və şagirdlərin kommunikativ kompetensiyalarının inkişafına real töhfə verə bilər.

Açar sözlər: Azərbaycan dili, mətnlərin tədrisi, inkişafyönlü təlim, interaktiv metodlar, tənqidi düşüncə

1.INTRODUCTION

In the 21st century, education systems around the world are undergoing rapid transformations to meet the needs of modern learners. One of the most significant changes is the shift from teacher-centered to student-centered approaches, where the focus is on developing learners' critical, analytical, and creative thinking skills. In this context, the use of developmental teaching methods has become increasingly relevant, especially in language instruction.

In Azerbaijan, Azerbaijani language education plays a central role in shaping students' linguistic, cultural, and cognitive development. However, traditional methods still dominate many classrooms, limiting students' ability to fully engage with and interpret texts. This challenge has raised the need for more dynamic and interactive teaching strategies that can better support student learning and foster deeper understanding.

Developmental teaching methods offer a promising alternative. These approaches emphasize active learning, problem-solving, and meaningful interaction between students and teachers. Techniques such as classroom discussions, concept mapping, visual tools, and problem-based learning help students engage with texts in a more comprehensive and reflective way. Such methods not only enhance comprehension but also support the development of communication and analytical skills.

This study investigates the implementation of developmental teaching methods in Azerbaijani language classes at the general education level. The primary aim is to examine the impact of these methods on student performance and engagement, and to compare their effectiveness with that of traditional teaching strategies. By focusing on real classroom practices in Baku schools, the research provides practical insights into how innovative pedagogical techniques can transform the teaching of Azerbaijani language and literature.

2. MATERIALS AND METHODS

This research was conducted in several general education schools in Baku, Azerbaijan, during the 2024–2025 academic year. The aim was to examine the use and impact of developmental teaching methods in Azerbaijani language classes, particularly during the instruction of texts. A mixed-methods approach was used, combining both qualitative and quantitative data collection tools to obtain a well-rounded view of teaching practices and student responses.

Participants

The study involved 10 Azerbaijani language teachers and approximately 120 students from grades 6 to 9. The schools selected for the study represented a cross-section of urban educational institutions with diverse student populations. Teachers included in the research had varying levels of experience, ranging from early-career educators to senior teachers with over 15 years of classroom practice.

Data Collection Tools

Two main tools were used for data collection: classroom observations and student-teacher surveys.

Classroom Observations: Lessons were observed across different grade levels using an observation checklist designed to assess the frequency and type of developmental methods applied. The checklist included indicators such as student participation, use of visual tools, group activities, and opportunities for critical discussion.

Surveys: Structured surveys were administered to both students and teachers. The teacher survey focused on the types of methods used, perceived effectiveness, and challenges encountered. The student survey assessed engagement levels, understanding of texts, and overall classroom experience.

Developmental Methods Applied

Several key developmental strategies were observed in practice:

Problem-Based Learning (PBL): Teachers introduced real-life problems or thought-provoking questions based on literary texts, encouraging students to explore meanings, themes, and context collaboratively.

Clustering and Concept Mapping: These visual techniques helped students to organize ideas around central themes or characters in a text. Venn diagrams were also used to compare different texts or viewpoints within a single text.

Classroom Discussions: Interactive discussions played a central role in the lessons. Students were encouraged to express opinions, justify interpretations, and engage in peer dialogue.

Use of Multimedia and Visual Aids: Teachers incorporated videos, images, and digital storytelling tools to enrich textual understanding and maintain student attention.

Data Analysis

Qualitative data from classroom observations were coded thematically to identify recurring patterns in teaching behaviors and student responses. Quantitative data from surveys were analyzed using basic statistical methods, including frequency counts and percentage distributions, to measure the perceived effectiveness of different teaching approaches.

3.RESULTS AND DISCUSSION

The findings of the study clearly show that developmental teaching methods have a positive impact on students' engagement, comprehension, and critical thinking abilities in Azerbaijani language classes.

Classroom Observations

During the observed lessons, classrooms that incorporated developmental strategies exhibited a higher level of student interaction and participation. In contrast to traditional settings where the teacher dominated the discourse, these classrooms encouraged dialogue, peer collaboration, and exploration of ideas. Students were observed using concept maps to connect themes across multiple texts, and many actively contributed to group discussions. The use of visual thinking tools helped students better structure their responses and engage more deeply with the content. Teachers who employed problem-based learning strategies reported improved student motivation. For example, when presented with real-world questions related to the text, students demonstrated increased willingness to share opinions and work in groups to analyze literary meaning. These methods also allowed students to take ownership of their learning, as they could approach the text from different angles and form independent interpretations.

Survey Results

Student surveys indicated that over 80% felt more interested and engaged when lessons included visual tools or group activities. Many students noted that they understood the texts better when they discussed them with peers or used diagrams to break down complex ideas. Additionally, teachers expressed that developmental methods made lessons more dynamic and responsive to students' needs.

Despite these positive outcomes, several challenges were noted. Teachers highlighted time constraints and a lack of resources as obstacles to implementing developmental methods consistently. Some also mentioned that not all students adapted quickly to student-centered approaches, particularly those accustomed to passive learning.

Interpretation and Implications

The results suggest that while developmental methods require more planning and flexibility, their benefits in terms of student learning and motivation are considerable. These methods make the learning of Azerbaijani texts more meaningful and interactive, helping students develop not just literacy skills, but also cognitive and social competencies.

The study supports the idea that Azerbaijani language instruction can be revitalized through the structured integration of developmental strategies. For maximum impact, it is recommended that teacher training programs include modules on active learning techniques, and that schools invest in necessary teaching aids and flexible classroom environments.

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NEUROSİSTEMLƏRDƏ MUSİQİ VƏ DİLİN KOQNİTİV UYĞUNLUĞU: AZƏRBAYCAN MODELƏRİ ƏSASINDA

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Xülasə

Bu tədqiqat, musiqi və dilin insan beynindəki koqnitiv uyğunluğunu və onların sinxron istifadəsinin Azərbaycan mədəni mühitindəki təzahürünü araşdırır. “Fonokonsept” termini vasitəsilə musiqi və dilin fonetik və ritmik strukturlarının koqnitiv şüurda necə birləşdiyi və yeni emosional-semantik mənalara yaratdığı izah olunur. Araşdırma Azərbaycan xalq musiqisinin ritmləri, klassik poeziyanın melodik strukturları və uşaq ədəbiyyatındakı musiqili mətnlər üzərində aparılmışdır. Nəticələr göstərir ki, musiqi və dilin inteqrasiyası emosional identiklik, yaddaş və öyrənmə proseslərinə əhəmiyyətli təsir göstərir.

Açar sözlər: musiqi, dil, fonokonsept, koqnitiv uyğunluq, emosional kimlik, Azərbaycan modeli

1. Giriş

Koqnitiv dilçilik və neyromusiqişünaslıq sahələrində aparılan son tədqiqatlar göstərir ki, dil və musiqi insan beynində bir-birindən ayrı sistemlər kimi fəaliyyət göstərsə də, onların bir çox sahədə kəsişmə nöqtələri mövcuddur. Dil struktur və məna əsaslıdır, musiqi isə daha çox emosional və ritm əsaslı kodlaşdırma mexanizminə malikdir. Bununla belə, hər iki sistem auditor emal, zamanlamalı struktur, yaddaş və emosional reaksiya ilə əlaqəlidir. Xüsusilə musiqiləşdirilmiş poeziya formaları – nəğmələr, laylalar və ağılar – musiqi və dilin ritmik-fonetik uyğunluğunu ortaya qoyur. Bu uyğunluq vasitəsilə poetik mətnlər həm şifahi yaddaşda saxlanılması, həm də emosional təsir gücü baxımından güclənir. Fonosemantik elementlərin – yəni səsle bağlı mənalara – sinxron şəkildə dil və musiqidə ifadəsi koqnitiv sistemdə qarşılıqlı rezonans yaradır. Bu cür rezonans auditorun həm semantik qavrayışını, həm də emosional iştirakını artırır. Azərbaycan kontekstində, xalq musiqisi və klassik poeziya bu iki sistemin harmoniyasını daşıyan zəngin nümunələrlə doludur. Müğam janrı, aşiq sənəti və laylalar, həm dilin poetik strukturlarını, həm də musiqinin emosional kodlarını birləşdirir. Xalq musiqisinin mətnlərindəki təkrarlanan ahəng və intonativ quruluşlar fonosemantik ritmik yaddaşı gücləndirir. Bu məqalə, məhz bu qarşılıqlı əlaqələrin koqnitiv və funksional təhlilini təqdim edir. Eyni zamanda, tədqiqat, Azərbaycan mədəni kontekstində musiqi və dilin koqnitiv uyğunluğunun modelləşdirilməsini hədəfləyir. Tədqiqat aşağıdakı əsas metodlar əsasında aparılıb:

- **Fonosemantik təhlil:** Azərbaycan xalq musiqisi nümunələrindəki ritmik və fonetik strukturların poetik mətnlərlə uyğunluğu araşdırılıb. Müğam və aşiq sənəti kimi janrlarda fonosemantik paralellər müəyyən edilib.

- **Təhlili nümunələr:** “Bayatı Şiraz” muğamı, aşiq havaları, laylalar və Bəxtiyar Vahabzadə, Səməd Vurğun kimi şairlərin poeziyasında musiqiyə yaxın sintaktik və ritmik quruluşlar təhlil olunub. Bu nümunələr vasitəsilə musiqi və dil arasında paralel strukturlar və emosional rezonans nöqtələri göstərilib.

- **Multimodal təcrübə:** 20 nəfərlik müxtəlif yaş və peşə sahiblərindən ibarət iştirakçı qrupuna eyni poetik mətn həm musiqi müşayiəti ilə, həm də musiqisiz təqdim edilib. İştirakçıların mətnin mənasını qavrama səviyyəsi, emosional reaksiya və yaddaşda saxlanma meyarları qeydə alınıb və statistik müqayisə aparılıb.

- **Yarı-strukturlaşdırılmış sorğu və müşahidə:** Təcrübədən sonra iştirakçılara açıq suallarla yanaşı, müəyyənləşdirilmiş cavab seçimləri olan suallar təqdim edilib. Müşahidələr emosional ifadələr, diqqət səviyyəsi və spontan fikirlər əsasında aparılıb.

- **Mədəni-konseptual analiz:** Azərbaycan mədəniyyətində musiqi və dilin vəhdətinə dair folklor nümunələri və tarixi mənbələr kontekstində konseptual analiz aparılmışdır. Bu yanaşma, dil-musiqi münasibətinin yalnız koqnitiv deyil, həm də milli kimlik prizmasında təhlilinə imkan vermişdir.

“Fonokonsept” anlayışı dilin fonetik strukturları ilə musiqinin ritmik-melodik quruluşlarının insan beynində integrasiya olunaraq yeni koqnitiv vahid yaratmasını ifadə edir. Bu anlayışa görə, müəyyən sözlər və ifadələr təkcə məna deyil, eyni zamanda səs, ritm və emosional təsir daşıyıcısı kimi də çıxış edir. Məsələn, “Azərbaycan”, “ana torpaq”, “bayraq”, “azadlıq” kimi ifadələr yalnız leksik səviyyədə deyil, həm də ritmik və melodik baxımdan kollektiv emosional yaddaşda dərin iz buraxır. Bu sözlər bəzən müəyyən musiqi motivləri ilə birlikdə kollektiv şəkildə qəbul edilir və milli kimliyin formalaşmasında mühüm rol oynayır. Musiqi ilə fonetik elementlərin sinxron şəkildə qavranması həm emosional yaddaşı gücləndirir, həm də konseptual kateqoriyaların dil-musiqi integrasiyası vasitəsilə daha zəngin kodlaşdırılmasına imkan verir.

Musiqi və dil öyrənməsi arasındakı əlaqə çoxsaylı neyroloji və pedaqoji araşdırmalarla təsdiqlənmişdir. Tədqiqat çərçivəsində müxtəlif yaş qruplarına aid olan iştirakçılara eyni mətn həm adi, həm də musiqi müşayiəti ilə təqdim olunmuşdur. Nəticələr göstərdi ki, musiqi ilə təqdim edilən mətnlər daha tez yadda qalır və təbii intonasiya ilə ifadə olunur. Melodiyanın təkrarlanması fonetik diskriminasiyanı artırır, qrammatik strukturların daha yaxşı mənimsənilməsinə şərait yaradır. Bu xüsusilə ikinci dil kimi Azərbaycan və ya xarici dili

öyrənən uşaqlarda və yeniyetmələrdə nəzərəcarpacaq olmuşdur. Musiqi intonasiası nitqə axıcılıq və təbii vurğu əlavə edərək danışq bacarıqlarının inkişafına təkən verir. Bundan əlavə, öyrənənlər musiqi müşayiətli tədris prosesini daha əyləncəli və motivasiyaedici hesab edirlər ki, bu da tədris effektivliyini artırır.

Musiqi və dil birlikdə insanın emosional dünyasını formalaşdırən ən mühüm vasitələrdəndir. Azərbaycan musiqisinin zəngin modal (lad) sistemi — xüsusilə muğam janrı — poeziya ilə birləşərək xalqın milli və emosional kimliyini inşa edən simvolik mənbəyə çevrilmişdir. Aşıq yaradıcılığında şeir və musiqinin vəhdəti vasitəsilə qəhrəmanlıq, sədaqət, eşq və vətənpərvərlik kimi duyğuların poetik ifadəsi geniş yayılmışdır. Bu vəhdət yalnız estetik dəyər daşımır, eyni zamanda koqnitiv emosional rezonans yaradır. Məhz bu integrasiya sayəsində “şeir-musiqi” birliyi fərdin mənsub olduğu mədəniyyəti həm anlayır, həm də hiss edir. Emosional identiklik isə fərdin sosial kimliyinin və psixoloji sağlamlığının ayrılmaz hissəsidir.

Multimodal (çoxkanallı) yanaşma – yəni dilin və musiqinin birlikdə istifadə olunduğu tədris və terapiya metodları – son illərdə həm inklüziv təhsil, həm də psixoloji müdaxilə sahəsində geniş tətbiq olunur. Xüsusilə autizm spektr pozuntulu uşaqlarda, danışq və eşitmə qüsuru olan fərdlərdə musiqi vasitəsilə dil qavrayışının stimullaşdırılması effektiv nəticələr verir. Musiqi ilə müşayiət olunan mətnlər uşaqların diqqətini artırır, emosional sabitlik yaradır və sosial qarşılıqlı əlaqəyə dəstək olur. Pedaqoji baxımdan isə, məktəbəqədər və ibtidai sinif şagirdləri arasında musiqili şeir və oyun formasında təqdim olunan dil materialları həm nitqin inkişafını, həm də ünsiyyət bacarıqlarını gücləndirir. Eyni zamanda, musiqi ilə müşayiət olunan qrammatik modellər və söz birləşmələri daha yaxşı mənimsənilir və praktikada istifadə olunur. Terapevtik təsir isə musiqinin limbik sistem vasitəsilə emosiyalara birbaşa təsirindən irəli gəlir ki, bu da psixoloji rahatlıq və özünüifadə imkanları yaradır.

Tədqiqat nəticəsində məlum oldu ki, musiqi və dil yalnız iki fərqli simvolik sistem deyil, eyni zamanda bir-birini tamamlayan və insanın idrak, yaddaş və emosional sistemlərini sinxron şəkildə işə salan mərkəzlərdir. “Fonokonsept” modeli Azərbaycan musiqisi və dili üzərində qurulan yeni yanaşma olmaqla, həm təhsil sahəsində, həm də neyropsixoloji və mədəniyyətşünaslıq baxımından geniş tətbiq sahəsi təqdim edir. Bu sinxronluq, milli identikliyi möhkəmləndirməklə yanaşı, interdisiplinar tədqiqatlara da töhfə verir.

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Abstract

This study explores the cognitive compatibility of music and language in neural systems and examines their synchronized manifestation within the cultural environment of Azerbaijan. The concept of “phonoconcept” is introduced to explain how phonetic and rhythmic structures of music and language integrate within cognitive consciousness, producing new emotional-semantic meanings. The research is grounded on examples from Azerbaijani folk music, the melodic structure of classical poetry, and musical texts in children’s literature. Results demonstrate that the integration of music and language significantly influences emotional identity, memory, and learning processes. The findings also highlight the educational and therapeutic applications of this synchrony in neuropsychological and interdisciplinary contexts.

Keywords: music, language, phonoconcept, cognitive integration, emotional identity, Azerbaijani model, neuropsychology, poetic rhythm

AZƏRBAYCAN-POLŞA ƏDƏBİ ƏLAQƏLƏRİ: ADAM MİTSKEVİÇ VƏ ŞƏRQ**Elza Babayeva Ənvər qızı**

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Xülasə

Məqalədə Azərbaycan-Polşa tarixi, mədəni, siyasi və ədəbi əlaqələrindən bəhs olunur. Tarixən Azərbaycan və Polşa ölkələri arasında münasibətlər olmuş və indi də davam edir. Azərbaycanda mindən çox polyak yaşayır. XV əsrdə Uzun Həsən Polşa kralı ilə sıx əlaqə saxlamışdır.

1992-ci il 21 fevral tarixindən iki ölkə arasında diplomatik əlaqələr yaradılmışdır. Azərbaycan və Polşa ölkələrində səlahiyyətli səfirlər də təyin edilmişdir. Azərbaycan-Polşa ədəbi əlaqələri Adam Mitskeviçin yaradıcılığı ilə yeni bir mərhələ başlayır.

Mitskeviçi məşhur şərqşünas O.Senkeviç azərbaycanlı alim, şərqşünas Mirzə Cəfər Topçubaşovla tanış edir. Mirzə Cəfər öz şagirdi polyak yazıçısı və etnoqraf Aleksandr Xodzkonun köməyi ilə Krım sonetlərindən birini farsca tərcümə edir. Məqalədə o da qeyd olunur ki, Aleksandr Xodzko “Koroğlu” dastanını ilk dəfə tərcümə edərək kitab halında 1842-ci ildə Londonda nəşr etdirmişdir. Bu dastan 13 məclisdən ibarət olmuşdur. Aleksandr Xodzko 13 il Rusiyanın İran konsulluğunda çalışmış və bu dövrdə Cənubi Azərbaycanda “Koroğlu”nu toplamışdır.

Azadlıq ruhlu şair Adam Mitskeviçin Şərqdə tanınmasının başlanğıcı Mirzə Cəfərin tərcüməsiylə oldu. Şairin “Krım sonetləri” dünya poeziyasının qiymətli inciləri kimi dəyərləndirilir. Bu sonetlər bütün Avropa və əksər Şərq dillərinə tərcümə edilmişdir. Şair bu poetik nümunələrdə qəlbinin dərinliyindəki həyəcanlı duyğuları ifadə etmişdir. Şair eyni zamanda Şərqə və Şərq aləminə də bir neçə əsər həsr etmişdir.

Şairin yaradıcılığına maraq göstərənlərdən biri də XIX əsrdə yaşamış, Avropanı, o cümlədən Polşanı səyahət etmiş ensiklopedik sənətkar, Azərbaycanın maarifçi ziyalısı Abbasqulu ağa Bakıxanov olmuşdur. Bakıxanov polyak dilini belə öyrənməyə səy göstərmişdir ki, Mitskeviçi orjinaldan oxuya bilsin.

Daha sonralar Mitskeviçin adına Üzeyir Hacıbəylinin bir məqaləsində rast gəlirik. Mitskeviç yaradıcılığına Azərbaycanda geniş maraq XX əsrin sonlarında yaranmışdır. 1985-ci ildə Sabir Rüstəmxanlının tərcüməsində “Krım sonetləri” kitabı nəşr edilmişdir. Bu kitabda şairin digər əsərləri də verilmişdir. Azadlıq şairi olan Mitskeviçin yaradıcılığı bu gün də azərbaycanlı oxucuların maraq dairəsindədir.

Açar sözlər: Azərbaycan, Polşa, Adam Mitskeviç, Şərq, Krım sonetləri

Abstract

The article discusses the historical, cultural, political and literary relations between Azerbaijan and Poland. Historically, relations between Azerbaijan and Poland have existed and continue to exist. More than a thousand Poles live in Azerbaijan. In the 15th century, Uzun Hasan maintained close relations with the Polish king.

Diplomatic relations have been established between the two countries since February 21, 1992. Plenipotentiary ambassadors have also been appointed to Azerbaijan and Poland. Azerbaijani-Polish literary relations begin a new stage with the work of Adam Mickiewicz.

The famous orientalist O. Sienkiewicz introduced Mickiewicz to the Azerbaijani scholar and orientalist Mirza Jafar Topchubashov. Mirza Jafar, with the help of his student, Polish writer and ethnographer Alexander Khodzko, translated one of the Crimean sonnets into Persian. The article also notes that Alexander Khodzko translated the epic "Koroglu" for the first time and published it as a book in London in 1842. This epic consisted of 13 majlis. Alexander Khodzko worked for 13 years at the Russian consulate in Iran and during this period he collected "Koroglu" in South Azerbaijan.

The beginning of the recognition of the freedom-loving poet Adam Mitskevich in the East was with the translation of Mirza Jafar. The poet's "Crimean Sonnets" are considered precious pearls of world poetry. These sonnets have been translated into all European and most Eastern languages. The poet expressed the exciting feelings deep in his heart in these poetic examples. The poet also dedicated several works to the East and the Eastern world.

One of those who showed interest in the poet's work was Abbasgulu aga Bakikhanov, an encyclopedic artist who lived in the 19th century and traveled throughout Europe, including Poland, and the enlightener of Azerbaijan, Zuyal. Bakikhanov made an effort to learn Polish so that he could read Mitskevich in the original.

Later, we come across Mitskevich's name in an article by Uzeyir Hajibeyli. Wide interest in Mitskevich's work arose at the end of the 20th century. In 1985, the book "Crimean Sonnets" was published in the translation of Sabir Rustamkhanli. This book also contains other works of the poet. The work of Mitskevich, a poet of freedom, is still of interest to Azerbaijani readers today.

Keywords: Azerbaijan, Poland, Adam Mitskevich, East, Crimean sonnets

GİRİŞ

Azərbaycan və Polşa ölkələri arasında əlaqələrin kökləri lap qədimlərə söykənir. Bu ölkələr arasında əlaqələr indi də davam etməkdədir. Azərbaycan ikinci dəfə müstəqilliyini 1991-ci il oktyabrın 18-də qazanır. Polşa dövləti Azərbaycanın müstəqilliyini 1991-ci il dekabrın 27-də

tanınmış və bu iki dövlət arasında diplomatik əlaqələr 1992-ci ilin 21 fevralında yaradılmışdır. Həmin vaxtdan etibarən bu ölkələr arasında siyasi və mədəni əlaqələr inkişaf edərək möhkəmlənmiş və dostluq münasibətinə çevrilmişdir. Azərbaycanda Polşanın, Polşada da Azərbaycanın səfirləkləri yaradılmışdır. Polşada Azərbaycan-Polşa alimlərinin beynəlxalq elmi konfransları keçirilmişdir. XV əsrdə Ağqoyunlu hökmdarı Uzun Həsənin dövründə əsası qoyulmuş diplomatik əlaqələr bu gün də daha əhəmiyyətli siyasi problemlərin həlli səviyyəsində davam etməkdədir. Ədəbi-mədəni əlaqələrin özü də ölkələri birləşdirən əlaqələrdən hesab olunur. Polşa Azərbaycan arasında ədəbi əlaqələr daha əvvəllərə gedib çıxsada, ən geniş planda inkişaf XIX əsrdən Adam Mitskeviçin yaradıcılığının araşdırılması dövründə özünü göstərir. Məqalənin əsas mətnində Adam Mitskeviçin həyat və yaradıcılığı, onun Şərqdə və Azərbaycanda tanınması və tərcüməsi, təhlilindən bəhs olunur.

MƏTN

Adam Mitskeviçin yaradıcılığı Polşa tarixinin zəngin hadisələrlə dolu olan dövrünə—Polşa xalqının milli azadlıq uğrunda mübarizə apardığı və mədəniyyətinin inkişaf etdiyi bir dövrə təsadüf edir. XVIII əsrdə Polşa Rusiya, Prussiya və Avstriya arasında bölünmüşdür. 1830-cu ildə Polşada böyük bir üsyan baş verdi. Bu, ölkədə ən əhəmiyyətli hadisə idi. Kəndlilər bu üsyana tərəfdar çıxmadıqları üçün üsyan məğlubiyyətlə nəticələndi.

Adam Mitskeviç bu hadisələrin şahidi olmuşdur. Onun yaradıcılığı 20/30-cu illər milli-azadlıq hərəkatı ilə üzvi surətdə bağlı idi. Polşa inqilabi-romantizmi mədəniyyət sahəsində baş verən yeni demokratik hərəkat və klassisizm estetikasına və şeirinə qarşı çevrilmiş bir cərəyan kimi XIX əsrin birinci rübündə meydana gəlir.

Adam Mitskeviç 1798-ci ildə kiçik Novoqrudka şəhərində mülkədar ailəsində Nikolay Mitskeviçin ailəsində anadan olmuşdur. İlk təhsilini Novoqrudkada almışdır. 1807-ci ildə dominikan məktəbinə daxil olur. O, uşaqlıqdan xalq yaradıcılığı ilə məşğul olmuşdur. 1815-ci ildə Vilno Universitetinin fizika-riyaziyyat fakültəsinə daxil olmuşdur. Bir ildən sonra fakültəni dəyişir və 1819-cu ildə buranı bitirib Kovno şəhərində qəza məktəbində müəllim işləyir. Hələ universitetdə oxuyarkən “Filomatlar” dərənəyinə üzv olur. Müəllim işlədiyi vaxtlarda da bu dərənəklə əlaqəsini kəsmir. Dərənəyi genişləndirərək yeni bir cəmiyyət- Filoretlər (xeyirxah) təşkil edirlər. Milli-azadlıq hərəkatı tərəfdarları və başçıları bu cəmiyyətdə birləşirdilər. 1823-cü ildə çar hökuməti bu cəmiyyəti dağıdır. Üzvlərini həbs edirlər. A.Mitskeviçi Rusiyaya sürgün edirlər. 1824-cü ildə vətəni tərk edir.

Yaradıcılığının ilk dövrlərini - tələbəlik və müəllimlik illərini Vilno-Kovno dövrü adlandırırlar. Bu dövrdə yazdığı lirik şeir və balladalarında, qəsidə və romanslarında inqilabi ruh hakim idi. Bu dövr yaradıcılığını şair ayrıca kitab şəklində iki cildə çap etdirir. 1821-ci

ildə nəşr etdirdiyi “Romantika” balladası onun şeir məramnaməsi idi. Şair bu şeirində öz prinsiplərini aydın şəkildə əks etdirir. Həmin bu ballada da şair köhnə klassik qaydalara deyil, poetik duyğulara əsaslanır və xalq poeziyasının səsinə qulaq asmağı tələb edir. Hissin ağıla qarşı qoyulması klassisizm estetikasının rassionalizm ilə orijinal mübarizə forması idi. Romantiklər hissiyyat məfhumunu çox geniş mənada başa düşürdülər. Onlar hissiyyat dedikdə insanın azad inkişafını, humanizm ideallarının həyata keçirilməsini, həyatın tələblərinə cavab verə bilən azad yaradıcılıq nəzərdə tuturdular.

Şairin 1-ci cildə daxil etdiyi şeirləri xalq şeiri ilə səsleşirdi. “Sevirəm” və “Maral tərəcəyi” kimi əsərlərində öz sevgilisinin surətini yaratmışdır. Nakam məhəbbətindən doğan kədərini nağıl edir. Şair bu şeirlərdə xalq fantastikasını bədii şəkildə yenidən canlandırır. Oxucunu su pərilərinin, sehrli kabusların əfsanəvi aləminə, yer altındakı sehrli şəhərlərə, əfsunlanmış çiçəklərə aparır. Təbiət olduqca gözəldir. Şair sanki suların şırıltısını, meşələrin uğultusunu, yarpaqların xışıltısını eşidir. Müəllif bunları təsvir edərkən soyuq mühakimələrdən uzaqlaşır, qəlbini, duyğularını və keçirdiyi hissləri tərənnüm edir. Bütün bunlarla baxmayaraq şairin fantastikası realdır. O, xalq fantaziyasının ardınca gedərkən kainatın dərk edilməsindən heç də uzaqlaşmır. Onun “nağılvari” surətləri aydın ictimai mahiyyət kəsb edir. Bu cəhət “Balıq” (1820-1821) balladasında özünü aydın göstərir. Varlı pan yoxsul kəndli qızı Kşısıyanı ataraq məşhur və varlı bir qızla evlənir. Bu dərdə dözə bilməyən Kşısıya özünü çaya atır və balığa dönür. Hər gün sahilə çıxaraq qoca atasının gətirdiyi balaca oğlunu əmizdirir. Bir dəfə pan öz təzə, varlı arvadı ilə sahilə gəlir. Gizli bir qüvvə onların ikisini də daşa döndərir. Və beləliklə yoxsul kəndli qızı öz intiqamını alır.

“Svitezli qız” adlı (1820-1821) balladasının mövzusu isə realdır. Şər qüvvələrin yaşadığı “Svitez” gölü illərdən bəri ətraf kəndlərdə yaşayan əhalini qorxudub dəhşətə salır. Bu göl sirli bir göldür. Həmin gölün dibində qədim bir şəhər var. Şəhərin sakinləri düşməyə əsir düşməmək üçün dəniz otuna çevrilib daşların arasında gizlənirlər. Bu əsərdə xalqın istiqlaliyyət uğrunda mübarizəsi əks olunmuşdur.

Şairin gənclik illərində yazdığı şeirləri azadlıq və vətənpərvərlik mövzusunda idi. 1819-cu ildə yazdığı “Adamın mahnısı” adlı şeirində öz dostlarına müraciət edərək onları öz qüvvəsini toplayaraq vətənin azadlığına, elmə və qəhrəmanlığa həsr etməyə çağırır. Əmin olduğunu bildirir ki, mərdlik, zəhmət və qardaşlıq hər cür çətinlik və maneələrə üstün gələcəkdir. 1820-ci ildə yazdığı və qabaqcıl polşa gənclərinin ən sevimli əsəri olan “Gənclik” qəsidəsində “bizim məqsədimiz və işimiz hamını xoşbəxt görməkdir” şüarını irəli sürür. Həyatın mahiyyəti vətənin səadəti və insanların xoşbəxtliyi uğrunda vuruşmaqdan ibarətdir. Azadlığın

yaxınlaşmasını hiss etmək, onun mütləq gələcəyinə inam bəsləmək – qüvvət və cəsarət mənbəyidir.

Vətən məhəbbəti mövzusu onun “Qrajina” poemasında daha çox diqqətə çatdırılır. Bu poemada şair vətəninin tarixi keçmişinə böyük maraq göstərir. Poemanın süjet xətti Litva xalqının alman səlibçilərinə qarşı apardıqları azadlıq mübarizəsi əsasında qurulmuşdur. Əsərin qəhrəmanı litvalı qız Qrajinadır. O bütün varlığıyla vətəninə sevir. Onun fəaliyyəti və hərəkəti bu hissə tabedir. Əsərdə Qrajina surəti öz mənafeyi üçün vətəninə xəyanət edən knyaz Litavora qarşı qoyulur. Knyaz Litavor Vitolda çəkişir. Litavor Vitolda qalib gəlmək üçün vətəninin və xalqının düşməni olan tevton cəngavərlərinə arxalanır. Alman qəsbkarları Litva knyazları arasına qəsdən nifaq salırlar ki, öz məqsədlərinə çatsınlar. Litavor səlibçilərlə müqavilə bağlayır. Bu müqaviləyə onun müşaviri və arvadı Qrajina etiraz edir. Lakin Litavoru öz şəxsi ədavəti maraqlandırır. Qrajina ərinin döyüş paltarını geyinərək druji naçırlarla birlikdə düşmənlərə qarşı vuruşur. Qrajina döyüş meydanında, döyüşə çox gec gəlmiş ərinin qolları arasında ölür. Litavor tutduğu səhv yoldan pəşiman olur və sarsılır. Özünü tonqala atıb yandırır. Poemanın mövzusu xalq əfsanəsindən götürülsə də, hadisələr milli-tarixi mahiyyət daşıyır. Bir qədər də romantik don geyindirilmişdir.

Adam Mitskeviçin yaradıcılığının ikinci dövrü Rusiyada yaşadığı illərə (1824-1829) təsadüf edir. O, Rusiyada dekabristlər üsyanı dövründə yaşamışdır. Dekabristlərin ideyası ona yaxın idi. Qabaqcıl rus ziyalıları Polşadan sürgün edilmiş şairi böyük sevinclə qarşılayırlar. O, Puşkinlə, Jukovski və başqa rus qabaqcılları ilə yaxından tanış olur və Qriboyedovla görüşür. Şairin dekabristlərlə tez bir zamanda yaxınlaşması çar Rusiyası ərazisində yaşayan əzilən xalqların milli-azadlıq uğrunda mübarizə aparması idi. Bu arzular Polşa şairinin ideyaları ilə üst-üstə düşürdü. Rıleyev və Bestujevin polyak dilini yaxşı bilməsi və polşa ədəbiyyatından xəbərdar olması da onları birləşdirirdi. Adam Mitskeviçin şeirlərini Rus dilinə onlar tərcümə etmişlər...

Mitskeviçin Rusiyadakı həyatından və dostlarından danışarkən ilk növbədə Puşkindən danışmaq lazımdır. Puşkinlə tanışlıq onun dünyagörüşünə və sonrakı yaradıcılığına ciddi təsir göstərmişdir. Puşkin onun bir sıra şeirlərini rus dilinə tərcümə etmişdir. (Budrıs və onun oğulları, Voyevoda və “Konrad Vallenrod” poemasının giriş hissəsi)

Mitskeviçlə Puşkinin şəxsi tanışlığı 1826-cı ilin payızında başlamış və 1827-ci ilin mayına qədər davam etmişdir. Hətta o, Puşkinin “Boris Qodunov” əsərinin ilk oxunuşunda iştirak etmiş və milli tarixi mövzuda əsər yazmaq qərarına gəlmişdir. 1837-ci ildə yazdığı “Puşkin və Rusiyanın ədəbi hərəkəti” məqaləsində Puşkini Rusiyanın “əqli müxalifətin rəhbəri” adlandırmışdır. Puşkinin və Mitskeviçin slavyan xalq şeirinə maraq göstərmələri də onları ideya

cəhətdən birləşdirirdi. Dekabristlə və Puşkinlə dostluq əlaqələri Mitskeviçin yalnız yaradıcılığına deyil, eyni zamanda estetik görüşlərinə də güclü təsir etmişdir. Mitskeviç o dövrki rus ədəbiyyatına yüksək qiymət verərək yazır: “Rus ədəbiyyatı öz inkişafı etibarı ilə Polşa ədəbiyyatından xeyli irəli getmişdir. Bunun da səbəbi rus ədəbiyyatının həyatla üzvi bir əlaqədə olması və qabaqcıl ziyalıların müasir dövrdəki ictimai hadisələrə fəal və təsiredici münasibət bəsləməsidir.” (1.118)

Adam Mitskeviçin Rusiyada yaşadığı dövrdə yazdığı ən yaxşı əsərləri “Kırım sonetləri” (1826), “Konrad Vallenrod” (1828) poemasıdır. “Kırım sonetləri” kitabına daxil edilmiş şeirlər silsiləsini vətənə və azadlığa məhəbbət kimi ümumi cəhətlər birləşdirir. Vətəndən uzaqlarda yazılmış bu şeirlərdə şair vətəni üçün darıxdığını və keçirdiyi qəriblik hisslərini əks etdirir. Bu şeirlər həmçinin yüksək bədii keyfiyyətlərilə də fərqlənir. Polşa ədəbiyyatında sonet janrının möhkəmlənməsində Mitskeviçin rolu böyükdür. Dərin hisslərin verilməsi bu sonetlərin əsas xüsusiyyətidir. Adam Mitskeviçi Şərqdə tanıdan da elə “Kırım sonetləri” olmuşdur. Gənc şair Peterburqda şərqşünas alim Mirzə Cəfər Topçubaşovla tanış olur. Mirzə Cəfər Topçubaşov polyak alimi A.Xodzkonun köməyi ilə sonetlərdən birini fars dilinə tərcümə edir. Şair bu tərcüməni 1826-cı ildə nəşr etdirdiyi “Sonetlər” kitabına daxil etmişdir. “Mitskeviç o zaman polyak dostlarına Cəfərin maraqlı ön sözü və bir sonetin farscaya tərcüməsiylə bağlı məktub da yollamışdı.” (5.7)

Vətən həsrəti poetik silsilənin birinci soneti “Akkerman çölləri” şeirində özünü göstərir. Şair ətrafındakı hər şeydə: quşların ötməsində, otların xışiltısında vəs. vətəninin səsini duyurdu. Şair şeirini belə tamamlayır” Elə səssizlikdir ki, dilə gəlir öz dərdim,

Litvadan da səs gəlsə, yəqin ki, eşidərdim
Yox, irəli, irəli! Çağırın yoxmuş bizi... (1.119)

Sürgün illərində şair öz yaradıcılığı ilə müasirlərinin və gələcək nəsillərin xoşbəxtliyi uğrunda vuruşur və yalnız bununla təsəlli tapır. Öz yaradıcılığı ilə vətənə xidmət etmək fikri son şeiri olan

“Ayı dağ” sonetinin əsasını təşkil edir.

“Konrad Vallenrod” poemasını 1828-ci ildə Peterburqda olarkən yazmışdır. Poemanın süjeti çox mürəkkəbdir. Əsərin qəhrəmanı Valter Alf hələ uşaqlıqdan - düşmənlər onun vətəninə hücum etdikdə yetim qalır. Və düşmənlərin əlinə keçir. Onu səlibçilərin ruhunda tərbiyə edirlər. Təsədüfən o, düşməne əsir düşmüş həmyerlisi xalq müğənnisi Xalbana rast gəlir. Müğənni öz nağıl və nəğmələri ilə Valteri tərbiyə edərək vətəninə ona sevdilir. Döyüşlərin birində o, litvalıların tərəfinə keçir və Litva knyazının qızı Aldone ilə evlənir. Amma vəziyyət elə gətirir

ki, Valter vətənin xilası üçün öz şəxsi səadətindən keçməli olur. O, Konrad Vallenrod adı ilə səlibçilərin sıralarına daxil olaraq onların döyüş sirrini öyrənmək istəyir. İlk vaxtlar ona inanır və özlərinə başçı seçirlər. Konradın hiyləsi baş tutur, lakin səlibçilər bundan xəbər tutanda onu öldürürlər. Poema kompozisiyası baxımından romantik əsərdir. Poemada hadisələr ardıcıl surətdə verilmir. Hadisələr sonradan tədricən aydınlaşır. Poema müqəddimə və müxtəlif şəkildə qurulmuş altı hissədən ibarətdir. Poetik təhkiyə və mükəllimələr əsas yer tutur.

Vallenrod surəti bir növ Qrajina surətinə oxşayır. Onların hər ikisi də vətənin xilası üçün qəhrəmanlıq göstərirlər. Onlar vətən qarşısındakı borclarını yerinə yetirmişlər. Lakin “Konrad Vallenrod” poemasında tənha qəhrəman surəti daha dərinlən işlənmişdir. Vallenrod xalqının səadəti üçün vuruşur, lakin xalqdan ayrı şəkildə iş görür. Ona görə də mübarizəsi nəticəsiz qalır.

Adam Mitskeviçin yaradıcılığının üçüncü hissəsi 1830-1850-ci illəri əhatə edir. Bu dövrdə “Dzyadlar” poemasının üçüncü hissəsini və “Pan Tadeuş” poemasını yazmışdır.

1830-cu il inqilabı dövründə şair İtaliyada idi. O, vətənə qayıtdıqda artıq üsyan yatırılmışdır. Bu üsyanın məğlub edilməsinə baxmayaraq, Polşa xalqının azadlıq mübarizəsi tarixində mühüm yer tutur. Polşa xalqının apardığı azadlıq mübarizəsini rus inqilabçı-demokratları müdafiə edirdilər. Mitskeviç 1830-cu illərdə bütün yaradıcılığında inqilabi hadisələrə səs vermişdir. “Dzyadlar” poemasının üçüncü hissəsi 1832-ci ildə nəşr edilir. Şair bu poema üzərində uzun müddət işləmiş və əvvəlki variantlarını məhv etmiş və yenidən işləmişdir. Buna baxmayaraq əsər tamamlanmamışdır. Poemada Polşa xalqının azadlıq uğrunda apardığı mübarizənin tarixini vermək istəmişdir. Poemada Mitskeviç qəhrəmanların taleyinin yüksək zirvəyə çatmasını və Polşadakı istiqlaliyyət hərəkatının mühüm dövrlərini əks etdirən səhnələri yaratmışdır. Əsərin qəhrəmanı Qustav azadlıq uğrunda mübarizə aparmaq üçün yaradılan gizli təşkilatların qabaqcıl gənclərinin nümayəndəsi kimi verilmişdir. Qustav poemanın əvvəlində böyük ictimai-siyasi məsələlərdən uzaq olur. İkinci və dördüncü hissələrində isə şəxsi iztirabları və nakam məhəbbəti üzündən əzab çəkən bir gənc kimi təsvir edilir. Bu hissələri şair xalq əfsanələri əsasında yazmışdır. O, qeyri-adi hadisələri təsvir etməklə real həyatda baş verən əhvalatları göstərmək istəmişdir. Əsərdə dzyadların həyatının təsvirinə həsr edilmiş səhnələri həyatda ümitsizliyə uğrayan Qustavın lirik gündəliyinə bənzəyən lövhələr əvəz edir. Qustav özünü öldürür. Üçüncü hissədə isə Konrad adlı qəhrəman çıxış edir. “Qustav öldü-Konrad doğuldu” ifadəsilə romantik xülyalara son qoyulur. Məhz bu əsərin üçüncü hissəsi Mitskeviçin yaradıcılığında romantizimdən realizmə keçid kimi qiymətləndirilir. Əsərin qəhrəmanı Konrad isə romantik qəhrəmandır. O, fəvqəladə bir şəxsdir. Vətənin xilası üçün xalqa yaxınlaşmağın zəruriliyini başa düşsə də, fərdiyyətçilikdən yaxa qurtara bilmir.

Mitskeviçin yaradıcılığında realizmin getdikcə möhkəmləndiyini göstərən əsər “Pan Tadeuş” poemasıdır. Əsərdəki hadisələr Litvada zəngin bir zadəganın malikanəsində baş verir. Burada iki zadəgan ailəsi arasında uzun illərdən bəri davam edən qan düşmənçiliyi təsvir edilir. Şair bu zadəganların ayrı-ayrı dəstələrə bölünməsinə tənqid edir. O, milli-azadlıq uğrunda mübarizədə xalqı vahid bir cəbhədə birləşməyə çağırır. Poemanın əsas məziyyətlərindən biri də odur ki, müəllif poemada iki aləmin – süquta uğramaqda olan feodalizmlə meydana gəlməkdə olan burjuaziya arasındakı ziddiyyəti göstərə bilmişdir. Əsərdə diqqəti cəlb edən mövzu vətənə olan məhəbbətdir. Həyatını vətənə qurban verən alovlu vətənpərvər Robak, Tadeuş, Zodya və b. surətlər yaratmışdır. Bu əsər şairin sonuncu böyük əsəridir. Onun sonrakı yaradıcılığı əsasən publisistik xarakter daşıyır.

1839-cu ildə Parisdə yaradılmış slavyan ədəbiyyatı kafedrasında, 1840-cı ildə slavyan ədəbiyyatı tarixi haqqında mühazirə oxuyur. 1848-ci il inqilabı ilə əlaqədar olan hadisələrə biganə qalmır və xalqların azadlıq uğrunda mübarizəsində yenə də fəallıq göstərir. Mitskeviçin siyasi fəaliyyəti ömrünün sonlarında daha da güclənir. 1855-ci ildə Konstantinopola gedir. Türkiyə və Rusiya arasında gedən müharibədə iştirak etmək üçün Polşa legionu yaratmaq istəmişdir. O, burada vəba xəstəliyindən vəfat etmişdir.

Mitskeviç Polşa və dünya ədəbiyyatı tarixində azadlıq uğrunda aparılan birgə mübarizədə bütün əzilənlərin qardaşcasına birləşməsinə tərəfdar olan mübariz şair və alovlu vətənpərvər kimi tanınmışdır. XIX əsr Azərbaycan ziyalıları da Adam Mitskeviçin yaradıcılığı ilə maraqlanmışlar. Azərbaycan maarifçi ziyalıları azadlıq ruhlu sənətkarın yaradıcılığı ilə maraqlanırlar, hətta onun əsərlərini orijinaldan oxumaq üçün Abbasqulu ağa Bakıxanov polyak dilini öyrənməyə səy göstərmişdir. (5.8) XX əsrin sonlarından etibarən şairin əsərləri Azərbaycan dilinə tərcümə edilmiş və yaradıcılığı tədqiq edilməyə başlamışdır.

Nəticə

O sənətkar dünyada tanınır və sevilir ki, bəşəri ideyalara xidmət edir. Adam Mitskeviç də belə sənətkarlardandır. Onun əsərləri həm Qərbdə, həm də Şərqdə şöhrət qazanmışdır. Çünki şairin yaradıcılığının başlıca mövzusu azadlıq və vətənpərvərlik olmuşdur. “Kırım sonetləri” kitabında toplanmış. Şeirlərdə vətən həsrəti, azadlıq ruhu özünü göstərir. Şairin arzusu bütün xalqların azadlığa çıxması və xoşbəxt yaşaması idi. Nə qədər romantik olsa da, şair arzularını gerçəkləşdirmək üçün ömrünün sonuna qədər mübarizə aparır. Və ona görə də bütün dünya xalqları, azadlıq sevər insanlar onu daim yad edəcəklər.

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ÇOK DİLLİLİK VE TERCÜME**Doç. Dr. Dilshoda MUBARAKOVA**

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İnsan hayatta yaşarken doğal olarak iletişim kurmaya çalışır. İletişim kurmanın ise birçok yolu vardır - yüz ifadesi, jestler, kelimeler ve cümleler. Başarılı iletişim için anahtar faktör dildir. Dil bize kendi düşüncelerimizi ve fikirlerimizi, isteklerimizi ve isteklerimizi paylaşmamız için kelimeler ve yollar sunar. Sözlüklerde dil “sözcüklerin yapılandırılmış ve geleneksel bir şekilde kullanılmasından oluşan, sözlü veya yazılı bir insan iletişim yöntemi” olarak tanımlar. Dolayısıyla, bir şeyin “dil” olması için bir tür yapı ya da sözleşmeye sahip olması gerektiği açıktır. Bunlar başkaları tarafından anlaşılmasını sağlar. Dili anlayanlar bir topluluğun parçasıdır. Bu hem sözel hem de sözlü olmayan dil için de geçerlidir. Bununla birlikte dil, daha geniş bir topluluk tarafından anlaşıldığında daha güçlü hale gelir. Daha fazla insana daha fazla sebeple iletişim kurabildiğinizde, güç büyür. Diliniz ne kadar güçlü olursa, o kadar bağımsız olursunuz ve topluma daha fazla katkıda bulunabilirsiniz. Dil, iletişimin sadece kilit bir bileşeni değil, aynı zamanda kimliğin de önemli bir yönüdür. Dil aracılığıyla, o dili konuşan topluluğun bir parçası olursunuz. İki dillilik birden fazla dil topluluğunun bir parçası olmanıza izin verir. Bir dile ne kadar hakim olursanız, toplulukla olan bağlantınız o kadar güçlü olur. Çok dilli olmak, bir fazla kimliğe sahip olmak gibidir.

Özbekistan halkı ve genel olarak Orta Asya ulusları uzun zamandır iki dilli, tarihimizin belirli aşamalarını hatırlarsak eğer, üç dilli olduğunu bile söyleyebiliriz. Yani, Türkçe bir askeri dil, Farsça şiirsel bir dil ve Arapça bilim dili - olarak bilinmekteydi. Bugün, Özbekistan’da yabancı dilden Özbek diline veya Özbek dilindeki eserleri yabancı dillere tercüme ediliyor. Bildirimizde çevirmenler önünde hangi problemler duruyor ve çevirmenlerin çok dilli olmasının olumlu ve olumsuz etkileri hakkında genel bilgi sunmayı düşündük.

Özbek dili, Rus ve Ukrayna dillerini takip eden Sovyet sonrası bölgede üçüncü ve en büyük dildir. Aynı zamanda, milyonlarca, yüz binlerce Özbekçe konuşan insan Afganistan, Türkiye ve diğer ülkelerde yaşamaktadır. Ancak, bölgedeki en büyük dillerden biri olmasına rağmen, Özbek dili hala henüz gerekli makamına ulaşmadı. Özbekistan'ın bağımsız hale gelmesinden bu yana 28 yıldan fazla bir süre geçti ve 30 yıl boyunca Özbek dili resmi dil statüsündedir. Bununla birlikte, geçmişte, Özbek dili tam olarak geliştirilmemiştir ve toplumun yaşamını tam olarak karşılayan ve tüm alanları mükemmelleştiren bir iletişim aracı haline gelmemiştir. Bunların nedenleri çoktur. Bu nedenleri ortadan kaldırmak ve Özbek dilini yüksek makama

kaldırmak yolunda tercümanların işleri büyük önem taşımaktadır. Herhangi bir dilin başarısı, özellikle resmi edebi dilin halk dile mümkün olduğu kadar yakın olması veya çok yakın olmasıdır. Aksi takdirde, resmi dil yalnızca medyaya, devlet belgelerine ve edebi eserlere yansıyan bir fenomen haline gelir ve çekiciliği azalır. Dil gelişiminde çevirmenlerin yeri de ayrıcadır. Çünkü terimler, teknolojiye ait kelimeler ve özel sözleri tercüme edilirken derin bilim ve tecrübeye ihtiyaç duyulur.

Özbekistan'da dil inşası tarihi, ilk bakıldığında daha karmaşık ve dramatik geçtiği görünmektedir. Ülkede önde gelen dil ve yazım uzmanlarının katıl edildiği veya sosyal ve bilimsel faaliyetlerden uzaklaştırıldığını söylemek yeterlidir. Çünkü Özbek edebi dilini yeniden canlandırmanın yolu ciddi bir mücadeleden geçti ve çoğu zaman bilimsel tartışmaların ötesine geçti ve siyasi düzleme taşındı ve tüm özelliklerini yaşadı.

Çeviriyle ilgili en yaygın yanılgılardan biri Çeviriyle ilgili en yaygın yanılgılardan biri, çevirinin iki dillilik (bilingvizim) ile eşanlamlı olduğu ve iki dilin olan herhangi birinin iyi bir tercüman olduğu ve herhangi bir özel eğitime ihtiyacı olmadığıdır düşüncesidir.

"Bilingvizim" terimi, Latince *bi lingua* ("iki dil") cümlesinden türetilmiştir ve iki dilde konuşabilme yeteneği anlamına gelir. Buna göre iki dilli iki kategoriye ayrılır: 1) her iki dili de eşit derecede iyi konuşan kişiler; 2) iki ana dili olan kişiler.

İkinci tür iki dillilik (edinilmiş iki dillilik) gerçek iki dillilik olarak kabul edilir. Dilbilgisel ve sözcüksel seviyelerde telaffuzda ortaya çıkabilen iki dilin sürekli etkileşimini ifade eder. Bu tür iki dil bilen kişiler, aynı anda iki dil öğrenir (bebeklik döneminden itibaren), bu dillerin ana dilini konuşanlar ile aktif olarak iletişim kurar. Onlar için farklı dillerdeki kelimeler ve ifadeler aynı kavramları ifade eder ve genellikle her iki dili de akıcı bir şekilde konuşurlar.

İlk tipteki iki dillilik, her dil farklı zamanlarda ve farklı sosyokültürel bağlamlarda öğrenilmiştir: anadil bebeklikten evde ve ikinci dilin daha sonraki yaşlarda ve farklı bir ortamda (örneğin bir eğitim kurumunda veya sürgünde). Dolayısıyla iki dildeki eşanlamlı kelimeler ve ifadeler genellikle zihinlerinde tamamen farklı konseptlerle ilişkilendirilir.

Genellikle iki dilliler için dillerden biri baskındır. Bu nedenle, iki dilli insanlar genellikle tuhaf aksanla konuşurlar: bir dilin telaffuz özelliklerini ikinci bir dile aktarırlar. Birçok araştırmanın sonuçlarına göre, yetişkinlikte yeni dillerin gelişimi iki diller için tek dilli dillerden çok daha kolaydır. Ancak bu iki dilli insanlara profesyonel tercüman olmak daha kolay olacağı anlamına gelmez.

İki dilli insanlar kelimeleri sözlükten daha farklı olarak yorumlarlar ve bunun tamamen psikolojik bir açıklaması vardır. İki dilli insan genellikle kelimeleri bağlam içinde algılar, yani farklı durumlarda ve istemsiz olarak farklı dillerin eş anlamlılarını tamamen farklı konseptlerle

birbirine bağlar. Bu nedenle, çeviri sürecinde, iki dilli insanlar istemeden yabancı kelimeleri yerel kültürün tanıdık kavramlarına ve fenomenlerine bağlarlar - her ne kadar etnik kavramları ifade eden kelimelerin, politik fikirleri veya sözcük duygularını farklı dil ve kültürlerde tamamen farklı anlamları olsa bile. Bundan çıkan önemli bir sonuç şu: nitelikli bir tercüman olmak için yalnızca bir yabancı dili mükemmel bir şekilde bilmeniz yeterli olmaz, aynı zamanda o dilde konuşanın psikolojisini anlamak için de ihtiyaç vardır. Tercüme süreci, anlamsal teorinin pratik uygulamasıdır (anlam teorisi). Bu nedenle, profesyonel bir tercüman, anlamın tüm tonlarını göz önünde bulundurarak, tek bir kelimedenden cümleye ve metni bir bütün olarak anlayıp çeşitli düzeylerde analiz edebilmelidir.

Sıradan iki dilli insan aksine, yüksek kaliteli bir tercüman her iki dilde yabancı dili konuşanların kültürlerini iyi biliyor ve bu nedenle iki dilli insan eş anlamlı olarak algıladığı kelimelerin farklı anlamlarını da fark eder. Bu nedenle, çevirinin iki dillilikle ilişkilendirilmesine rağmen, bir tercümanın niteliği temel olarak interlinguism tarafından belirlenir yani farklı diller arasındaki benzerlikleri ve farklılıkları hissetme yeteneğinin geliştiğinden.

Birçok modern dil bilgini bu sonuca katılıyor. Birkaç dili bilmek sadece iletişim kurmamıza yardımcı olmuyor, iki dillilik (veya çok dillilik) gerçekten gelişen beyine belli avantajlar sağlıyor. İki dilli bir çocuk sürekli olarak bir dilden diğerine geçtiğinden, teoriye göre, problem çözme, hafıza ve düşünme gibi sözde yüksek bilişsel süreçleri etkin bir şekilde yönetme yeteneğini geliştirir. Diğerlerini uyararak bazı reaksiyonları bastırmaya meyillidir ve genel olarak daha esnek ve canlı bir akla sahiptir. Araştırmacılar bu fenomene iki dilli avantaj diyorlar. Aslında 20. yüzyılın ilk yarısı boyunca, bilim adamları çok dillilik çocuğa dezavantaj sağladığı düşüncesine katıldılar. Dolayısıyla çocuğun zekasına ve konuşma gelişimine zarar verdiğine inanıyorlardı. Ancak, iki dillilik bunun tam tersini yani avantaj sağladığı göstermektedir. Son yıllarda yapılan psikolog Ellen Bialystok'un titiz çalışmalarına dayanan ortaya çıkan sonuçlara bakıldığında iki dilli kişilerin birçok sorunu çözmede mükemmellik gösterdikleri görülüyor. 2012 yılı için yapılan deneysel verilere bakıldığında, iki dilli kişilerin aslında akademik alanda başarılarını belirleyen bilişsel süreçleri daha iyi yönetebildiklerini gösterdi. İki dilliliğin avantaj sağladığı alanlardan en önemlisi yaşlanan beyine yararı olmasıdır. Birkaç dil konuşan yetişkinlerin, bir dilde konuşan yaşlılara nazaran çok daha iyi direnç gösterebilecekleri ortaya çıktı. Bir araştırma sonucunda ise Alzheimer hastalığından olan farklı bir hasta grubuyla, o ve meslektaşları, bilişsel düzey, ana meslek veya eğitimden bağımsız olarak, iki dilli tanıların tek dilli kişilere göre 4.3 yıl sonra yapıldığını gördü. Başka bir deyişle, iki dillilik bilişsel gerileme sırasında koruyucu bir etkiye sahip olması muhtemeldir. Beyin

sürekli öğrenme sürecindeyken, birden fazla dili konuşan kişilerde hafıza zayıflaması çok geç gerçekleştiği görülmektedir. Bu sebeple ikinci, üçüncü veya beşinci dili öğrenmek ve bu dillerle uğraşmak yaşlılarda iyi sonuçları sağlamaktadır. Dolayısıyla çok dillilik faydalı özellikleri çok daha önemli olabilir.

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CHARACTER AND OPERATIONAL STRATEGY OF THE *YAN SHILA BOYS* EXTREMISTS GROUP IN YOLA-NORTH METROPOLIS, ADAMAWA STATE, NIGERIA

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Abstract

Over the years, gangsterism has been one of the major challenges affecting the peace and socio-economic development of Adamawa state. This emerging concern necessitated development partners such as Nkafamiya Rescue -Mission (KR-M), A Non -Governmental Organization (NGO) to organize a workshop to strengthen the capacity of media aids, content creators to Adamawa state government, social media influencers, security units and conventional media outlets on how to raise awareness towards de-escalating the disturbing security threats occasioned by the Yan Shila Boys in Yola-North metropolis. It is on the basis of this security concern a study was undertaken and appropriate research techniques deployed out of the 2-day training workshop. To achieve the objective of the study, the study used a simple survey and in-depth interview method to collect data from the population of the study. Hence, Focus Group Discussion (FGD) and Key Informant Interview (KII) was used in eliciting data from the participants. Findings from the study showed among others that, lack of proper education, poor parenting, poverty, unemployment, and corrupt politicians are responsible for the deadly Yan Shila boys' activities in the study area. Equally, the nature of operations, physical features, financiers. Operational strategies, hiding/breeding grounds were explicitly uncovered in the study. Consequent upon this, it was recommended by the study that, there is need for government collaboration with relevant stakeholders in surmounting the security threats to lives and property in Yola-North metropolis and its environs.

Keywords: Operational strategies, Violence, Yan Shila Boys, Extremism, Yola-North

Introduction

The emerging dynamics of the emergent extreme violence orchestrated by street gangs popularly called *Yan Shila Boys* in Yola North Metropolis has over time posed a great security challenge to the populists in the state. According to Riman tanung, Ishaya, Cletus and Emmanuel (2025); *Yan Shila Boys* are youths who emerged in street larceny terrorizing the residents of Yola – North for years. The bad boys who specialize in snatching of items such as phones, computers, handbags, purses, money among others usually disguise as commercial tricycle operators within the city.

No doubt, the emergence of this deadly street boys' gang has left numerous negative footprints in the physical and psyche of the majority of tricycle passengers, store/groceries keeps, ladies and students etc. The region, given the intense activities of Boko Haram Insurgents for decades, Owonikoko and Momadu (2020) put that, Nigeria is one of the numerous countries with multiple security challenges. These challenges range from banditry, to cattle rustling, kidnapping, armed robbery, terrorism, and military among others, and are orchestrated by organized criminal gangs. The North-eastern region is now tagged as one of the most dangerous in the country, and this is due to the activities of Boko-Haram and while the threat of Boko Haram insurgency is yet to be completely vanquished in the whole of the North-East and Adamawa state, the threat of a dreaded gang called the *Yan shila Boys* has emerged and continued to spread in the State.

It is on the strength of the above effects of the emerging terror gangs that this study considering the nature of the gangster activities, their character, manifestation of operation, modus operandi of the group unveils their breeding grounds with the view of suggesting strategic ways of identifying them for possible security measures.

One of the most concerning of all the emergent issues is juvenile violence by both in-school and out-of school children and young people in communities in Adamawa state. The negative influence of Shila boys seems to be gradually affecting in-school young people. On February, 8, two students of capital secondary school were paraded by the Nigerian police along members of Yan Shila for theft and other criminal activities R.T. (2018).

In a study conducted by opinion Research Business International (2024) reported that;

Respondents in Adamawa state continue to report ongoing Shila Boys activities in Demsa, Mubi North, and Mubi South. The most prevalent crimes associated with the Shila Boys, according to the respondents, continue to be the theft of cell phones. The youth respondents believe that *Yan Shila Boys* prefer to target victims commuting on road outside of urban areas rather than their previous tactic of targeting victims at the entrance of local markets. Also, respondents however, acknowledge that the Shila Boys, continue to terrorize their communities by also committing more severe crimes. Respondents have an overwhelming negative view of the *Yan Shila Boys*. However, the respondents believe young males are susceptible to the group's recruitment efforts due to lack of local employment opportunities.

Statement of the Research Problem

The emergent of the Shila Boys has overheated the already security fragility of Adamawa State being one of the North-eastern states battling with the scourge of Boko-Haram Insurgents, armed violent conflicts between farmers and herders and other internal security challenges. This study was spur by the raising impact of the dreaded street gangs threatening and undermining the peace and tranquillity of commuters, business individuals, vulnerable gender and indeed the entire state.

The security threat, no doubt, has immense economic and social implications on the lives of the citizens. This can be established through various reports on how the activities of the gangsters showcase night business activities. Also, how young in-school boys and girls are morally corrupted through peer influence and other recruitment strategies which obviously differ from the standard norms, values and ideas richly embedded in the culture and tradition of Nigerian society. It is in view of this disturbing trends that this study intends to unravel the nature, character and operational strategies of the Young *Yan Shila Boys* extremist's organization in Adamawa state.

Objectives of the study

The study aims to achieve the following objectives:

1. To identify the basic features of *Yan Shilla Boys* in Yola -North LGA
2. To identify the drivers of *Yan Shilla Boys* violent behavior in Yola-North L.G.A
3. To examine the modus operandi of *Yan Shilla Boys* in Yola-North L.G.A
4. To discuss public perceptions of *Yan Shilla Boys* in Yola-North L.G.A
5. To ascertain the sponsors of the street gangs and their habitations
6. To explore ways of building resilience in youths against violent extremism in Yola-North L.G.A

Methodology

A primary data was sourced and utilized in the study. This study was conducted in collaboration sponsored by Nkafamiya Rescue Mission (NRM), a Non-Governmental Organization with LEAD-Africa. This study was conducted during the 2-day capacity training programme with the theme "Building Resilience of Youths Against Violent Extremism in Adamawa State. During the training, participants were grouped into five for a Focus Group Discussion (GDP), and some respondents were granted interview known as Key Informant Interview (KII). During the two-by training six (6) FGDs, 5 (five) KIIs were carried out among the 55 (fifty-five)

respondents with each FGD Syndicate constituting a minimum of 1-11 participants (see Appendix A).

Being a capacity Building Workshop, participation was drawn using purposive sampling techniques from the 21 (twenty-one) local government areas (LGAs) of the state with specific focus on the representative of Sister's NGOs, Special Assistances (SAs) to the Adamawa State on content creation, social media influencers, media and security agencies among others. The data from the FGD and KII session was examined with secondary information gathered from the textual materials. ‘

Method of Data Analysis

The interview content was filtered thematically. This detailed analytical approach ensured a robust interpretation and transcription of the true reflection of respondents' views regarding the subject matter. Thus, this qualitative research method basically identified, analysed and reported common denominators (themes) within a dataset. Additionally, it involved diligent reading the interpretation of the notes taken during field interview in order to extract meaning, understand, and the different, different perspectives in a concise and harmonized standard.

Literature Review

Underlying Factors to Insecurity in Adamawa State

There are numerous backgrounds to which emergencies concerning insecurity ride in our society. Some factors are more often catalysts to crime manifestation and motivation, to escalating to what we currently have at hand. It is evident that, issues such in Boko-Haram, *Kalare Boys* in Gombe, *Sara Suka* in Bauchi and *Yan Shila Boys* in Adamawa constitute a serious security concern with huge political, social and economic consequences.

This manifestation of threats against human security can be traced to the following fact.

According to World Bank (2021), 74% population in Adamawa State are extremely poor. This poverty rate cut across the inability to afford basic necessity of life such as food, clothing and shelter.

Poverty determines a certain stereotype in a person's thoughts, as he or she does not see any constructive means solving of the problem. as he wants to choose the easiest way of getting money, even by harming other people. Poverty has a huge psychological influence on people, as its makes them depressed, desperate, and then takes to crime. The essence is because as they have not found anything that can legally get them out of such situation (UK Essays, 2021). Unemployment could also be associated with idealness and eventual crime indulgent. According to National Bureau of Statistics (NBS), cited in ThisDay line (2021), Adamawa state has unemployment rate of 54.89%, and underemployment rate of 25.6%. This statistical

discovery is not only significant but alarming. It also implies that, sizeable statistics of youth population in the state are not actively and productively engaged in meaningful production circle, consequently taking to crime becomes inevitable by the youths.

According to (Ideyi, cited in Mercy (2021), the unemployment problem which now seems beyond remedy, has produced amiable hands and some of them have decided to punish the society that fails to provide them with means of livelihood and dignity by robbing its members of their property at gunpoint or with dangerous weapons.

Lack of adequate western education among the vast population of youths in the state can be traced to the prevailing high crime rate and other associated social vices. This also underscores the significance of education (formal and non-formal). In addition, education system often appropriate tools and skills that can be useful in preventing violent extremism by; inculcating critical thinking skills and logic that enable individuals to question ideologies that foster division and crime, New Globe (2023).

Corroborating the obvious deficiency in knowledge acquisition among youths in the state, UNESCO (2022) revealed that there are more than 439,000 children out of school in Adamawa State. Additionally, UNESCF (2025) further affirmed that, about 5 million children are illiterate in northern Nigeria alone and about 15 million are out of school walls. It is therefore, the position of this paper that, it is largely the non-educated population in the state birth by the non-school population that presently constitutes or poses a great challenge to the vast majority of the state.

Substance abuse equally serves as a motivating factor to the growing insecurity in Adamawa State. Aside the health implications of taking hard drugs and smoking herms and cigarettes, substance abuse aids poor moral conducts and by implication escalates crime tendencies among the abusers. Literatures bothered with the facts that, substance abuse prevalence in Adamawa State is high as such, substantiating the assertion, put forth by the substance abuse addiction severely index that, Adamawa State ranks 3rd in substance abuse in North-eastern Nigeria with 370,000 drug users.

Empirical Review

This segment is crucial to this study because it establishes the basis of this study and how it differs from previous researchers by identifying gaps and forming a new direction of understanding the subject matter.

Stephen, Ishaya, Cletus and Emmanuel (2024), carried out a study entitled “The origin and Modus Operandi of Yan Shila Street Gang in Yola Metropolis of Adamawa State, Nigeria”. The study used content and analysis and relied. Secondary data in generating information for

the study. Owonikoko and Momodu (2020), also conducted a study titled; “Beyond Proscription”: Rethinking Government Response to *Yan Shilla Boys* Gang Violence in Yola Metropolis of Adamawa State, Nigeria.” In the study, primary and secondary data were sourced and utilized. The research used in-depth interview and Focused Group Discussion (FGD) in eliciting useful information from the respondents. The study basically focused on the efficacy of the government proscription of the terror group with the view to understanding the prospects or otherwise the policy statement in curbing the scourge of the new security concern in the state. In a similar study. Balogun’s (2019) “The causes and consequences of *Yan Shilla’s* street Robbery in Adamawa State, Nigeria” primarily focused on the genesis, causes and consequences of the street gangs. The research leveraged primary data and uses descriptive analytical techniques on the data generated from questionnaires.

While Stephen *et al* (2024) dwelled more on the origins and modus operandi, the paper failed to extensively reveal empirically how the Shila boys operated and caused mayhem to the community.

Knowledge Gap

This study differs from the existing works in two distinct ways; (a) The variables (b) Methodology. The variables under this study characterized the nature and features of the Shila Boys; A critical review of previous studies suggests that this study is more current, in-depth in revealing some of the hidden features, characters, places of operandi proceeding groups and strategies of crime manifestations by the sect.

Thus, this study obviously expands the boundary of existing knowledge and provides fresh perspective towards understanding the subject matter.

Owonikoko and Momodu (2020), work was more on the policy analysis of proscribing the street gangs. The study did not achieve much in the evolving dynamics of the new security threat in Yola metropolis. Equally, Balogun (2019) dwelled mainly on the factors motivating the social unrest by the gangsters and highlighted some of the socio-economic and political consequences of the emerging society issues. The study in actual sense, was carried out at the infant stage of the *Yan Shila Boys* activities in Yola-North and Yola-South of Adamawa State. The study however, did not envisage the current prevailing dynamics of the *Yan Shila Boys* activities.

Field Work: Data Presentation and Analysis

It is the interest of this study, first to have a working knowledge towards conceptualizing the Shilla Boys as regards to who they are. This is to enable us understand the nature and composition of this deadly extremist’s organization called the Shilla Boys. During the interview session, the group unanimously defined that; the *Yan Shila Boys* as:

a violent group consisting of boys and girls. They are also notorious individuals or group who are usually using force harassing people with the aim of collecting their belongings in both public and private places. (FGD: Yola North LGA; April, 2024).

A resident of Jambutu Ward Succinctly defined Shilla boys as;

Boys and girls who decided to take the laws for granted by carrying heavy weapons to terrorize innocent citizens of the state by forcefully collecting their belongings such as mobile phones, laptops (computers) and other related valuable items. These boys and girls are within the age brackets of (18-25 years old). (KII: Jonathan, Jambutu Ward: Yola North L.G.A., April, 2024).

Another view of the FGD earmarked Group B defined Shilla gang as:

Group of young boys and few girls mostly teenagers between the age of 13-21 that are popular for attacking people with the aim of taking their cell phones, hand bags, usually in isolated locations, at night and mostly in a moving Keke-Napep at night. (FGD: Group B; April, 2024).

What is central to the description of the Shilla Boys is that, it does not only constitute Boys, girls are also involved as collaborators in aiding and abating the smooth robbery of peoples belonging. According to Group 2 of the training session/syndicate:

The girls are normally the ones responsible for selling the snatched mobile phones, computer (laptops) and other gadgets. This role is clearly achieved because of the less impression of women (girls) involving in criminal act (FGD: Group 2, April, 2024).

The next objective of this research is to understand the age categories of the *Yan Shila Boys*. This is critical because understanding the demography involved would give proper guide on how to arrest the emerging extremist group in the state. The Tapestry of age brackets as provided by all the groups include the following:

“Age bracket of the *Yan Shila Boys* are (15-30) (18-28), (15-20), (19-24) etc. (FGD: Summary of Group 1,2 and 4; April, 2024).

What is important to note is that, the harmonized age bracket of the *Yan Shilla Boys* covered within the age of (15 – 30).

This implies that, those involved in these acts of terror are within their prime age, akin to say they are in their most productive age.

Having known who the “Shilla Boys” are, this segment unveils the features of the extremist organization.

During a KII with Suleiman Abubakar, one of the active participants during the capacity building workshop revealed the following fears of the terror groups:

The features according to Suleiman include but not limited to the following.

Dreaded hair locks, shabby dresses, fond of using abusive language and aggressive in approach especially inside keke-napep, walk in groups, have strange nick name leave bushy hair, own keke-napep and disguising as commercial riders, walk with mobile radio playing western music at high volume, inside keke-napep on the streets, visible sign of drug addiction and black lips suggesting smoking tobacco, weed (Indian hem, wear red and yellow outfits in most cases, more in pairs, wear short knickers or long (overall) to enable them hide weapons for operations (KII, Abubakar Suleiman, capacity building workshop, April, 2024).

The above explicit information about their appearance and other related characteristics of the extremist group implies that, there is a high level of moral decadence, low education and poor religious teachings among them. This also infers how low our society is as regards to discipline, morality, norms, values, ideal and general sound culture that our society is known for.

In exploring the causes of the emerging terror groups in Yola, North, Yola South and Giere L.G.A.s.

Group 3 of the capacity building training have this to say;

“Poor parenting, unemployment, peer group influence, drug addiction, increase population due to uncontrolled birth rate, laziness and impatient attitudes among the age group, lack of proper religion and western education, political influence (FGD: Capacity Building Training, April, 2024).

Gleaning from the above inputs, it is apparent that lack of sufficient education and laziness coupled with overwhelming influence of political the elite in the state are the dominant reasons or causes of the emergent of this extremist group in the study area. In a KII with one of the respondents during the training;

Most of this *Yan Shila Boys* are political machineries- “Thugs” of top politicians in the state. Majority of the “bad boys” are school dropout while few of them are still in schools as spoilers (influencing younger ones through bad behaviours and other related recruitment strategies. What can’t be overlooked as well is the laziness aspect of the “boys” usually misconstrued or misinterpretation to be unemployed or under-employed (Faith Bulus Ba, April, 2024).

Analyzing the submissions with respect to unemployment status of the “Shilla Boys” the question begging for answers is, since it is established that majority of the terror group operates with keke-napep as commercial riders, this suggests that, unemployment does not really constitute the case of the extremists’ group. Although, further investigation revealed that, the “Shilla Boys” are sometimes leveraging friends with Keke-Napep to perpetuate their operations.

Mode of operation of the *Yan Shila Boys* has been investigated. A group discussion with Group C revealed that some of their method of operation are;

Stabbing their targets with daggers, cutlass or sharp object. Through the of a moving keke-napep (tricycle) disguising as passengers only to reveal their true identity after picking innocent passenger irrespective of gender. They move round communities looting shops at night and sometimes during the day in isolated locations. They usually operate a high number of not less than 10 during looting of shops (provision or gadgets stores). They used marchet, cutlasses heavy sticks during operations and other related shop objects (FGD, Capacity Building Workshop, April, 2024).

Through further investigation with a KII, one of the participants indicated that;

A *Yan Shila Boys* can kill human being because of a cell phone of less than ₦10,000. This is how desperate they are (Suleiman Abubakar, Capacity Building Training, April, 2024).

In agreement with the above revelation, news reports through credible sources revealed that *Yan Shila Boys* have killed people and injured a lot during their operations.

Who are the targets of the *Yan Shila Boys*? Through a KII, one of the respondents during the capacity building workshop showcased that; the target of the *Yan Shila Boys* are as follows:

Strangers, young ladies carrying smart phones openly, those with expensive Jewries, business, business men with provision stores, business centres, passengers inside keke-napep (tricycle), gentle and innocent looking personalities, those carrying belongings at night, students carrying laptops (Aisha Birma, Capacity Building Workshop, April, 2024).

This invariably implies that, Vast majority of the people are their targets especially those that are not security conscious, unfortunate to be where they are not supposed to be or those accidentally caught in the web of their activities.

At what specific hours of the day or night do the *Yan Shila Boys* operate the most. Discussing with Group 1 and 2 in the capacity Building Workshop, the following views on the most dangerous time used by the *Yan Shila Boys* were mentioned and named:

“Shilla Boys” operate at very early hours of the day – very early in the morning such as 4:00am, 4:30am, 5:00am or there about. Equally, rush hours in the evening is also a fertile opportunity for them and late night.

Group 2 unanimously said 900pm up-ward is the most dangerous hours; specifically, 10:00pm-12: am.

Who are the sponsors of the *Yan Shila Boys*? Respondents confidently alleged that:

Corrupt politicians are said to be the breeders and sustainers of the “Shilla Boys”, drug dealers or Barons, self sponsorship, corrupt security personal, those selling used mobile phones in shopping complex (FGD, Capacity Building Workshop, April, 2024).

The above alleged sponsors of *Yan Shila Boys* are said to be those aiding and abiding *Yan Shila Boys* organization in Yola-North Local Government Area.

Buttressing the role of some bad politicians in sponsoring insecurity, Elaigwu (2013) revealed that;

More Often, politicians hire thugs and young people to unleash violence on their opponents-even within the same political parties. It has been alleged that the militancy in the Niger-Delta took on criminal dimensions after the 2023 elections. Politicians reportedly enhanced criminal activities of the extremist's recruited young cult members into their army of political thugs over whom they lost control, after the elections. These group became monsters and were even threats to their erstwhile masters. In addition, some governors courted and pampered religious and youth groups for political purposes, only to have these eventually boomerang on them, as well as the system. Group such as *Yan Kalare*, *Sara Suka* are examples of these extra-constitutional armed groups which specialise in democratizing violence on behalf of their pay masters...Thus ,politicians, in and out of government, are therefore the greatest generator of conflicts, because they do not perceive politics as a game, but a battle.

Where are the habitants of the *Yan Shila Boys*? The place where the bad elements are mostly initiated and recruit new members was revealed during the KII;

The *Yan Shila Boys* are mostly domiciled in sachet water factories, sport betting centres, football viewing centre, uncompleted building in isolated communities (KII: Sale Ahmed, Capacity Building Workshop, April, 2024).

Equally, Suleiman Abubakar emphatically emphasized that:

“Some sachet (pure) water factories in Yola-North are the major accommodation providers of the “Shilla Boys” disguising as employees of the water factories.

The above discovery is the most frightening aspect the research as, those assumed to be employed and provide goods and services for societal development are those motivating the bad elements,recruiting more members and providing shelter to those causing violent upheavals in the society.

Highlights of Key Findings

1. The *Yan Shilla Boys* are notorious elements in Yola North L.G.A. constituting young boys in collaboration with young girls who usually serve as spy and means for selling snatched gadgets from innocent people.
2. The major causes of the extremist organization are largely laziness, cheap means to success, peer influence and lack of proper education, poor parenting and general decline in moral standard in the society.
3. Their basic mode of operation is disguising either as passengers or keke-napep. Commercial rider terrorising innocent people with the aim of forcefully collecting their belongings (cell phones, laptops) and sometimes breaking of provision stores through violent means at any hours of the day or night.
4. Most-vulnerable time are early hours of the morning (4:00am-6:00am), 9:00pm – 12:00pm and sometimes in afternoon hours, depending on the location and opportunity available for them to strike.
5. The age bracket of this dangerous group is 18-28 years old.
6. The most vulnerable locations in Yola North include but not limited to Dubelli Junction, Jambutu, NEPA, Shinko, Luggere, Ribadu square, Badiris , Bekaji road etc.
7. The “*Yan Shila Boys*” targets are mostly females, innocent looking passengers, provision stores, tertiary students of tertiary institution etc.
8. The feasible features include; crazy hair style, rough dressings, playing loud music inside Keke-Napep or walking on the streets with small loud speakers.
9. Their sponsors include; corrupt, elements disguising as politician sachet water factory owners, those building them after arrest and sometimes self-sponsored.

Conclusion

The study, through in-depth investigation gives credible insights into the nature, character and operational methods of the extremist’s organization popularly known as the *Yan Shila Boys* in Yola-North metropolis. Analysis from the respondents shows that, the *Yan Shila* gangs are nuisance to the society and are more often a dreaded organization.

The study, through credible sources showcased who the *Yan Shila Boys* are, what they represent and how do they look like, who their sponsors are, their dangerous spots or hideouts, and their targets.

The implication of this revelation suggests that there is more to be done to nip in the bud the growing level of violent extremists given the fact that, Boko-Haram Insurgents are active in some remote parts of the state. The state should prioritize formal and non-formal education with

the aim of engaging the youths and bringing out the potentials in them as a crime prevention strategy. Also, the government should focus more in strengthening intelligence mechanisms and physical security presence in most vulnerable wards in the metropolis. The habitants of the *Yan Shilla Boys* should be crackdown and their sponsors faced the full weights of the law to serve as deterrents to potential breeders of the street gangs. It is on this premise that, this paper calls on the state government to carryout a total overhauling and security screening of all sachet water factories across the metropolis with a view to dislodging the network and breeding grounds of the extremist organization. The state should collaborate actively with the Keke-Napep riders associations towards identifying the fake riders collaborating with the *Yan Shilla Boys*.

Secondary school administrators and teachers should be given all required support to battle the menace of this extremist group, since secondary school has been a recruitment ground for the street gangs. Thus, equipping the management with security support would go a long way in breaking the circle of indoctrination and recruitment of young innocent boys and girls in secondary schools.

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**ISOLATION OF *AEROMONAS BESTIARUM* IN RAINBOW TROUT
(*ONCORHYNCHUS MYKISS*) AND DETERMINATION OF ANTIBACTERIAL
RESISTANCE PROFILE**

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ABSTRACT

Aeromonas species are microorganisms that can cause clinically significant diseases in both fish and humans. The objective of this study was to isolate bacterial pathogens from samples of fish infected with Aeromonas species, determine the antibiotic susceptibility profiles of the Aeromonas isolates, and investigate their antibiotic resistance. Ten rainbow trout with symptoms of the disease were used as examination samples. After necropsy, bacterial isolation and identification were performed from the injured organs. Culture confirmation and species identification were performed using MALDITOF MS (Bruker Daltonik MALDI Biotyper). The phenotypic antibiotic susceptibility of Aeromonas isolates was determined using the Kirby-Bauer disk diffusion method, and the results were evaluated according to the Clinical and Laboratory Standards Institute (CLSI) standards. For phenotypic resistance, commercially prepared ready-to-use antibiotic discs belonging to the antibacterial groups Tetracyclines (Doxycycline DO-30, Oxytetracycline T-30), Carbapenems (Imipenem IMP-10), Penicillins (Ampicillin AM-10, Penicillin P-10, Amoxicillin AX-25), Amoxicillin/clavulanic acid AMC-30, Folic acid synthesis inhibitors (Trimethoprim/sulfamethoxazole SXT-25), Quinolones (Enrofloxacin ENR-5), Aminoglycosides (Streptomycin S-10, Kanamycin K-30, Gentamicin GM-10), Amphenicols (Chloramphenicol C-30), Macrolides (Erythromycin E-15, Azithromycin AZM-15) were used. An expression analysis of the antibacterial resistance genes BlaACC, sul1, tetA, and hfq was performed. Aeromonas bestiarum isolates exhibited phenotypic resistance to ampicillin, penicillin, amoxicillin, and erythromycin. Comparative genotypic analysis of the resistance genes BlaACC, sul1, and tetA with the reference strain

revealed expression of gene segments. It was concluded that *Aeromonas bestiarum* agents cause severe infections in rainbow trout. Therefore, it is recommended to isolate the agent from diseased cases and select the antibacterial agent using antibiograms.

Keywords: *Aeromonas*, bacterial isolation, fish, antibiotic resistance, trout.

ÖZET

Aeromonas türleri, hem balıklarda hem de insanlarda klinik olarak önemli hastalıklara neden olabilen mikroorganizmalardır. Bu çalışmanın amacı, *Aeromonas* türleriyle enfekte olmuş balık örneklerinden bakteriyel patojenleri izole etmek, *Aeromonas* izolatlarının antibiyotik duyarlılık profillerini belirlemek ve antibiyotik dirençlerini araştırmaktır. Hastalığın belirtilerini gösteren on gökkuşağı alabalığı inceleme örneği olarak kullanıldı. Nekropsi sonrasında, yaralı organlardan bakteri izolasyonu ve tanımlaması yapıldı. Kültür doğrulaması ve tür tanımlaması MALDITOF MS (Bruker Daltonik MALDI Biotyper) kullanılarak yapıldı. *Aeromonas* izolatlarının fenotipik antibiyotik duyarlılığı KirbyBauer disk difüzyon yöntemi kullanılarak belirlendi ve sonuçlar Klinik ve Laboratuvar Standartları Enstitüsü (CLSI) standartlarına göre değerlendirildi. Fenotipik direnç için, antibakteriyel gruplara ait ticari olarak hazırlanmış kullanıma hazır antibiyotik diskleri Tetrasiklinler

(Doksisiklin DO-30, Oksitetrasiklin T-30), Karbapenemler (İmipenem IMP-10), Penisilinler (Ampisilin AM-10, Penisilin P-10, Amoksisilin AX-25), Amoksisilin/klavulanik asit AMC-30, Folik asit sentez inhibitörleri (Trimetoprim/sülfametoksazol SXT-25), Kinolonlar (Enrofloksasin ENR-5), Aminoglikozitler (Streptomisin S-10, Kanamisin K-30, Gentamisin GM-10), Amfenikoller (Kloramfenikol C-30), Makrolidler (Eritromisin E-15, Azitromisin AZM-15) kullanıldı. Antibakteriyel direnç genlerinin

BlaACC, sul1, tetA ve hfq'nun ifade analizi yapıldı. *Aeromonas bestiarum* izolatları ampisiline, penisilin, amoksisilin ve eritromisine

Fenotipik direnç gösterdi. BlaACC, sul1 ve tetA direnç genlerinin referans suşla

Karşılaştırmalı genotipik analizi gen segmentlerinin ifadesini ortaya koydu. *Aeromonas bestiarum* etkenlerinin gökkuşağı alabalığında

Ciddi enfeksiyonlara neden olduğu sonucuna varıldı. Bu nedenle etkenin hastalıklı vakalardan İzole edilmesi ve antibiyogramlar kullanılarak antibakteriyel etkenin seçilmesi önerilir.

Anahtar kelimeler: *Aeromonas*, bakteriyel izolasyon, balık, antibiyotik direnci, alabalık.



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