1. ULUSLARARASI

PAMUKKALE

Bilimsel Araştırmalar ve İnovasyon Kongresi

15-16 Mart 2026

DENİZLİ

EDİTÖRLER :

DOÇ. DR. FARUK GÜN

DR. ALPER GÜNGÖREN

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KONGRE KİTABI

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CONGRESS ID

CONGRESS TITLE

1. INTERNATIONAL PAMUKKALE SCIENTIFIC RESEARCH AND INNOVATION CONGRESS

DATE AND PLACE

15-16 MARCH 2026 DENİZLİ/ TÜRKİYE ONLINE PRESENTATIONS

ORGANIZATION

ISARC Academy INTERNATIONAL SCIENCE AND ART RESEARCH CENTER

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Scıentific Development and Innovative Approach

1th INTERNATIONAL PAMUKKALE SCIENTIFIC RESEARCH AND INNOVATION CONGRESS
15-16 MARCH 2026/ DENİZLİ-TURKİYE

Congress Program

Participant Countries:

ALGERIA/BANGLADESH/GEORGIA/INDIA/MOROCCO/UKRAINE/USA/UZBEKISTAN/ RUSSIA/PAKISTAN

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TECHNICAL INFORMATION

Make sure your computer has a microphone and is working. You should be able to use screen sharing feature in Zoom. Attendance certificates will be sent to you as pdf at the end of the congress. Moderator is responsible for the presentation and scientific discussion (question-answer) section of the session. **Before you login to Zoom please indicate your name surname and hall number, exp. Hall-1, Fatih KARİPOĞLU**

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MEETING ID: 842 2217 2958

PASSCODE: 405997

https://us06web.zoom.us/j/84222172958?pwd=nAjV2DCnsggJIEa5bKJ8YXxTeAniuX.1

16.03.2026 / Hall-1, Session-1

ANKARA LOCAL TIME

10 ^{00} : 11 ^{00}

MEETING ID: 842 2217 2958

PASSCODE: 405997

HEAD OF SESSION: *Assist. Prof. Dr. Alper GÜNGÖREN*

TOPIC TITLE	AUTHORS	AFFILIATION
Quantıtatıve Evaluatıon Of The Geosıte Potentıal Of Su Batan Cave (Kastamonu)	Prof Dr.Ekrem MUTLU Yasin BOZTEPE	Kastamonu University
Kızılırmak Havzası Delice Kolu Kırgıbayır (Badlands) Topoğrafyasının Eğitici Jeosit Potansiyeli	Prof. Dr. Ekrem MUTLU Halise YILDIRIM	Kastamonu University
Farmers' Knowledge and Practices on Antibiotic Use, Resistance, and Residues in Livestock Production: Evidence from Kastamonu, Türkiye	Assist. Prof. Dr. Alper GÜNGÖREN Assist. Prof. Dr. Sedat GÖKMEN	Kastamonu University
Comparative Analysis Of Passive Design Strategies İn Office Buildings İn A Temperate Oceanic Climate Based On Climate Data: The Case Of Melbourne	Ayberk PAŞAOĞLU Ezgi YILMAZ	Istanbul Aydin University

16.03.2026 / Hall-2, Session-1

ANKARA LOCAL TIME

10 00 : 11 30

MEETING ID: 842 2217 2958

PASSCODE: 405997

HEAD OF SESSION: *Lect. Dr. Serkan DURMAZ*

TOPIC TITLE	AUTHORS	AFFILIATION
An Examınatıon Of The Investment Behavıors And Rısk Profıles Of Pamukkale Unıversıty Students	Mesut TUR Lect. Dr. Serkan DURMAZ	Pamukkale University
An Examınatıon Of The Effects Of Investment Behavıors On Unıversıty Students' Future Anxıety And Fear Of The Future	Cengizhan ÖZDEMİR Lect. Dr. Serkan DURMAZ	Pamukkale University
Non-Medıcal Use Of Methylphenıdate Among Medıcal Students: An Emotıon Regulatıon Perspectıve	Büşra ÇİFTÇİ Umut KIRLI Hür HASSOY	Ege University
Evaluatıon Of Lıp Anthropometry In Young Adults Usıng The Dırect Measurement Method: Sex Dıfferences	Aysun GÜLER KANTER Zeynep GÜL APAL	Kilis 7 Aralık University
A Lıterature Revıew On Aı-Supported Wrıtıng Skılls At The Secondary School Level	Pınar KAVUŞTU Ceren CIVLAN	Habaş Mehmet Rüştü Başaran Bilim ve Sanat Merkezi
Hierapolis Plutonion: Subterranean Cults, The Life–Death Cycle, And The Continuity Of Sacred Space	Hüma ZEYBEK	Kapadokya University

16.03.2026 / Hall-3, Session-2

ANKARA LOCAL TIME

10 30 : 12 30

MEETING ID: 842 2217 2958

PASSCODE: 405997

HEAD OF SESSION: *MUHAMMAD FAISAL*

TOPIC TITLE	AUTHORS	AFFILIATION
Exploring The Antidiabetic And Neuroprotective Properties Of Shahtara (Fumaria Indica) In Uncontrolled Diabetes	Tasawar Iqbal Sidra Altaf	University of Agriculture
Integrated Solar Desalination With Thermal Storage And Energy Recovery	Badre Zinaoui, Pr.Labjar Najoua, Pr.EL Hajjaji souad, ELABBARI Chaimaa	Mohammed V University/MOROCCO
Precision Fertilization And Sustainable Practices For Environmental Protection	ELABBARI Chaimaa Pr. Labjar Najoua , EL BOUZIDI Ahmed , ZINAOUI Badre , Pr.EL Hajjaji souad	Mohammed V University/MOROCCO
Sustainable Soil Management Practices for Environmental Protection	ELABBARI Chaimaa , Pr. Labjar Najoua , EL Ouali Ouijdane , EL BOUZIDI Ahmed , ZINAOUI Badre , Pr.EL Hajjaji souad	Mohammed V University/MOROCCO
Machine Learning in Entertainment	K.S. KAMALESWARAN B. MADHAN KUMAR DR. S. SELVAM	S. Vellaichamy Nadar College/INDIA
Results For Results For P-Derivations İn Left Near-Rings	Abdelkarim BOUA	Sidi Mohammed Ben Abdellah University
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AI-Enhanced Supply Chain Optimization in the Digital Era	MUHAMMAD FAISAL	System Development Specialist (CCT/NSER) at CRISP World Bank Project BISP

16.03.2026 / Hall-4, Session-2

ANKARA LOCAL TIME

10 30 : 12 30

MEETING ID: 842 2217 2958

PASSCODE: 405997

HEAD OF SESSION: *Dr.Iram SHAHZADI*

TOPIC TITLE	AUTHORS	AFFILIATION
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Potent Antifungal And Antibacterial Activity Of Saharan Actinomycetes Against Major Phytopathogens	Fedwa BEGHDADI El-Hadj DRICHE	Hassiba Benbouali University
Physiological Characterization And Growth Kinetics Of Bioactive Saharan Actinobacteria	Fedwa BEGHDADI El-Hadj DRICHE	Hassiba Benbouali University
Optimization Of Culture Conditions Using RSM And Solvent Extraction Of Bioactive Metabolites	Fedwa BEGHDADI El-Hadj DRICHE	Hassiba Benbouali University/ALGERIA
Detoxification Of Feed Using Lactic Acid Bacteria	Kutlieva G.D., Turaeva B.I., Kamolova H.F, Shonahunov T.	Institute of Microbiology of the Academy of Sciences of the Republic of Uzbekistan
Investigating The Catalytic And Antimicrobial Properties Of Ternary Cesium/Polyethylene Glycol-Sro Supported By Molecular Docking And DFT Analysis	Dr.Iram Shahzadi Ali Haider Muhammad Ikram	University of Management and Technology/ University of Agriculture/ Government College University/PAKİSTAN
Optimization of Green Hydrogen Production by Solar-Driven Photocatalysis	Chaimae Assata	Mohammed V University
A Problem of Implementing Representation	HASSAN ZARIOUH MOUNIA MOUZOURI	Mohammed First University

16.03.2026 / Hall-5, Session-3

ANKARA LOCAL TIME

10 [30] : 12 [15]

MEETING ID: 842 2217 2958

PASSCODE: 405997

HEAD OF SESSION: *Dr. Muhammad Ali Raza*

TOPIC TITLE	AUTHORS	AFFILIATION
Information Technology Management in Environmental Studies Programs: Enhancing Sustainability through Digital Integration	Md Iqbal Hossain , Moynul Islam Bahar , Md Bani Amin , Aspiya Akter , Rakib Ul Hasan	St. Francis College/Bangladesh University/BANGLADESH/USA
A Conceptual Framework for Integrating Artificial Intelligence into Strategic Management Processes	KMD Bhavani Renuka Abburu Dr. G. Sudhakar	------
An Adaptive EWMA Control Chart Based on Conway-Maxwell-Poisson Distribution for Dispersed Count Data with Applications in Industrial Processes	Dr. Muhammad Ali Raza Noor Ul Huda Tahir Nawaz	Government College University
Matricaria chamomilla L.: A Review of Ethnomedicinal Use, Phytochemistry, and Pharmacological Potential for Valorization in the Central Plateau of Morocco	Jaayefar, Fatima-ezzahra Dahmani, Jamila	Ibn Tofail University
Ocimum basilicum L.: A Review of Ethnomedicinal Use, Phytochemistry, and Pharmacological Potential for Valorization in the Central Plateau of Morocco	Jaayefar, Fatima-ezzahra Dahmani, Jamila	Ibn Tofail University
Arts-Based Methods And Vısual Educatıon For Supportıng Adults Wıth Autısm: Theoretıcal Foundatıons And Experıences	ZSUZSANNA HEDVIG SZIKORA	JOHN WESLEY THEOLOGICAL COLLEGE
Defect-Induced Electronic Structure Modulation İn Cr-Doped Cus Nanostructures: Experimental And COMSOL Multiphysics Investigation For Energy Storage Applications With Perspectives Toward Quantum Defect Engineering	Muhammad Ijaz Khalid, Muhammad Yasin Naz, Shazia Shukrullah	University of Agriculture Faisalabad

16.03.2026 / Hall-6, Session-3

ANKARA LOCAL TIME

10 [30] : 12 [15]

MEETING ID: 842 2217 2958

PASSCODE: 405997

HEAD OF SESSION: *DR.Kamal El Fallah*

TOPIC TITLE	AUTHORS	AFFILIATION
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An Integrated Methodological Framework For Ensuring Maritime Navigation Safety And Protecting The Marine Ecosystem Of The Republic Of Kazakhstan	Zhumayev Zholdybay Anatoli Nikolayevich Popov	Maritime Academy/Admiral Ushakov Maritime State University/RUSSIA
Environmentally-Oriented Methods For Protecting Telecommunication Equipment Of 4g Systems In The Kuryk Seaport Of The Republic Of Kazakhstan, Ensuring Operational Reliability And Minimizing Ecological Impact	Zhumayev Zholdybay Jerkin Ergeshovich Subanov-	Maritime Academy/Admiral Ushakov Maritime State University/RUSSIA
Predicting Climate-Driven Shifts İn Sweet Cherry (Prunus Avium L.) Suitable Habitats İn The Fes-Meknes Region Of Morocco Using Maxent	DR.Kamal El fallah, Amine Amar , Zahra El kettabi , El hassan Mayad , Miloud Maqas Jamal Charafi	University Ibn Tofail/Al Akhawayn University
Gel-Polymer Electrolytes Made From Polyacrylonitrile, Designed For Sodium-İon Batteries	Santu Khatua Ajay Shrivas Patit Pawan Kuila Mohan Murari Kanwar Sourav Panda	Dr. C.V. Raman University/(Govt Naveen College/Kolhan University/INDIA
Global Research Trends On Moroccan Medicinal Plants: A Bibliometric And Science Mapping Analysis (2000–2025)	Boutaina Louafi Sarah Abou el anouar Rania Akoh Meryem Benjelloun	Sidi Mohamed Ben Abdellah University
Energy-Efficient Capacitive Deionization Desalination Using A Pulsed Resonance Control Strategy	Abdelbast Karbal , Hassan Naanani ,Driss Bougmoum ,DRISS Azdem , JAMAL Mabrouki , Mustapha Faraji ,Guemimi chafik	Hassan II University/Mohammed V University

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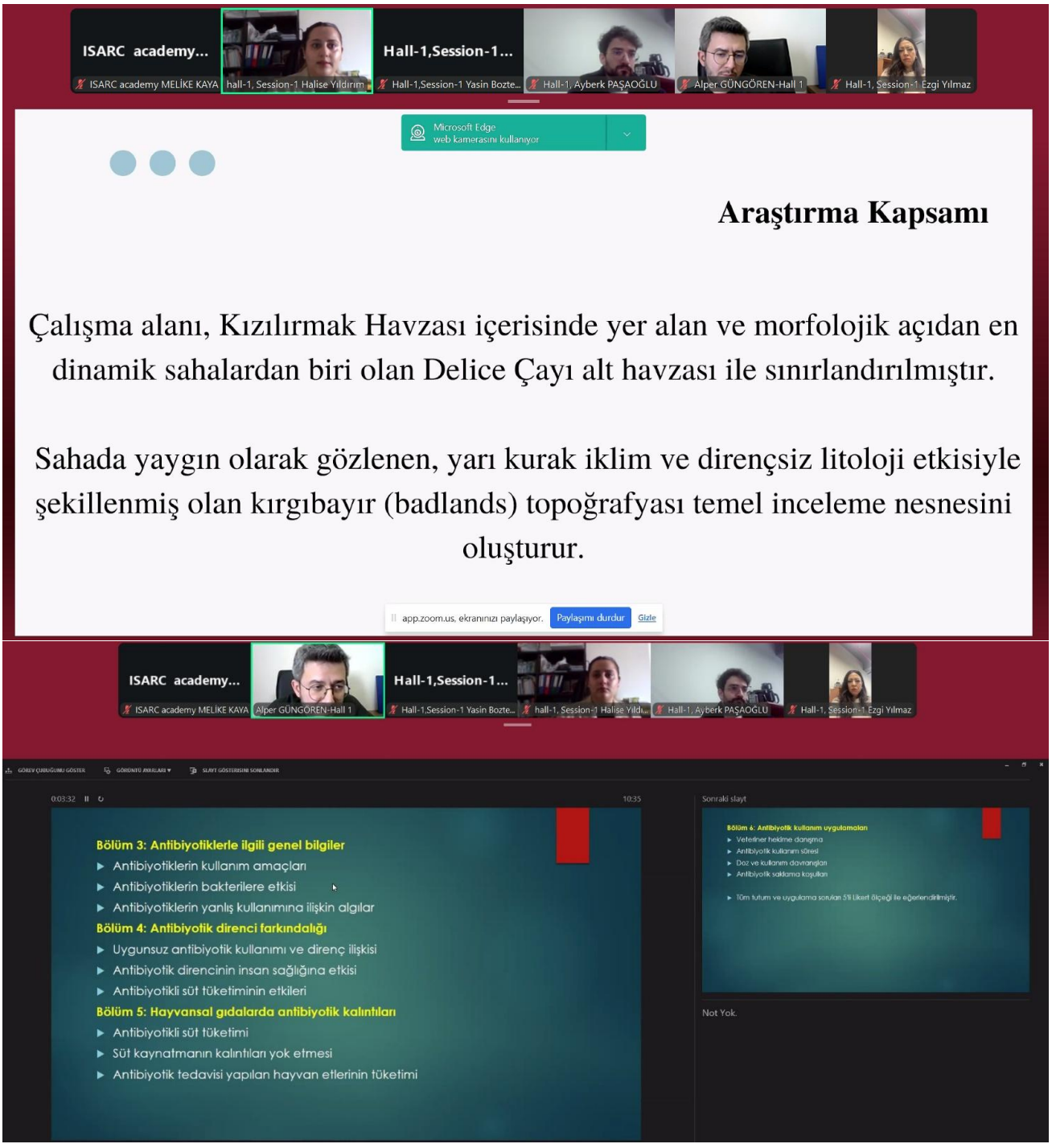

ÇALIŞMA ALANI COĞRAFİ ÖZELLİKLERİ

•**Su Batan Mağarası**, Kastamonu ilinin Pınarbaşı ilçesi sınırlarında, Batı Karadeniz Bölgesi'nde yer almaktadır.

- Çalışma alanı, Küre Dağları sisteminin güney kesiminde bulunmakta ve gelişmiş **karstik morfoloji** özellikleri göstermektedir.
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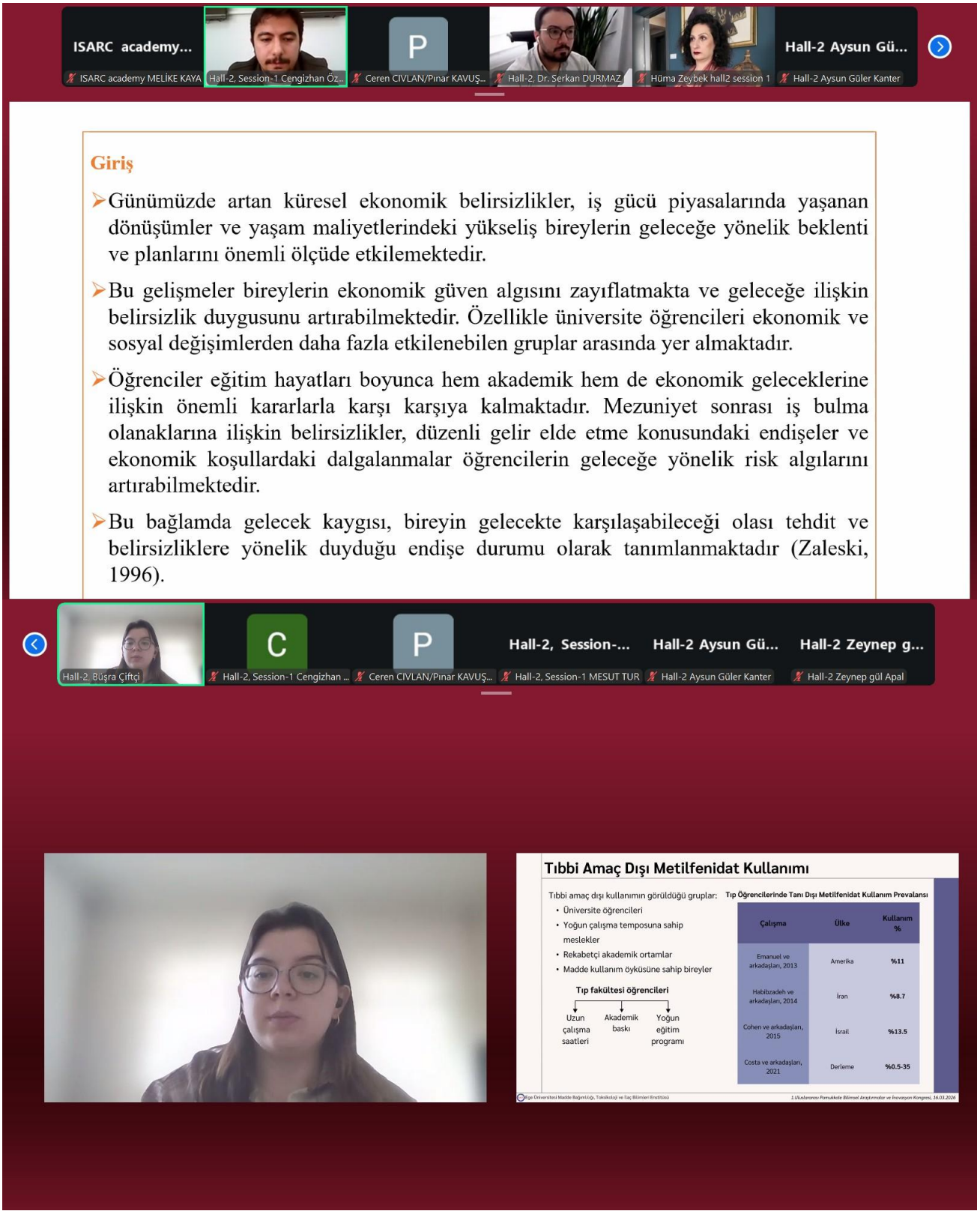
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ISARC academy MELİKE KAYA
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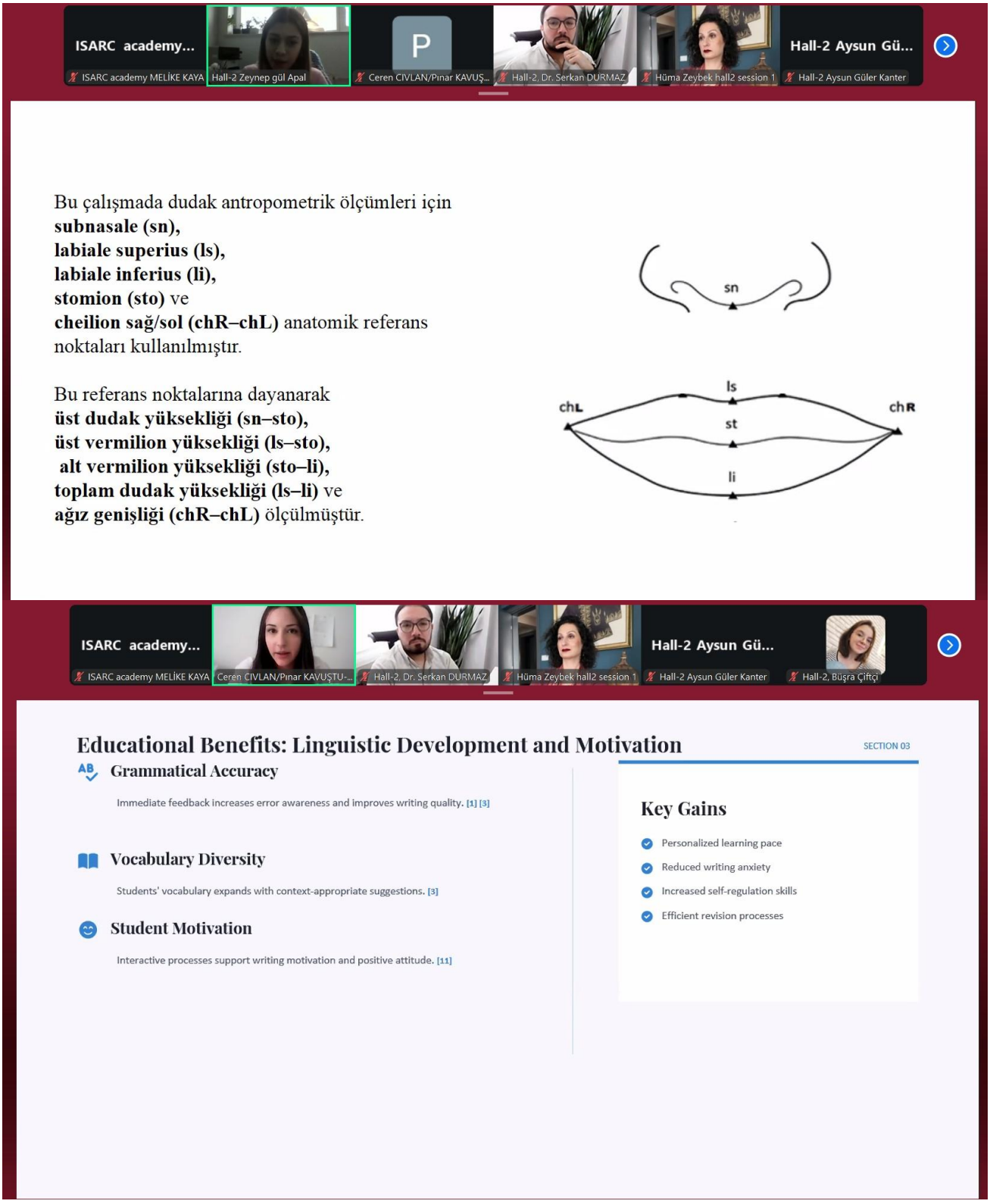
Ceren CIVLAN/Pınar KAVUŞ...
Hall-2, Dr. Serkan DURMAZ
Hüma Zeybek hall2 session 1
Hall-2 Aysun Gü...
Hall-2 Aysun Güler Kanter
Giriş
Günümüzde artan küresel ekonomik belirsizlikler, iş gücü piyasalarında yaşanan dönüşümler ve yaşam maliyetlerindeki yükseliş bireylerin geleceğe yönelik beklenti ve planlarını önemli ölçüde etkilemektedir.
Bu gelişmeler bireylerin ekonomik güven algısını zayıflatmakta ve geleceğe ilişkin belirsizlik duygusunu artırabilmektedir. Özellikle üniversite öğrencileri ekonomik ve sosyal değişimlerden daha fazla etkilenebilen gruplar arasında yer almaktadır.
Öğrenciler eğitim hayatları boyunca hem akademik hem de ekonomik geleceklerine ilişkin önemli kararlarla karşı karşıya kalmaktadır. Mezuniyet sonrası iş bulma olanaklarına ilişkin belirsizlikler, düzenli gelir elde etme konusundaki endişeler ve ekonomik koşullardaki dalgalanmalar öğrencilerin geleceğe yönelik risk algılarını artırabilmektedir.
Bu bağlamda gelecek kaygısı, bireyin gelecekte karşılaşabileceği olası tehdit ve belirsizliklere yönelik duyduğu endişe durumu olarak tanımlanmaktadır (Zaleski, 1996).
Hall-2, Büşra Çiftçi
Hall-2, Session-1 Cengizhan ...
Ceren CIVLAN/Pınar KAVUŞ...
Hall-2, Session-1 MESUT TUR
Hall-2 Aysun Güler Kanter
Hall-2, Session-...
Hall-2 Aysun Gü...
Hall-2 Zeynep g...
Hall-2 Zeynep gül Apal
Tıbbi Amaç Dışı Metilfenidat Kullanımı
Tıbbi amaç dışı kullanımın görüldüğü gruplar:
Üniversite öğrencileri
Yoğun çalışma temposuna sahip meslekler
Rekabetçi akademik ortamlar
Madde kullanım öyküsüne sahip bireyler
Tıp fakültesi öğrencileri
Uzun çalışma saatleri
Akademik baskı
Yoğun eğitim programı
Tıp Öğrencilerinde Tanı Dışı Metilfenidat Kullanım Prevalansı
Çalışma
Ülke
Kullanım %
Emanuel ve arkadaşları, 2013
Amerika
%11
Habibzadeh ve arkadaşları, 2014
İran
%8.7
Cohen ve arkadaşları, 2015
İsrail
%13.5
Costa ve arkadaşları, 2021
Derleme
%0.5-35


ISARC academy...
ISARC academy MELİKE KAYA
Hall-2 Zeynep gül Apal
P
Ceren CIVLAN/Pınar KAVUŞ...
Hall-2, Dr. Serkan DURMAZ
Hüma Zeybek hall2 session 1
Hall-2 Aysun Gü...
Hall-2 Aysun Güler Kanter
Bu çalışmada dudak antropometrik ölçümleri için
subnasale (sn),
labiale superius (ls),
labiale inferius (li),
stomion (sto) ve
cheilion sağ/sol (chR–chL) anatomik referans noktaları kullanılmıştır.
sn
Bu referans noktalarına dayanarak
üst dudak yüksekliği (sn–sto),
üst vermilion yüksekliği (ls–sto),
alt vermilion yüksekliği (sto–li),
toplam dudak yüksekliği (ls–li) ve
ağız genişliği (chR–chL) ölçülmüştür.
ls
chL
chR
st
li
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Ceren CIVLAN/Pınar KAVUŞTU-...
Hall-2, Dr. Serkan DURMAZ
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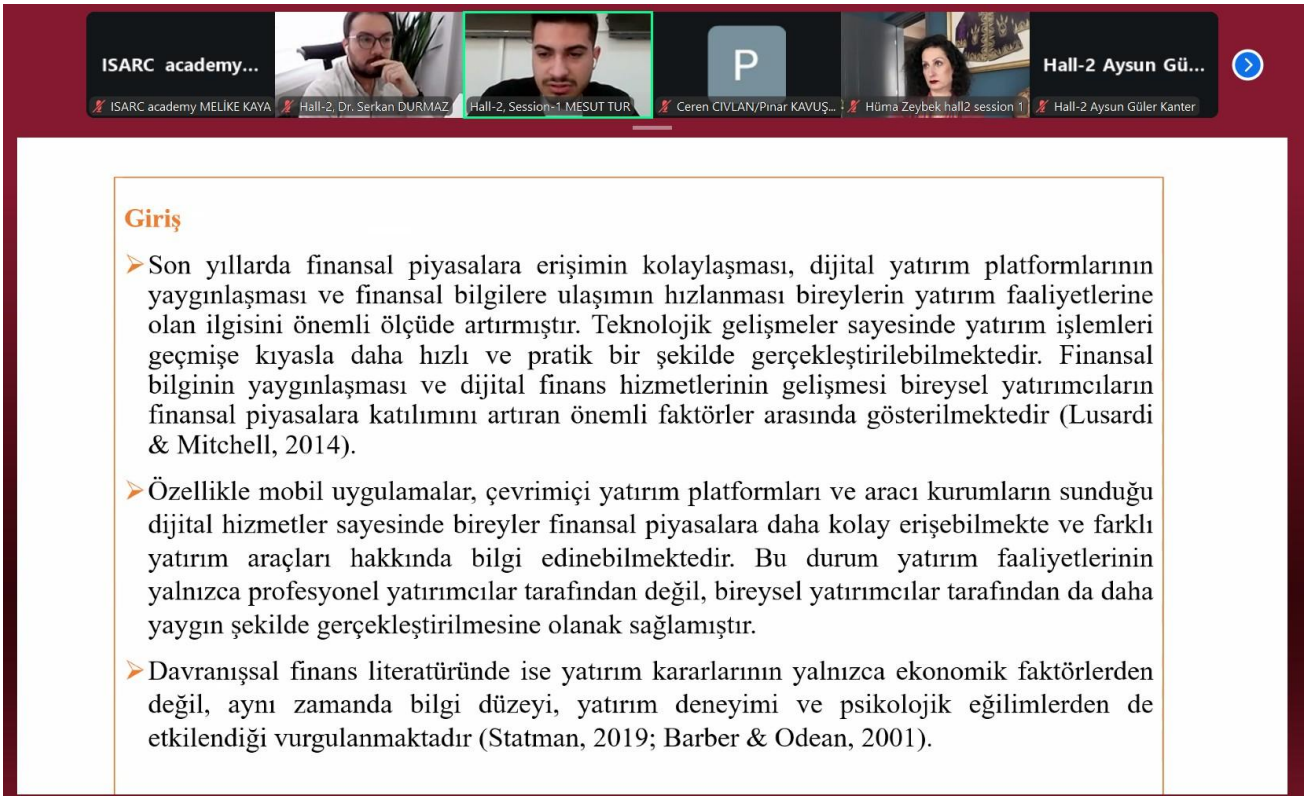
Hall-2 Aysun Güler Kanter
Hall-2 Aysun Gü...
Hall-2, Büşra Çiftçi
Educational Benefits: Linguistic Development and Motivation
SECTION 03
Grammatical Accuracy
Immediate feedback increases error awareness and improves writing quality. [1] [3]
Vocabulary Diversity
Students' vocabulary expands with context-appropriate suggestions. [3]
Student Motivation
Interactive processes support writing motivation and positive attitude. [11]
Key Gains
Personalized learning pace
Reduced writing anxiety
Increased self-regulation skills
Efficient revision processes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Hall-2, Dr. Serkan DURMAZ
Hall-2, Session-1 MESUT TUR
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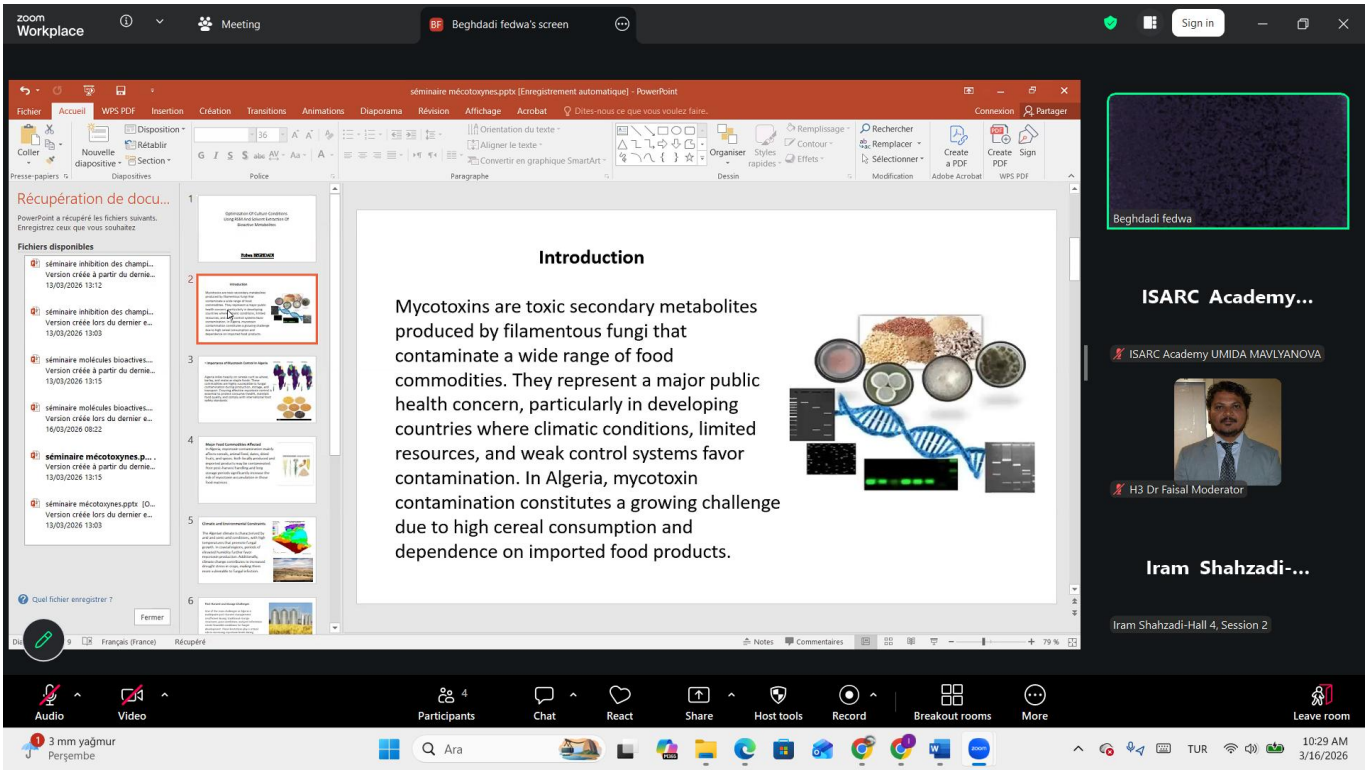
Hüma Zeybek hall2 session 1
Hall-2 Aysun Gü...
Hall-2 Aysun Güler Kanter
Giriş
Son yıllarda finansal piyasalara erişimin kolaylaşması, dijital yatırım platformlarının yaygınlaşması ve finansal bilgilere ulaşımın hızlanması bireylerin yatırım faaliyetlerine olan ilgisini önemli ölçüde artırmıştır. Teknolojik gelişmeler sayesinde yatırım işlemleri geçmişe kıyasla daha hızlı ve pratik bir şekilde gerçekleştirilebilmektedir. Finansal bilginin yaygınlaşması ve dijital finans hizmetlerinin gelişmesi bireysel yatırımcıların finansal piyasalara katılımını artıran önemli faktörler arasında gösterilmektedir (Lusardi & Mitchell, 2014).
Özellikle mobil uygulamalar, çevrimiçi yatırım platformları ve aracı kurumların sunduğu dijital hizmetler sayesinde bireyler finansal piyasalara daha kolay erişebilmekte ve farklı yatırım araçları hakkında bilgi edinebilmektedir. Bu durum yatırım faaliyetlerinin yalnızca profesyonel yatırımcılar tarafından değil, bireysel yatırımcılar tarafından da daha yaygın şekilde gerçekleştirilmesine olanak sağlamıştır.
Davranışsal finans literatüründe ise yatırım kararlarının yalnızca ekonomik faktörlerden değil, aynı zamanda bilgi düzeyi, yatırım deneyimi ve psikolojik eğilimlerden de etkilendiği vurgulanmaktadır (Statman, 2019; Barber & Odean, 2001).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Introduction
Mycotoxins are toxic secondary metabolites produced by filamentous fungi that contaminate a wide range of food commodities. They represent a major public health concern, particularly in developing countries where climatic conditions, limited resources, and weak control systems favor contamination. In Algeria, mycotoxin contamination constitutes a growing challenge due to high cereal consumption and dependence on imported food products.
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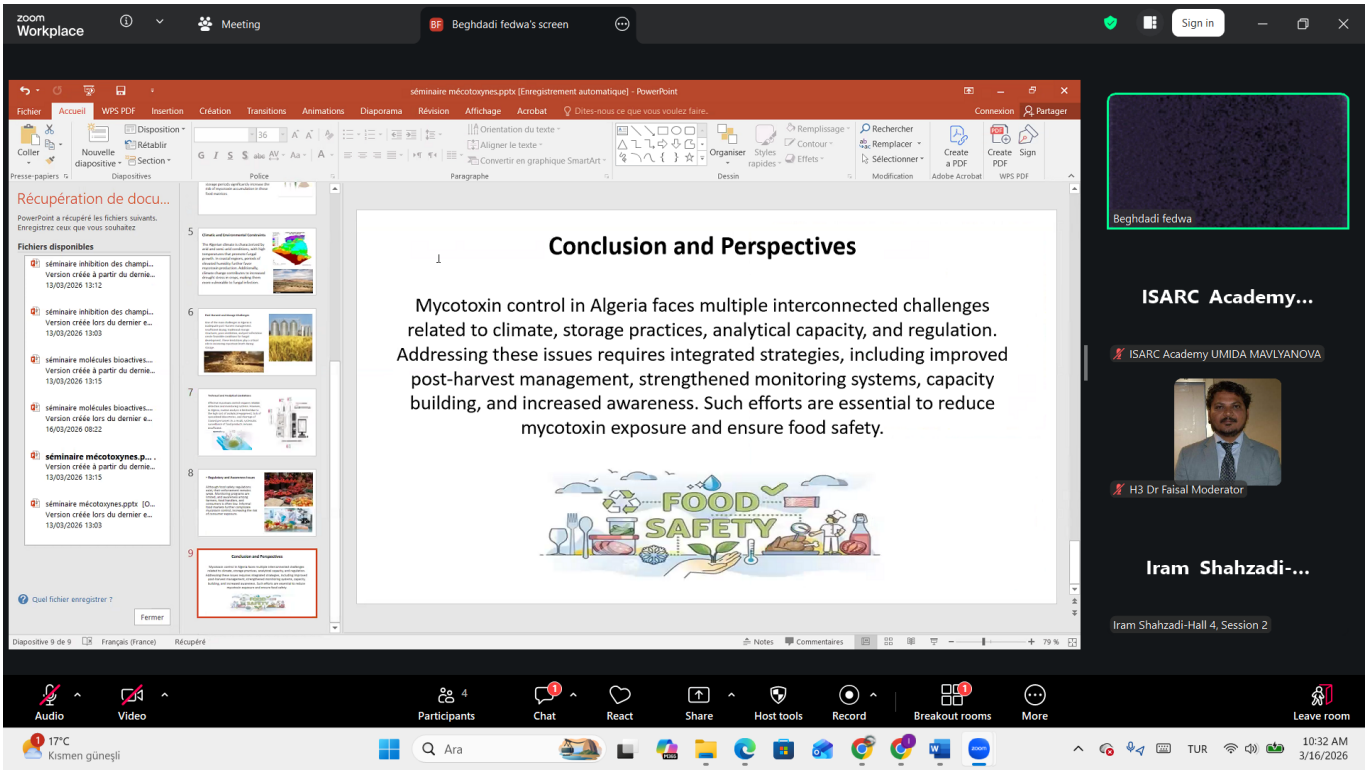
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Conclusion and Perspectives
Mycotoxin control in Algeria faces multiple interconnected challenges related to climate, storage practices, analytical capacity, and regulation. Addressing these issues requires integrated strategies, including improved post-harvest management, strengthened monitoring systems, capacity building, and increased awareness. Such efforts are essential to reduce mycotoxin exposure and ensure food safety.
FOOD SAFETY
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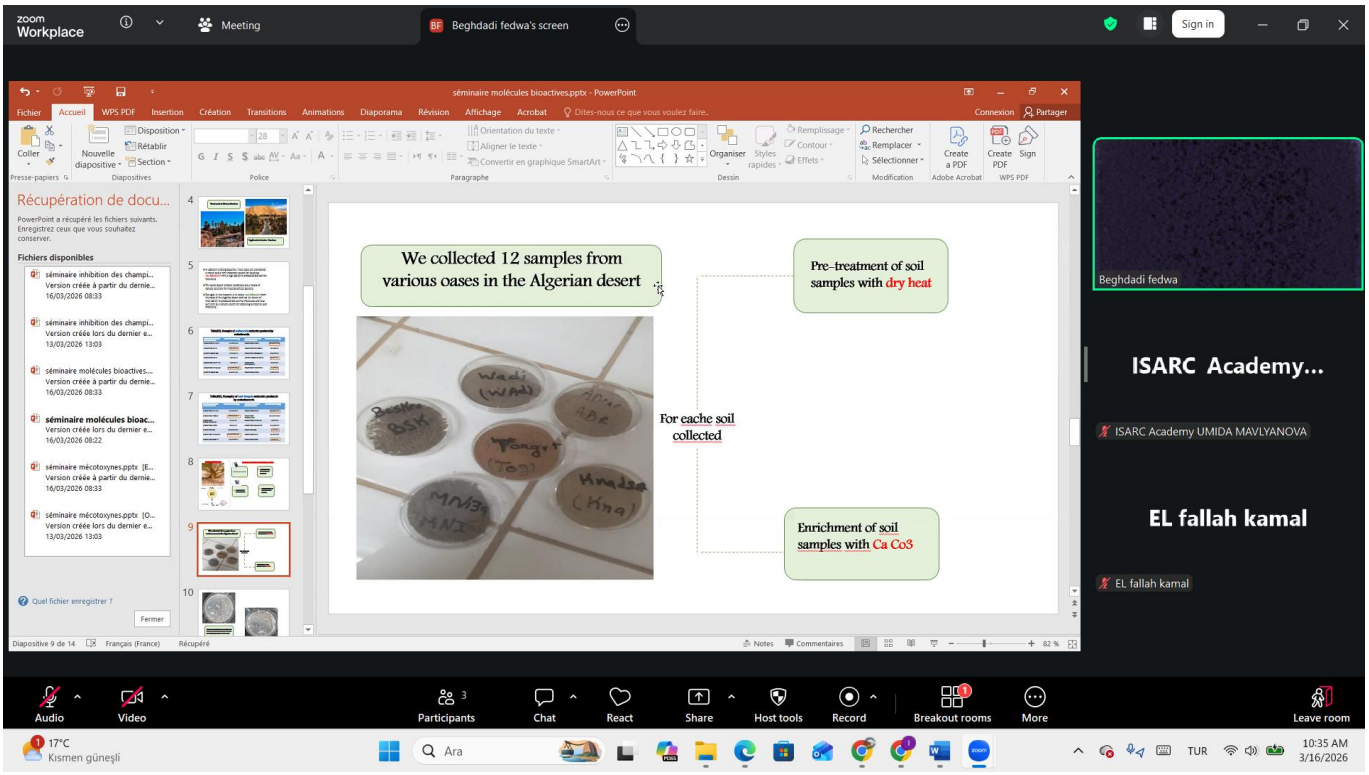
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We collected 12 samples from various oases in the Algerian desert
Pre-treatment of soil samples with dry heat
For eache soil collected
Enrichment of soil samples with Ca Co3
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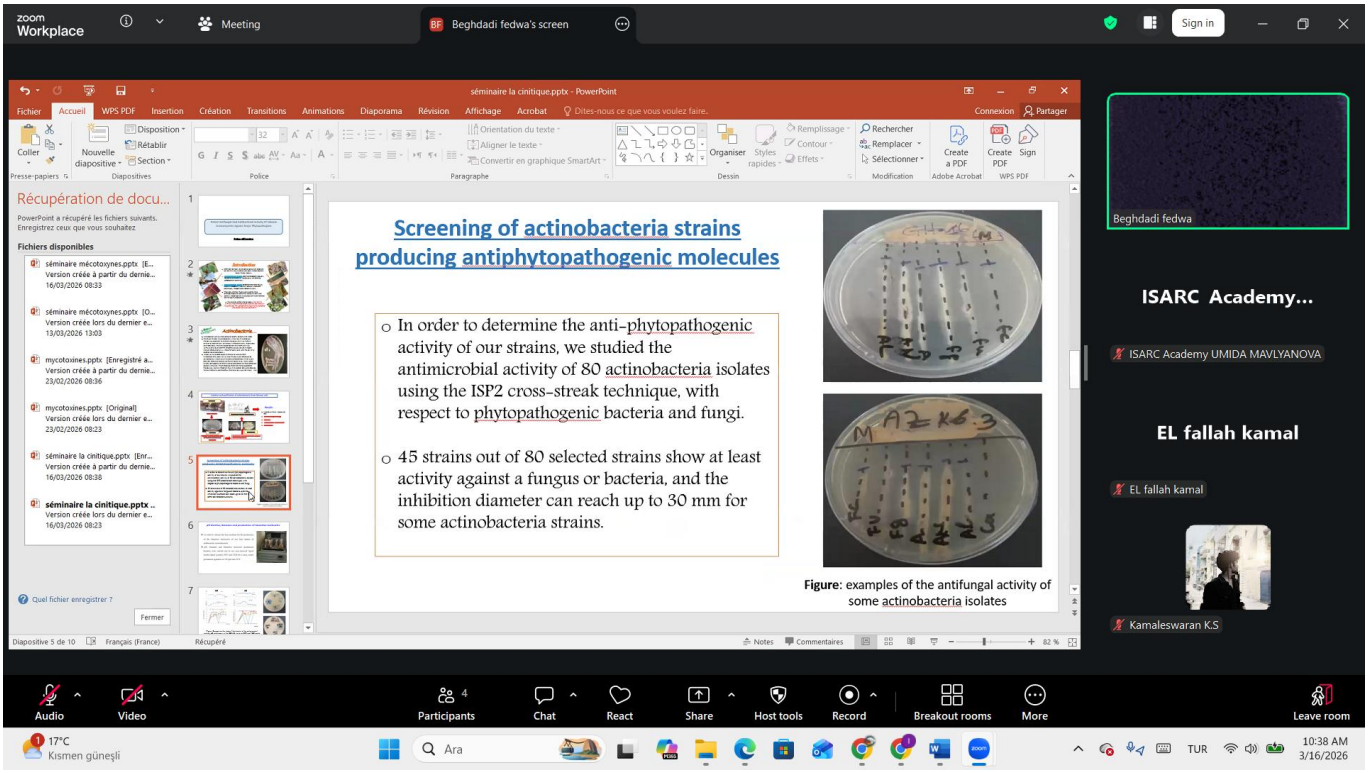
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Screening of actinobacteria strains producing antiphytopathogenic molecules
In order to determine the anti-phytopathogenic activity of our strains, we studied the antimicrobial activity of 80 actinobacteria isolates using the ISP2 cross-streak technique, with respect to phytopathogenic bacteria and fungi.
45 strains out of 80 selected strains show at least activity against a fungus or bacteria, and the inhibition diameter can reach up to 30 mm for some actinobacteria strains.
Figure: examples of the antifungal activity of some actinobacteria isolates
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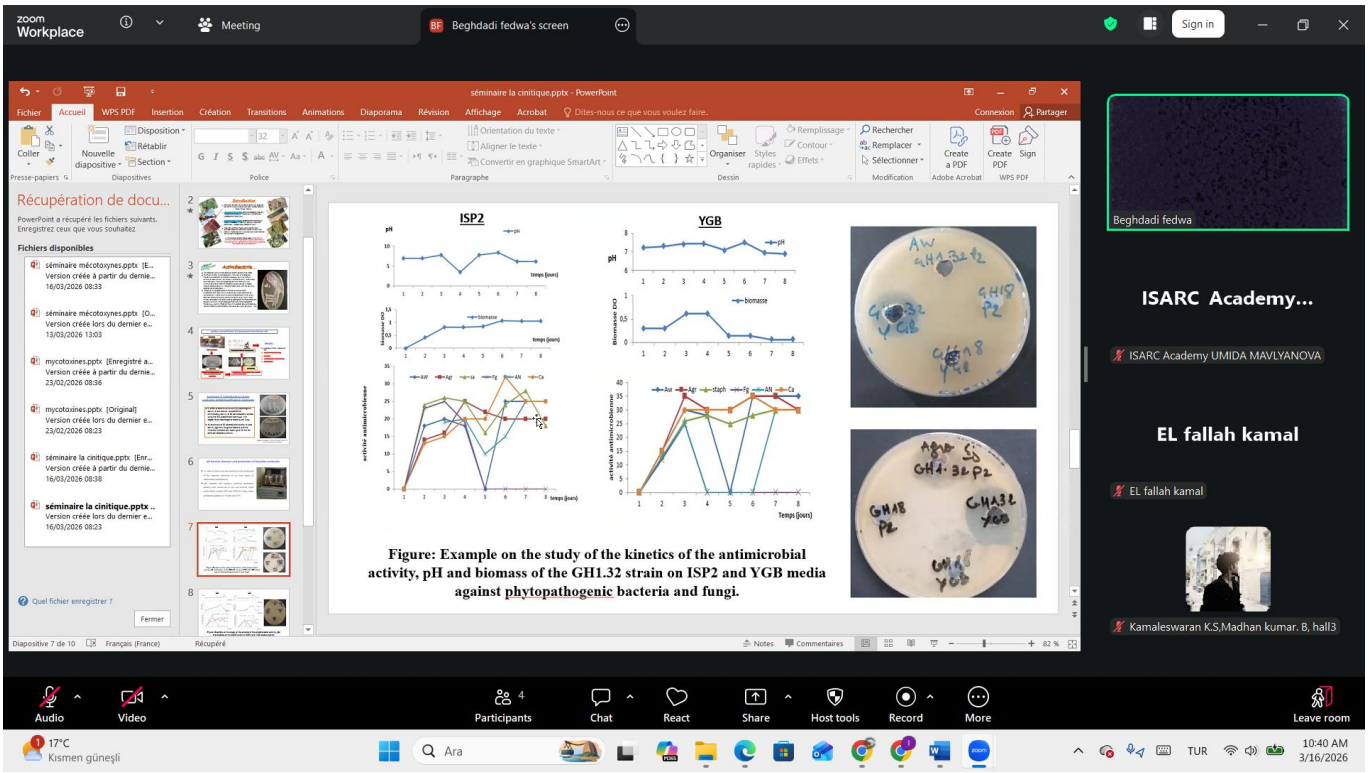
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ISP2
YGB
pH
biomasse
Temps (jours)
Figure: Example on the study of the kinetics of the antimicrobial activity, pH and biomass of the GH1.32 strain on ISP2 and YGB media against phytopathogenic bacteria and fungi.
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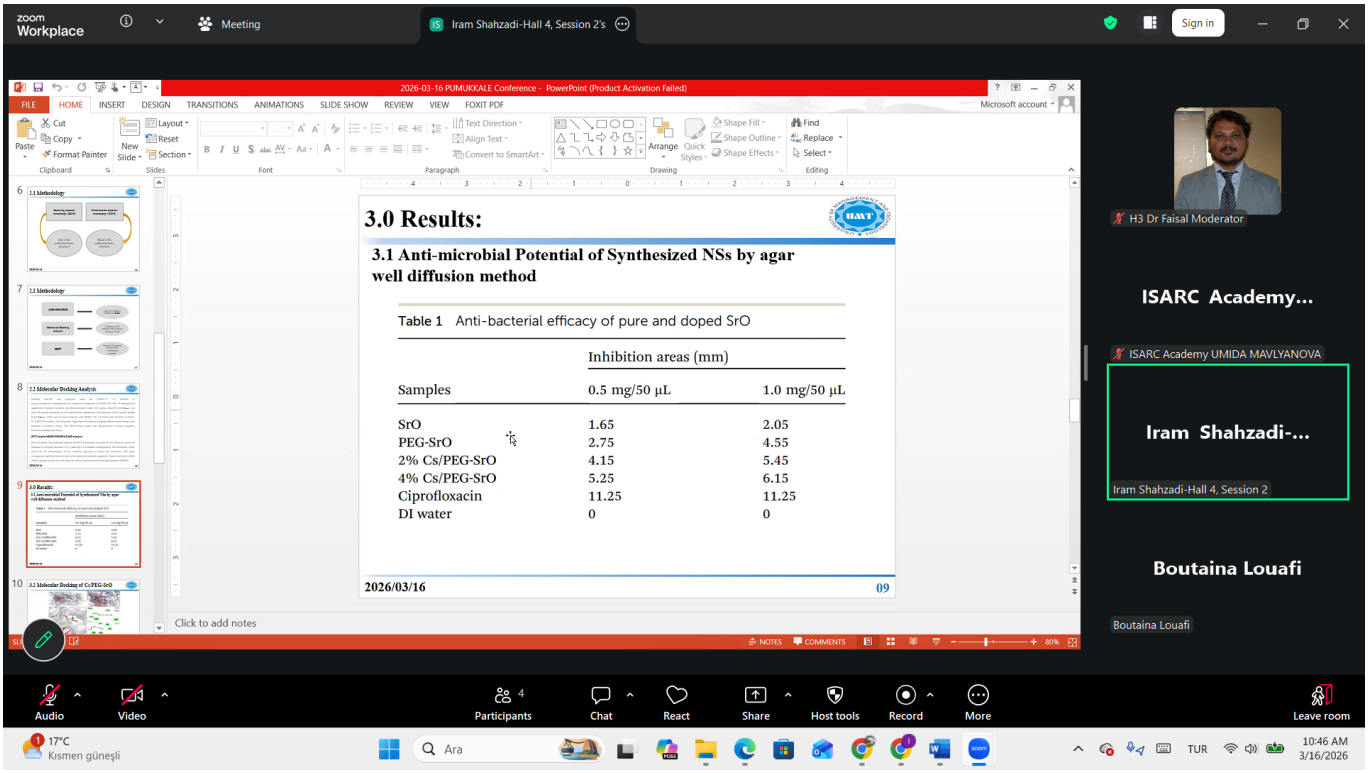
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3.0 Results:
3.1 Anti-microbial Potential of Synthesized NSs by agar well diffusion method
Table 1 Anti-bacterial efficacy of pure and doped SrO
Inhibition areas (mm)
Samples | 0.5 mg/50 µL | 1.0 mg/50 µL
SrO | 1.65 | 2.05
PEG-SrO | 2.75 | 4.55
2% Cs/PEG-SrO | 4.15 | 5.45
4% Cs/PEG-SrO | 5.25 | 6.15
Ciprofloxacin | 11.25 | 11.25
DI water | 0 | 0
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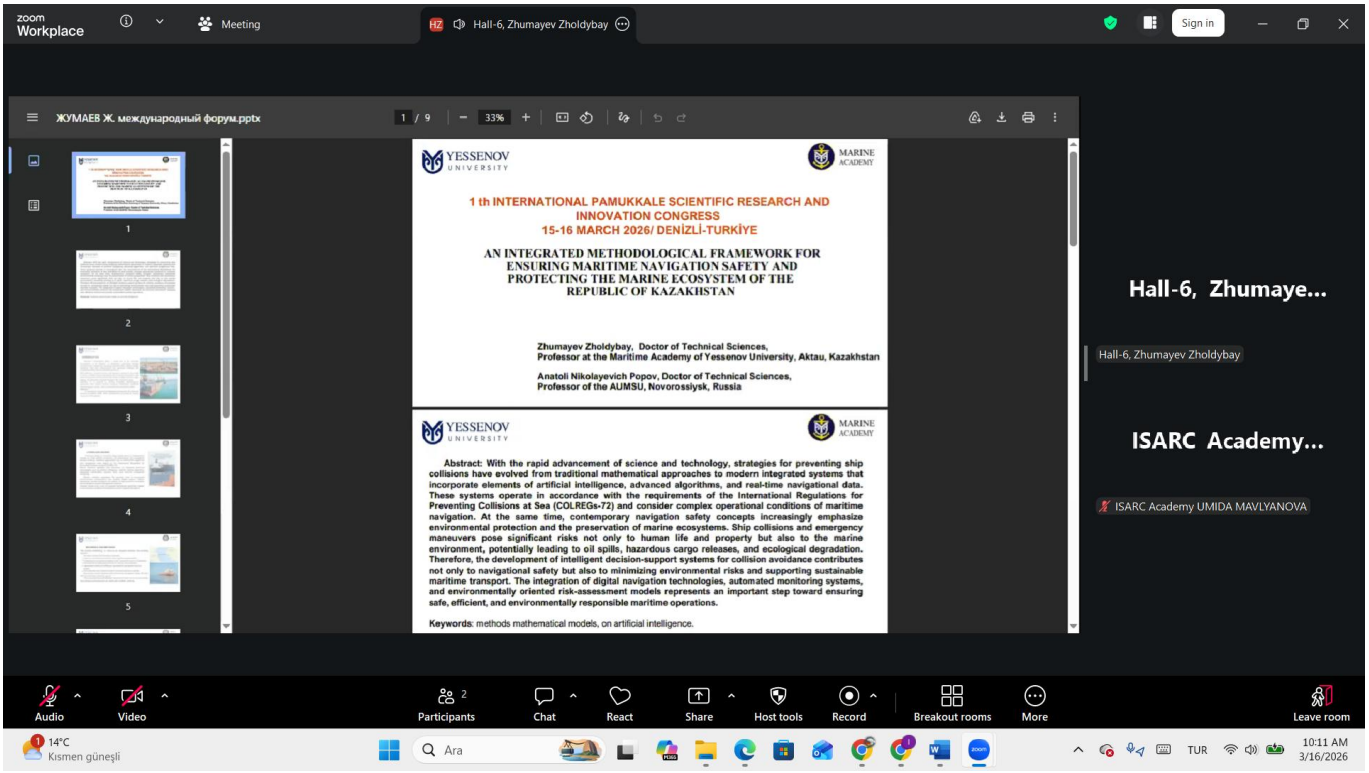
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1 th INTERNATIONAL PAMUKKALE SCIENTIFIC RESEARCH AND INNOVATION CONGRESS
15-16 MARCH 2026/ DENİZLİ-TURKİYE
AN INTEGRATED METHODOLOGICAL FRAMEWORK FOR ENSURING MARITIME NAVIGATION SAFETY AND PROTECTING THE MARINE ECOSYSTEM OF THE REPUBLIC OF KAZAKHSTAN
Zhumayev Zholdybay, Doctor of Technical Sciences, Professor at the Maritime Academy of Yessenov University, Aktau, Kazakhstan
Anatoli Nikolayevich Popov, Doctor of Technical Sciences, Professor of the AUMSU, Novorossiysk, Russia
Abstract: With the rapid advancement of science and technology, strategies for preventing ship collisions have evolved from traditional mathematical approaches to modern integrated systems that incorporate elements of artificial intelligence, advanced algorithms, and real-time navigational data. These systems operate in accordance with the requirements of the International Regulations for Preventing Collisions at Sea (COLREGs-72) and consider complex operational conditions of maritime navigation. At the same time, contemporary navigation safety concepts increasingly emphasize environmental protection and the preservation of marine ecosystems. Ship collisions and emergency maneuvers pose significant risks not only to human life and property but also to the marine environment, potentially leading to oil spills, hazardous cargo releases, and ecological degradation. Therefore, the development of intelligent decision-support systems for collision avoidance contributes not only to navigational safety but also to minimizing environmental risks and supporting sustainable maritime transport. The integration of digital navigation technologies, automated monitoring systems, and environmentally oriented risk-assessment models represents an important step toward ensuring safe, efficient, and environmentally responsible maritime operations.
Keywords: methods mathematical models, on artificial intelligence.
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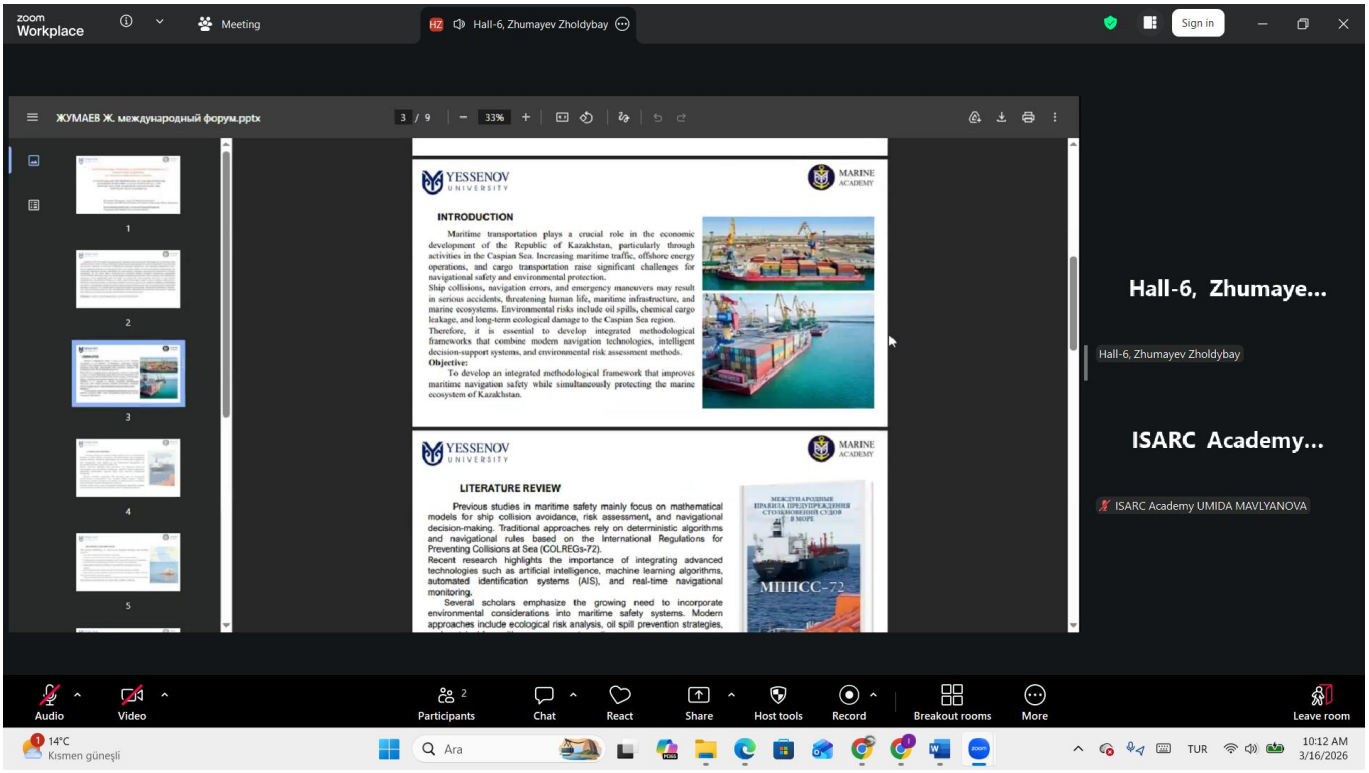
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INTRODUCTION
Maritime transportation plays a crucial role in the economic development of the Republic of Kazakhstan, particularly through activities in the Caspian Sea. Increasing maritime traffic, offshore energy operations, and cargo transportation raise significant challenges for navigational safety and environmental protection.
Ship collisions, navigation errors, and emergency maneuvers may result in serious accidents, threatening human life, maritime infrastructure, and marine ecosystems. Environmental risks include oil spills, chemical cargo leakage, and long-term ecological damage to the Caspian Sea region.
Therefore, it is essential to develop integrated methodological frameworks that combine modern navigation technologies, intelligent decision-support systems, and environmental risk assessment methods.
Objective:
To develop an integrated methodological framework that improves maritime navigation safety while simultaneously protecting the marine ecosystem of Kazakhstan.
LITERATURE REVIEW
Previous studies in maritime safety mainly focus on mathematical models for ship collision avoidance, risk assessment, and navigational decision-making. Traditional approaches rely on deterministic algorithms and navigational rules based on the International Regulations for Preventing Collisions at Sea (COLREGs-72).
Recent research highlights the importance of integrating advanced technologies such as artificial intelligence, machine learning algorithms, automated identification systems (AIS), and real-time navigational monitoring.
Several scholars emphasize the growing need to incorporate environmental considerations into maritime safety systems. Modern approaches include ecological risk analysis, oil spill prevention strategies,
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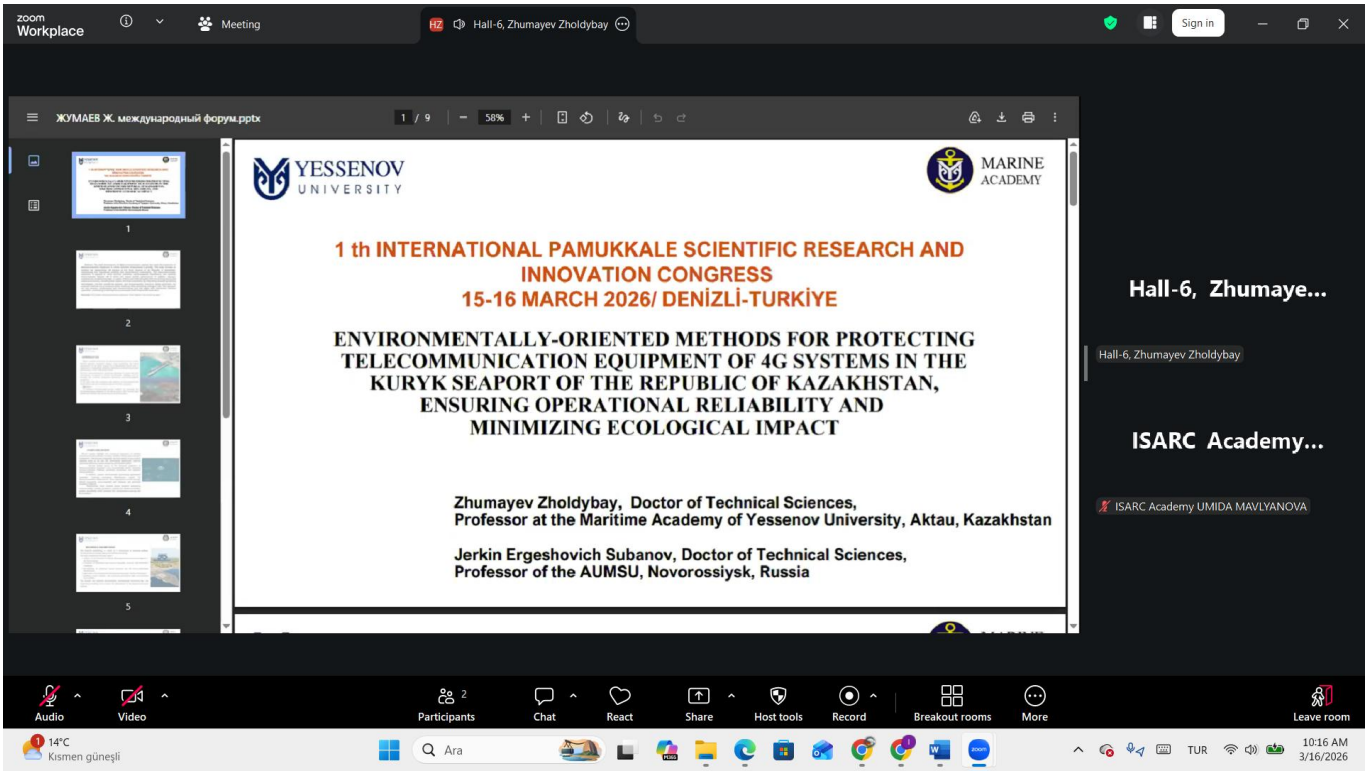
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ENVIRONMENTALLY-ORIENTED METHODS FOR PROTECTING TELECOMMUNICATION EQUIPMENT OF 4G SYSTEMS IN THE KURYK SEAPORT OF THE REPUBLIC OF KAZAKHSTAN, ENSURING OPERATIONAL RELIABILITY AND MINIMIZING ECOLOGICAL IMPACT
Zhumayev Zholdybay, Doctor of Technical Sciences,
Professor at the Maritime Academy of Yessenov University, Aktau, Kazakhstan
Jerkin Ergeshovich Subanov, Doctor of Technical Sciences,
Professor of the AUMSU, Novorossiysk, Russia
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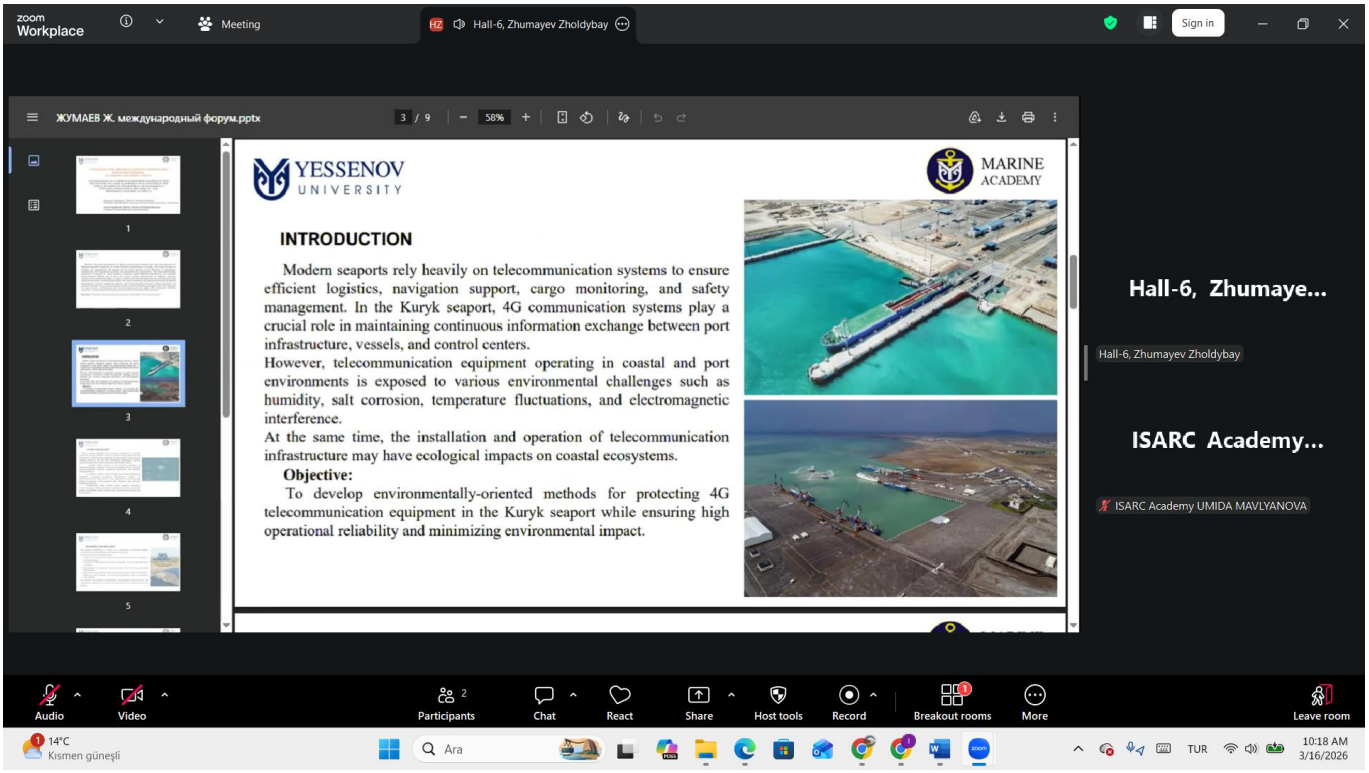
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INTRODUCTION
Modern seaports rely heavily on telecommunication systems to ensure efficient logistics, navigation support, cargo monitoring, and safety management. In the Kuryk seaport, 4G communication systems play a crucial role in maintaining continuous information exchange between port infrastructure, vessels, and control centers.
However, telecommunication equipment operating in coastal and port environments is exposed to various environmental challenges such as humidity, salt corrosion, temperature fluctuations, and electromagnetic interference.
At the same time, the installation and operation of telecommunication infrastructure may have ecological impacts on coastal ecosystems.
Objective:
To develop environmentally-oriented methods for protecting 4G telecommunication equipment in the Kuryk seaport while ensuring high operational reliability and minimizing environmental impact.
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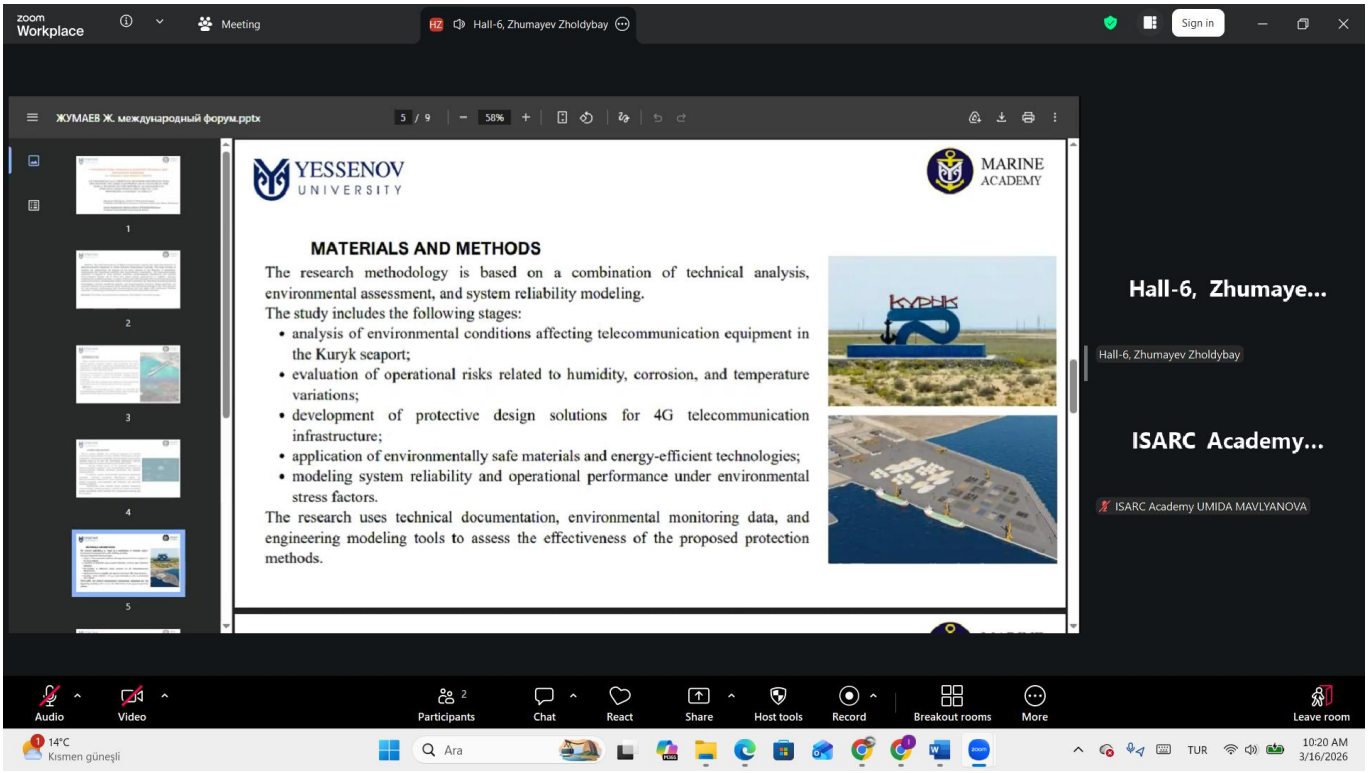
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MATERIALS AND METHODS
The research methodology is based on a combination of technical analysis, environmental assessment, and system reliability modeling.
The study includes the following stages:
• analysis of environmental conditions affecting telecommunication equipment in the Kuryk seaport;
• evaluation of operational risks related to humidity, corrosion, and temperature variations;
• development of protective design solutions for 4G telecommunication infrastructure;
• application of environmentally safe materials and energy-efficient technologies;
• modeling system reliability and operational performance under environmental stress factors.
The research uses technical documentation, environmental monitoring data, and engineering modeling tools to assess the effectiveness of the proposed protection methods.
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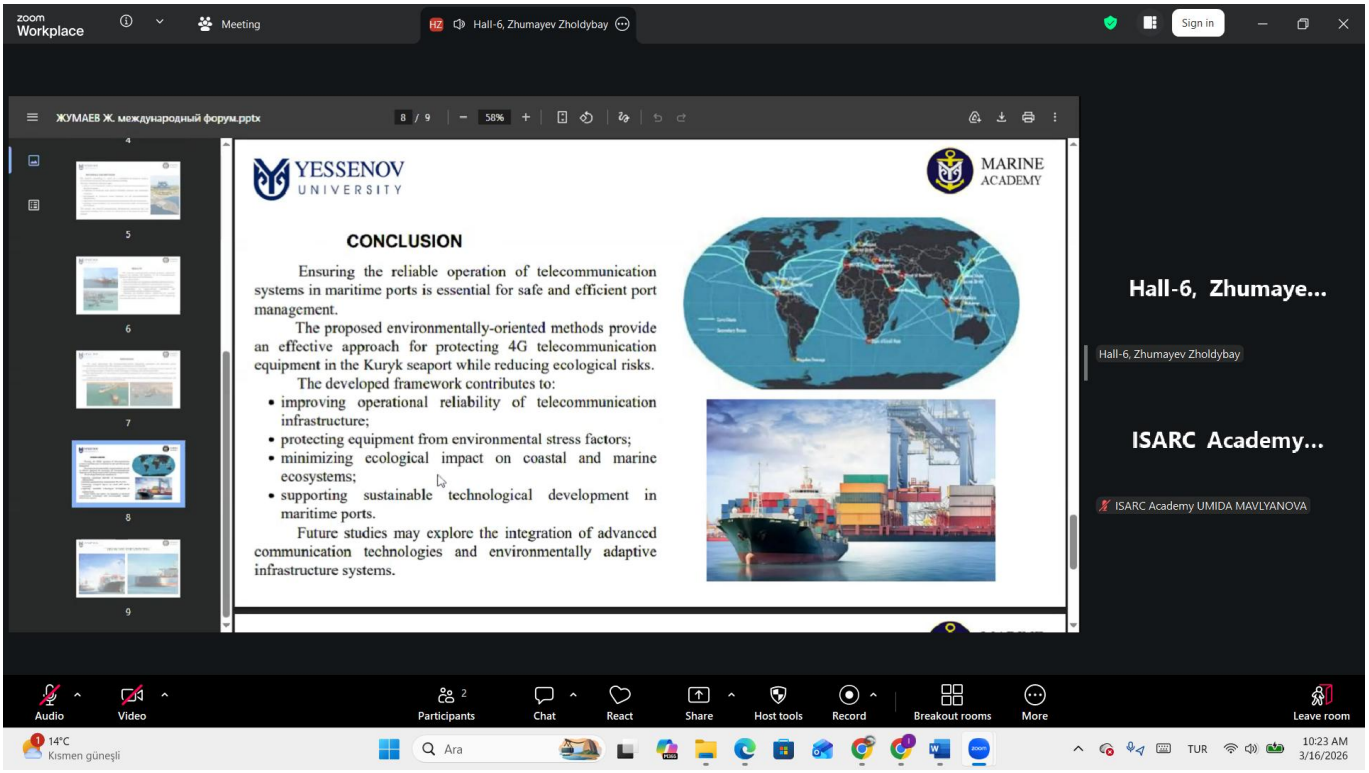
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CONCLUSION
Ensuring the reliable operation of telecommunication systems in maritime ports is essential for safe and efficient port management.
The proposed environmentally-oriented methods provide an effective approach for protecting 4G telecommunication equipment in the Kuryk seaport while reducing ecological risks.
The developed framework contributes to:
• improving operational reliability of telecommunication infrastructure;
• protecting equipment from environmental stress factors;
• minimizing ecological impact on coastal and marine ecosystems;
• supporting sustainable technological development in maritime ports.
Future studies may explore the integration of advanced communication technologies and environmentally adaptive infrastructure systems.
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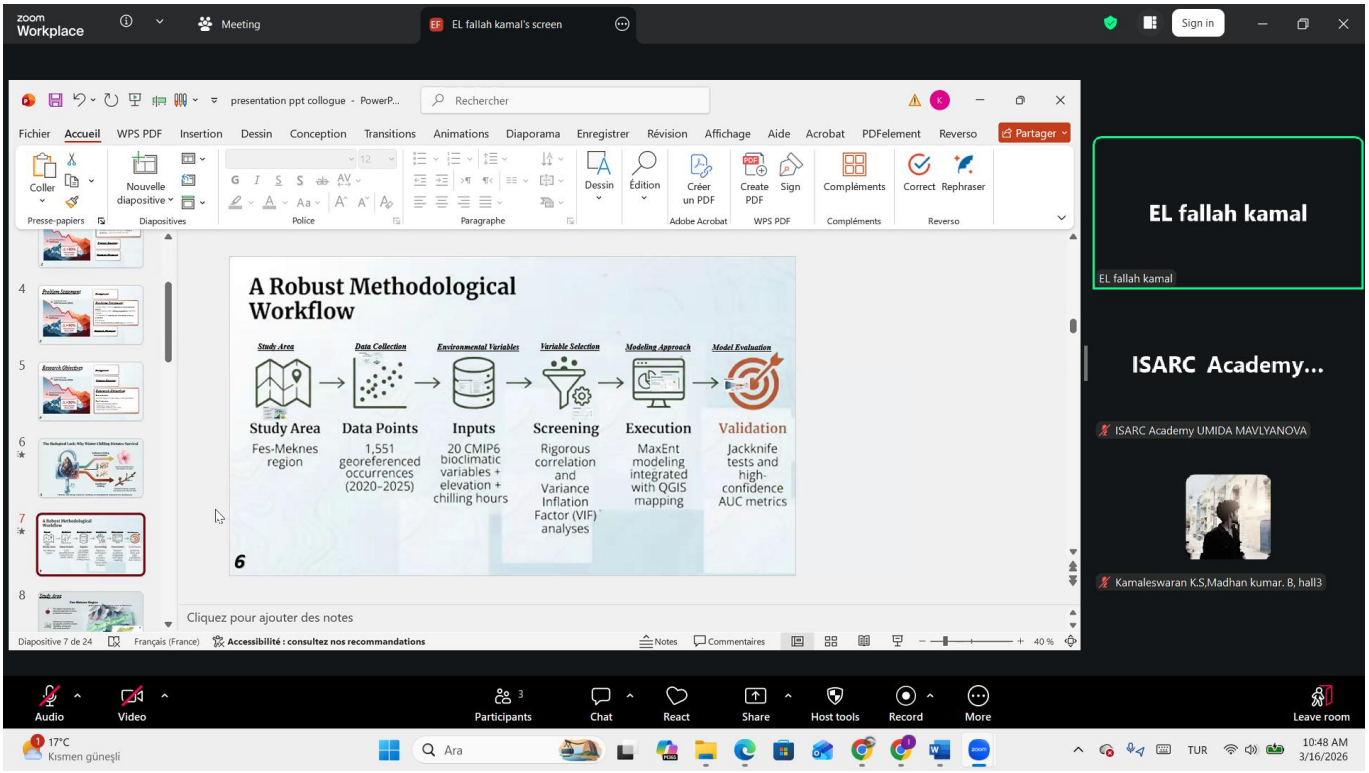
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Reverso
Partager
A Robust Methodological Workflow
Study Area
Fes-Meknes region
Data Points
1,551 georeferenced occurrences (2020–2025)
Inputs
20 CMIP6 bioclimatic variables + elevation + chilling hours
Screening
Rigorous correlation and Variance Inflation Factor (VIF) analyses
Execution
MaxEnt modeling integrated with QGIS mapping
Validation
Jackknife tests and high-confidence AUC metrics
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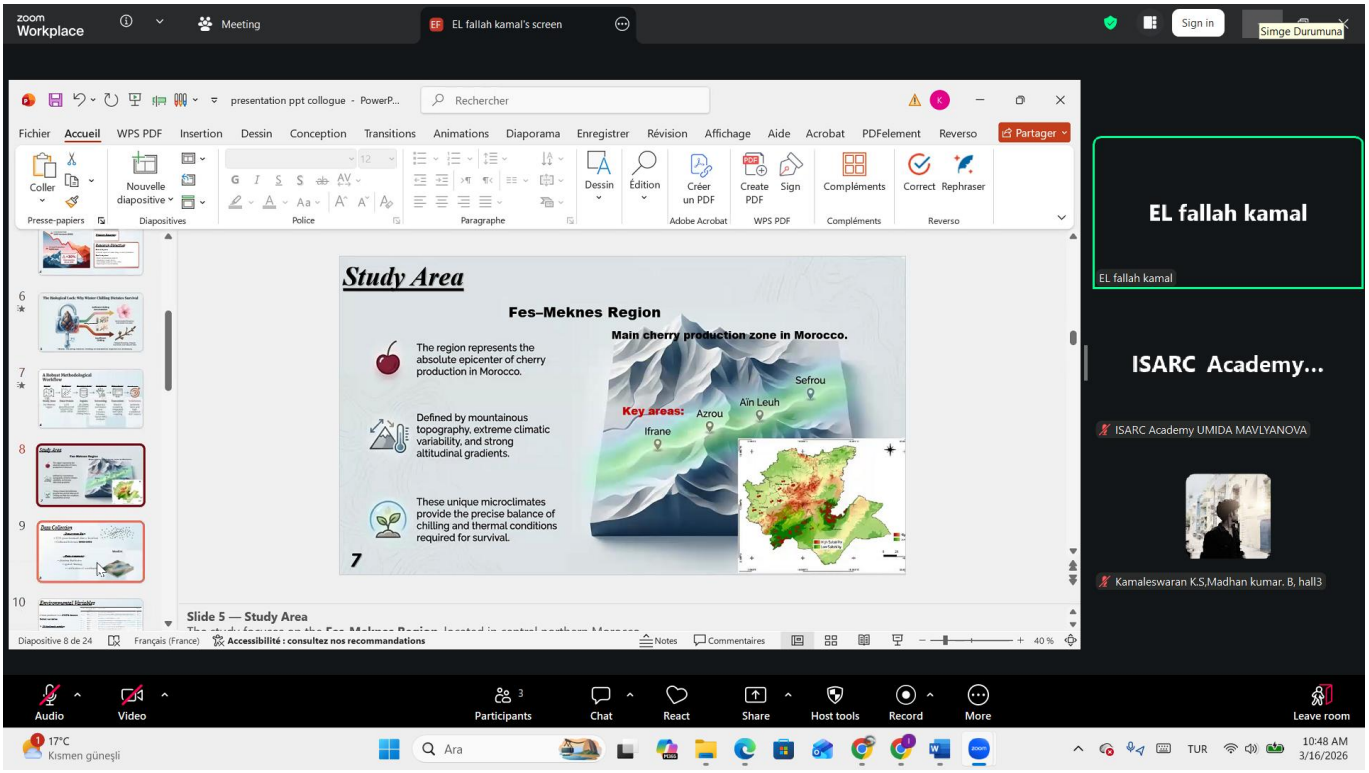
Study Area
Fes–Meknes Region
Main cherry production zone in Morocco.
The region represents the absolute epicenter of cherry production in Morocco.
Defined by mountainous topography, extreme climatic variability, and strong altitudinal gradients.
These unique microclimates provide the precise balance of chilling and thermal conditions required for survival.
Key areas:
Azrou
Ifrane
Ain Leuh
Sefrou
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Slide 5 — Study Area
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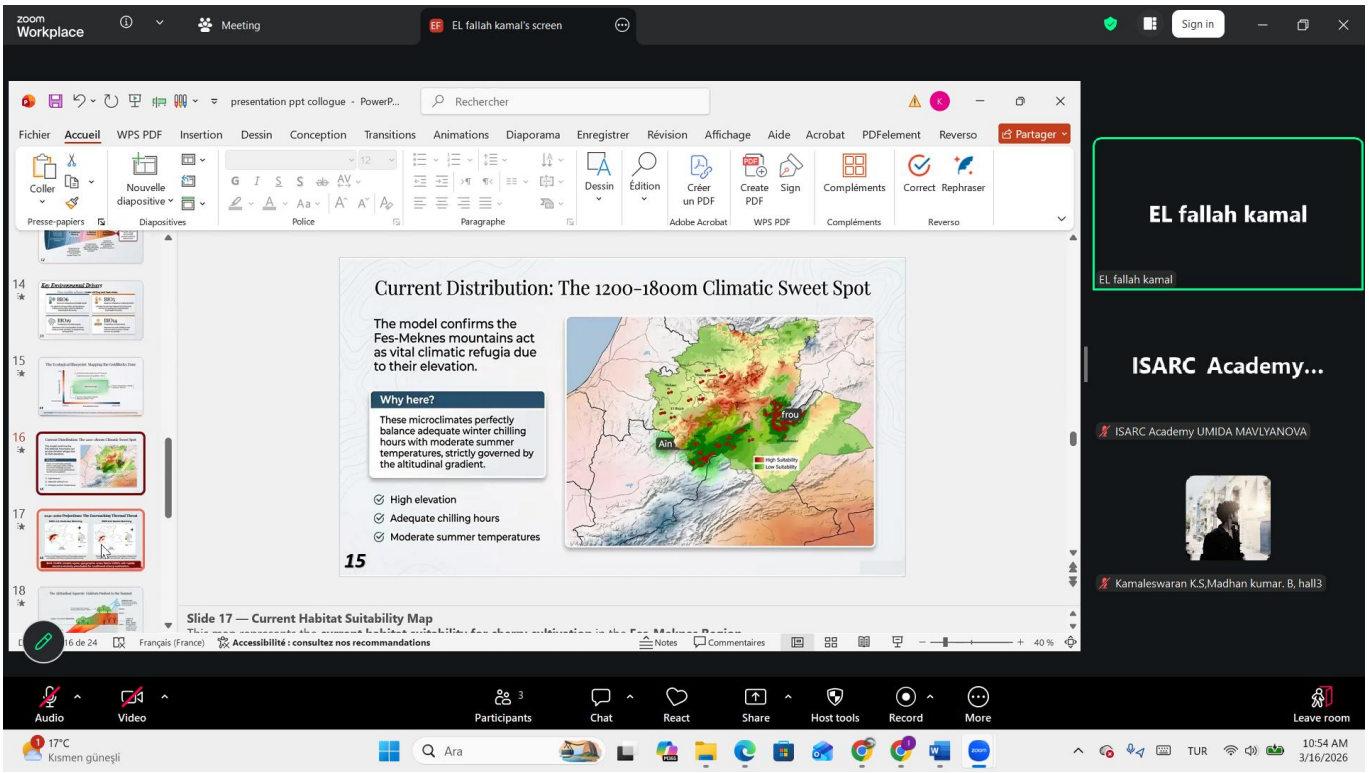
Current Distribution: The 1200–1800m Climatic Sweet Spot
The model confirms the Fes-Meknes mountains act as vital climatic refugia due to their elevation.
Why here?
These microclimates perfectly balance adequate winter chilling hours with moderate summer temperatures, strictly governed by the altitudinal gradient.
High elevation
Adequate chilling hours
Moderate summer temperatures
15
Slide 17 — Current Habitat Suitability Map
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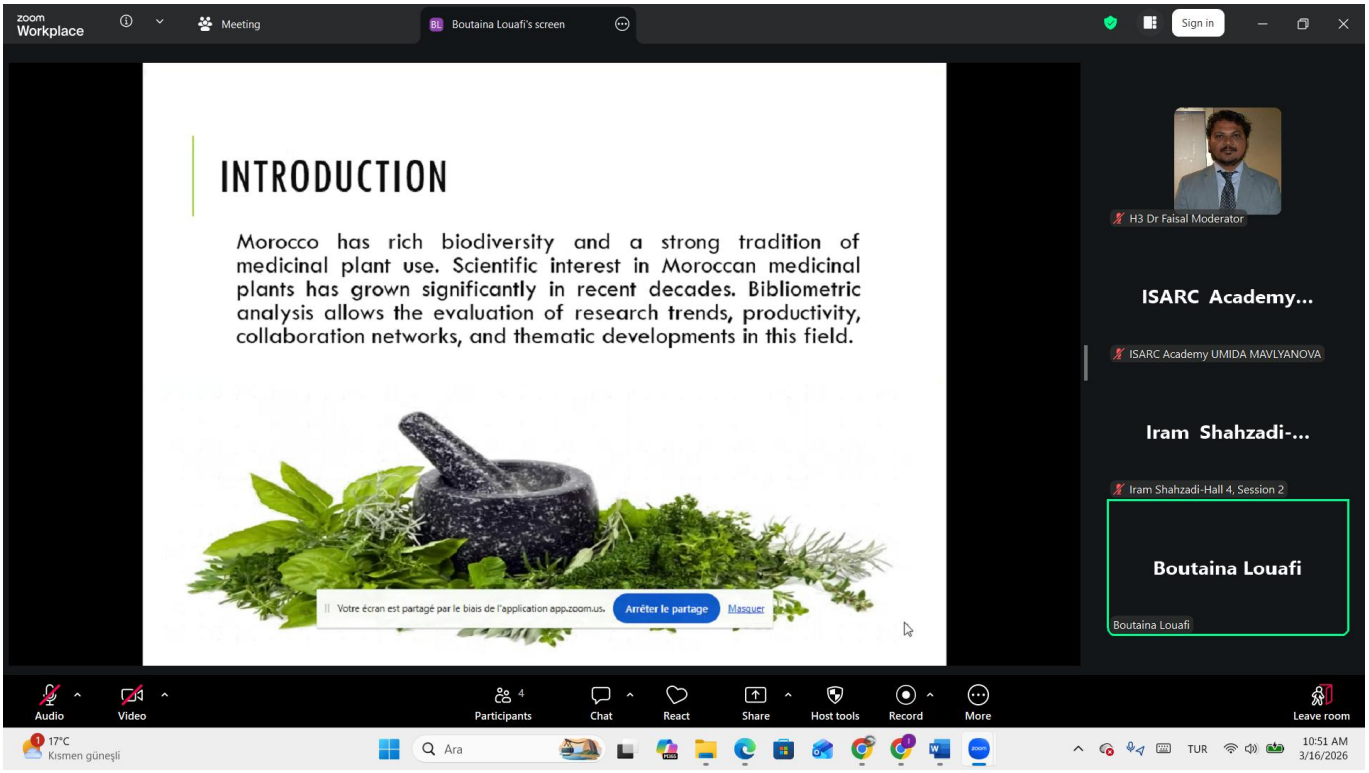
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INTRODUCTION
Morocco has rich biodiversity and a strong tradition of medicinal plant use. Scientific interest in Moroccan medicinal plants has grown significantly in recent decades. Bibliometric analysis allows the evaluation of research trends, productivity, collaboration networks, and thematic developments in this field.
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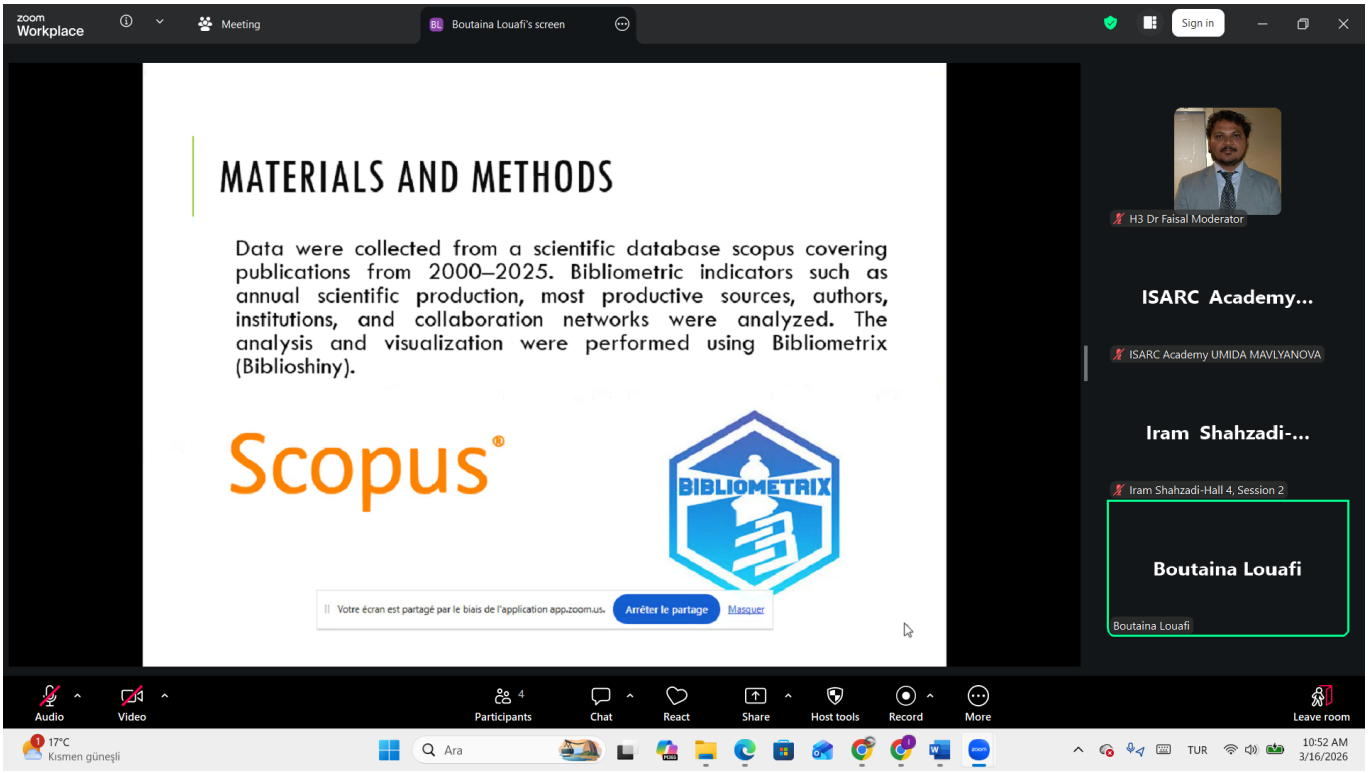
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MATERIALS AND METHODS
Data were collected from a scientific database scopus covering publications from 2000–2025. Bibliometric indicators such as annual scientific production, most productive sources, authors, institutions, and collaboration networks were analyzed. The analysis and visualization were performed using Bibliometrix (Biblioshiny).
Scopus®
BIBLIOMETRIX
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KONU: Kongre Katılımcı Bilgisi **23.03.2026**

İLGİLİ MAKAMA

1.ULUSLARARASI PAMUKKALE BİLİMSEL ARAŞTIRMALAR VE INOVASYON KONGRESİ 15-16 MART 2026 tarihleri arasında DENİZLİ ‘de online olarak 10 farklı ülkeden (Türkiye:10 ve diğer Ülkeler:30 Toplam:40 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 ve Doçentlik kriterlerine uygun düzenlenmiştir.
Bilgilerinize arz edilir.
Saygılarımla

Sefa Salih BİLDİRİCİ
HEAD OF İSARC

NOTIFICATIONS

SU BATAN MAĞARASI'NIN (KASTAMONU) JEOSİT POTANSİYALİNİN NİCEL YÖNTEMLE DEĞERLENDİRİLMESİ

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ÖZET

Bu çalışma, Kastamonu ili Pınarbaşı ilçesi sınırlarında yer alan Su Batan Mağarası'nın jeosit potansiyelini nicel değerlendirme yöntemiyle analiz etmeyi amaçlamaktadır. Alan, aktif karstik süreçlerin gözlemlenebildiği bir yutak sistemi olup bölgesel karst morfolojisi açısından önemli bir konuma sahiptir. Çalışmada Brilha (2016) tarafından önerilen jeosit değerlendirme yöntemi kullanılmış; bilimsel değer, eğitim değeri, turizm değeri ve bozulma riski kriterleri kapsamında puanlama yapılmıştır. Arazi gözlemleri, morfometrik analizler ve literatür taraması çalışmanın temel veri kaynaklarını oluşturmaktadır. Elde edilen bulgular, Su Batan Mağarası'nın özellikle bilimsel değer ve temsil gücü bakımından yüksek potansiyele sahip olduğunu göstermektedir. Bununla birlikte alanın koruma statüsünün güçlendirilmesi gerektiği ve plansız ziyaretçi baskısının uzun vadede jeomorfolojik bütünlüğü tehdit edebileceği belirlenmiştir. Sonuç olarak Su Batan Mağarası, Kastamonu karst alanları içinde öncelikli korunması gereken jeositlerden biri olarak değerlendirilmektedir. Çalışma, bölgesel jeomiras envanterine katkı sağlaması ve sürdürülebilir jeoturizm planlamasına bilimsel zemin oluşturması açısından önem taşımaktadır.

Anahtar Kelimeler: Subatan, jeosit, kastamonu, karstik

QUANTITATIVE EVALUATION OF THE GEOSITE POTENTIAL OF SU BATAN CAVE (KASTAMONU)

ABSTRACT

This study aims to analyze the geosite potential of Su Batan Cave, located within the boundaries of the Pınarbaşı district in Kastamonu province, using a quantitative evaluation method. The area is a sinkhole (ponor) system where active karstic processes can be observed and holds a significant position in terms of regional karst morphology. In this study, the geosite evaluation method proposed by Brilha (2016) was employed, and scoring was conducted based on the criteria of scientific value, educational value, tourism value, and degradation risk. Field observations, morphometric analyses, and a literature review constitute the primary data sources of the research. The findings indicate that Su Batan Cave possesses high potential, particularly regarding its scientific value and representativeness. However, it has been determined that the protection status of the area needs to be strengthened and that unplanned

visitor pressure may threaten the geomorphological integrity in the long term. Consequently, Su Batan Cave is evaluated as one of the priority geosites to be protected among the karst areas of Kastamonu. This study is significant for its contribution to the regional geo-heritage inventory and for establishing a scientific foundation for sustainable geotourism planning.
Keywords: Subatan, geosite, Kastamonu, karstic.

1. Giriş

Jeolojik ve jeomorfolojik oluşumlar, doğal mirasın önemli bileşenlerinden biri olarak kabul edilmektedir. Bu oluşumların bilimsel, estetik ve eğitimsel değerlerinin belirlenmesi amacıyla geliştirilen jeosit ve jeomiras kavramları, özellikle son yıllarda jeolojik mirasın korunması ve sürdürülebilir kullanımı açısından önem kazanmıştır (Gray, 2013). Jeositler, belirli bir bölgenin jeolojik veya jeomorfolojik evrimini temsil eden, bilimsel araştırma ve eğitim açısından değer taşıyan doğal oluşumlar olarak tanımlanmaktadır (Reynard, 2008). Bu alanların belirlenmesi ve değerlendirilmesi, jeolojik mirasın korunması ve sürdürülebilir turizm planlaması açısından önemli bir adımdır.Karstik alanlar, jeomorfolojik çeşitlilik ve jeolojik süreçlerin açık şekilde gözlemlenebilmesi nedeniyle jeosit çalışmalarında önemli bir yere sahiptir. Türkiye, özellikle karbonatlı kayaçların yaygınlığı nedeniyle geniş karst alanlarına sahiptir (Nazik, 2004). Bu alanlarda gelişen mağaralar, dolinler, polye ve yer altı drenaj sistemleri önemli jeomorfolojik değerler taşımaktadır.Kastamonu ili ve çevresi, karstik morfolojinin belirgin şekilde geliştiği alanlardan biridir. Özellikle Pınarbaşı çevresinde bulunan karstik oluşumlar, jeomorfolojik çeşitlilik açısından dikkat çekmektedir. Bu alanlardan biri olan Su Batan Mağarası, aktif karst hidrografyasının gözlemlenebildiği önemli bir doğal oluşumdur.Bu çalışmanın amacı, Su Batan Mağarası'nın jeosit potansiyelini nicel değerlendirme yöntemi ile analiz ederek alanın bilimsel, eğitimsel ve turizm açısından değerini ortaya koymaktır.

2. Çalışma Alanının Coğrafi Özellikleri

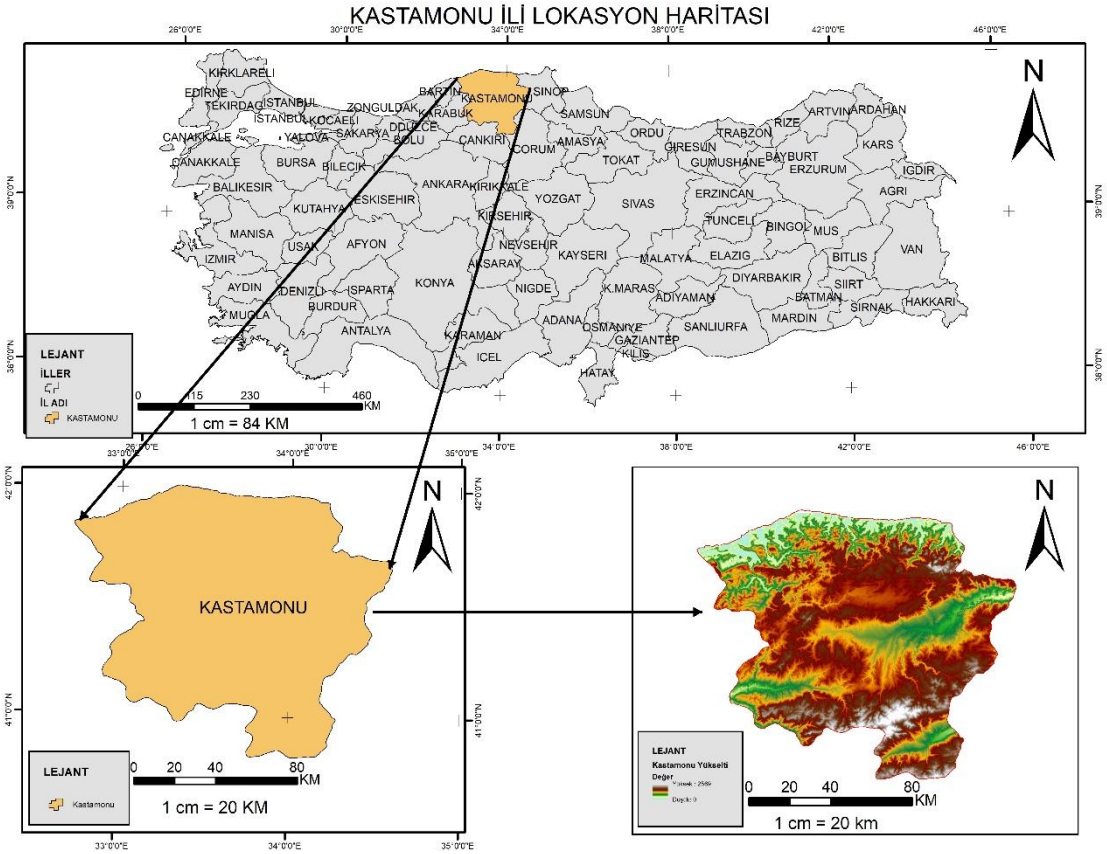
Su Batan Mağarası, Batı Karadeniz Bölgesi'nde yer alan Kastamonu ilinin Pınarbaşı ilçesi sınırları içerisinde bulunmaktadır. Bölge, Küre Dağları sisteminin güney kesiminde yer almakta olup karstik morfolojinin belirgin şekilde geliştiği alanlardan biridir.

Jeolojik olarak bölge büyük ölçüde kireçtaşı formasyonlarından oluşmaktadır. Bu karbonatlı kayaçlar, karstlaşma süreçlerinin gelişmesine uygun litolojik özellikler göstermektedir. Bölgedeki karstik süreçler sonucunda mağaralar, dolinler ve yer altı drenaj sistemleri oluşmuştur.

Su Batan Mağarası, özellikle yüzey sularının yer altına girdiği bir yutak sistemi olarak dikkat çekmektedir. Bu özellik, mağaranın karst hidrografyası açısından önemli bir konuma sahip olduğunu göstermektedir.

Bölgenin iklimi Karadeniz ikliminin etkisi altında olup yıl boyunca düzenli yağış almaktadır. Bu durum karstik çözünme süreçlerinin devam etmesine katkı sağlamaktadır.

Görsel 1. Kastamonu ili lokasyon haritası.



3. Yöntem

Bu çalışmada Su Batan Mağarası'nın jeosit potansiyelini değerlendirmek amacıyla nicel jeosit değerlendirme yöntemi kullanılmıştır. Bu yöntem, jeositlerin bilimsel, eğitimsel ve turizm değerlerinin belirli kriterlere göre puanlanmasını içermektedir (Brilha, 2016).

Araştırma sürecinde şu aşamalar izlenmiştir:

1. Literatür taraması
2. Arazi gözlemleri
3. Jeomorfolojik değerlendirme
4. Nicel puanlama analizi

Jeosit değerlendirmesinde dört ana kriter dikkate alınmıştır:

- Bilimsel değer

- Eğitim değeri
- Turizm değeri
- Bozulma riski

Her bir kriter belirli alt ölçütlere göre puanlanmış ve toplam jeosit değeri hesaplanmıştır.

4. Bulgular

Analiz sonuçları Su Batan Mağarası'nın özellikle bilimsel değer açısından yüksek potansiyele sahip olduğunu göstermektedir. Mağara, aktif karstik süreçlerin gözlemlenebildiği bir yutak sistemi olması nedeniyle karst hidrografyası çalışmalarında önemli bir örnek teşkil etmektedir. Eğitim değeri açısından değerlendirildiğinde alanın jeomorfolojik süreçlerin sahada gözlemlenebilmesi bakımından önemli bir potansiyele sahip olduğu görülmektedir. Mağara ve çevresindeki karstik şekiller, coğrafya ve jeoloji eğitimi açısından öğretici nitelik taşımaktadır. Turizm değeri açısından değerlendirildiğinde alanın doğal peyzaj özellikleri dikkat çekmektedir. Bununla birlikte ulaşım ve ziyaretçi altyapısı açısından bazı sınırlılıklar bulunmaktadır.

Bozulma riski açısından değerlendirildiğinde ise plansız ziyaretçi faaliyetlerinin uzun vadede alanın jeomorfolojik bütünlüğünü etkileyebileceği düşünülmektedir.

5. Tartışma

Jeosit değerlendirme çalışmalarında karstik mağaralar önemli bir yer tutmaktadır. Özellikle aktif karst sistemleri, jeolojik süreçlerin günümüzde de devam ettiğini göstermesi açısından bilimsel değeri yüksek alanlar olarak kabul edilmektedir (Reynard, 2008).

Su Batan Mağarası da bu bağlamda değerlendirildiğinde Batı Karadeniz karst alanları içerisinde önemli bir jeosit potansiyeline sahiptir. Alanın jeomorfolojik özellikleri, bölgesel karst sisteminin anlaşılması açısından önemli veriler sunmaktadır.

Ayrıca mağaranın jeoturizm açısından da belirli bir potansiyele sahip olduğu söylenebilir. Ancak sürdürülebilir kullanım için koruma ve ziyaretçi yönetimi planlarının oluşturulması gerekmektedir.

6. Sonuç

Bu çalışma kapsamında Su Batan Mağarası'nın jeosit potansiyeli nicel değerlendirme yöntemi kullanılarak analiz edilmiştir. Araştırma sonuçları mağaranın özellikle bilimsel ve eğitim değeri bakımından önemli bir jeomorfolojik oluşum olduğunu ortaya koymaktadır.

Alanın jeoturizm açısından değerlendirilmesi mümkün olmakla birlikte sürdürülebilir kullanım için koruma önlemlerinin geliştirilmesi gerekmektedir.

Tablo 1. Brilha modeline göre jeosit puanlama tablosu.

Kriter	Alt kriter	Puan (0-4)	Açıklama
Bilimsel Değer	Nadirlik	3	Aktif karst yutak sistemi
	Temsil gücü	4	Karst hidrografyasını temsil eder
	Jeolojik çeşitlilik	3	Kireçtaşı litolojisi
	Bilimsel araştırma potansiyeli	4	Karst hidrolojisi açısından önemli
Eğitim Değeri	Görsellik	3	Jeomorfolojik süreçler açık gözlemlenir
	Eğitim kullanımı	3	Arazi çalışmaları için uygun
Turizm Değeri	Estetik peyzaj	3	Doğal peyzaj değeri
	Ulaşılabilirlik	2	Kısmen sınırlı
Bozulma Riski	İnsan baskısı	2	Turistik ziyaretler
	Koruma durumu	2	Resmi jeosit statüsü yok

Toplam değerlendirme

Analiz sonucunda alan: Orta–yüksek jeosit potansiyeline sahip alan kategorisine girer.

Bu bağlamda aşağıdaki öneriler sunulabilir:

- Alanın jeomiras envanterine dahil edilmesi
- Bilgilendirici panolar ve eğitim materyalleri hazırlanması
- Ziyaretçi yönetim planı oluşturulması

Bu tür çalışmaların Kastamonu karst alanlarının jeomiras değerinin belirlenmesine katkı sağlayacağı düşünülmektedir.

KAYNAKÇA

Brilha, J. (2016). Inventory and quantitative assessment of geosites and geodiversity sites: A review. *Geoheritage*, *8*(2), 119–134.
Gray, M. (2013). *Geodiversity: Valuing and conserving abiotic nature* (2. baskı). Wiley-Blackwell.
Nazik, L. (2004). Türkiye karst alanlarının jeomorfolojik özellikleri. *Türk Coğrafya Dergisi*, *42*, 1–16.
Reynard, E. (2008). Scientific research and tourist promotion of geomorphological heritage. *Geomorphologie: Relief, Processus, Environnement*, *14*(3), 225–230.
Reynard, E., Coratza, P., & Regolini-Bissig, G. (2009). *Geomorphosites*. Verlag Dr. Friedrich Pfeil.

KIZILIRMAK HAVZASI DELİCE KOLU KIRGIBAYIR (BADLANS) TOPOGRAFYASININ EĞİTSEL JEOSİT POTANSİYALİ

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ÖZET

Bu çalışma, Kızılırmak havzasının Delice kolundaki Kırgıbayır(badlands) arazisinin Jeomorfolojik ve eğitsel niteliğini detaylı incelemeyi amaçlamaktadır. Kızılırmak nehrini besleyen ve önemli kollarından biri olan delice kolu, orta Kızılırmak hazasında yer almaktadır. Yarıkurak iklimde bulunmasından dolayı yumuşak toprak ve geçirgenli kayaçların su erozyonundan fazla etkilenmesi sonucunda derin yarıntı ve karmaşık bir Kırgıbayır morfolojisinin oluşmasına neden olmuştur. Cbs (ArcMap) arazi görüntüleri kullanılarak alana ait drenaj ağı ve morfolojik çeşitliliği değerlendirilmiştir. Delice koluna ait oluşan bu Kırgıbayırların aşınım süreçlerinin etkili olduğu alan daha çok sahadaki ortamlarda jeolojik süreçlerin gözlenebileceğine neden olmuştur.

Eğitsel Jeositi açısından önemli bir yere sahip olan Delice kolu Kırgıbayırları, araştırmacılar için oluşan Jeomorfolojik süreçleri sahada gözlemlenmesini ve sonucunda meydana gelen bu topografik farklılıkların yorumlanması bilimsel ve eğitimsel alanda önemli bir değer niteliği taşımaktadır. Özellikle suyun toprağı şekillendirmesiyle oluşan derin yarıntı ve erozyon süreçleri teorik bilginin yanı sıra sahada somut bir görsel bir öğrenme ortamı sunmaktadır. Bu morfolojik çeşitlilik doğal süreçler sonucunda oluşmuş olup aynı zamanda sahada araştırmalar için laboratuvar niteliği taşımaktadır. Kırgıbayırlar, bölgenin Jeomorfolojik yapısını korunması ve Jeoturizmle beraber eğitim faaliyetleri açısından önem taşımaktadır. Sonuç olarak, Kızılırmak havzasına özgün olan Kırgıbayır topoğrafya alanı bir eğitici Jeosit bölgesi olarak tescil edilip, bu bölgenin doğayı koruma bilincinin gelişmesi ve jeolojik mirasını gelecek nesillere aktarmasından dolayı hayati bir değer taşımaktadır.

Anahtar kelimeler: Jeosit, Kırgıbayır, Morfoloji, Jeomorfoloji

EDUCATIONAL GEOSITE POTENTIAL OF THE BADLANDS TOPOGRAPHY IN THE DELİCE TRIBUTARY OF THE KIZILIRMAK BASIN

ABSTRACT

This study aims to examine in detail the geomorphological and educational characteristics of the Badlands (Kırgıbayır) terrain located in the Delice tributary of the Kızılırmak Basin. The

Delice tributary, which feeds the Kızılırmak River and is one of its important branches, is located in the middle part of the Kızılırmak Basin. Due to the semi-arid climatic conditions of the region, soft soils and permeable rocks are highly susceptible to water erosion, which has led to the formation of deep gullies and a complex badlands morphology. Using GIS (ArcMap) imagery, the drainage network and morphological diversity of the area were evaluated. The badlands that developed along the Delice tributary are areas where erosion processes are dominant and where geological processes can be clearly observed in the field.

The badlands of the Delice tributary, which have significant importance in terms of educational geosite potential, provide valuable opportunities for researchers to observe geomorphological processes in the field and to interpret the topographic differences that emerge as a result of these processes. In particular, the deep gullies and erosion features formed by the action of water shaping the soil offer a concrete visual learning environment in addition to theoretical knowledge. This morphological diversity has developed through natural processes and also functions as a natural laboratory for field research. Badlands are important not only for the preservation of the region's geomorphological structure but also for educational activities associated with geotourism. As a result, the badlands topography unique to the Kızılırmak Basin should be registered as an educational geosite, as it holds vital importance for promoting nature conservation awareness and for transferring the region's geological heritage to future generations.

Keywords: Geosite, Badlands, Morphology, Geomorphology

Giriş

Yeryüzünde oluşan şekillerin gelişimini inceleyen Jeomorfoloji bilimi, çevrenin yorumlanması ve anlaşılması açısından önemli bir inceleme alanı oluşturur. Jeomorfolojik süreçler beşerî ve fiziki faktörlerin etkileşimiyle meydana gelmektedir. Bu süreçler; aşındırma, taşıma ve biriktirme faaliyetleri ile yeryüzü şekillerinin oluşumunda önemli rol oynamaktadır. Beşerî süreçler daha çok kazıma- doldurma ve aşındırma gibi süreçler olarak görülmektedir. Fiziki coğrafya faktörleri ise iklim, litoloji, hidrografi gibi özelliklerin etkileşimi sonucunda çeşitli topografik şekillerin ortaya çıkmasına neden olmuştur. (Uzun, 2021)

Bu süreçlerin en önemli karakteristik alanlardan biri de Kırgıbayır(badlands) topoğrafyasıdır. Kırgıbayırlar genellikle bitki örtüsünün çok az olduğu kurak-yarıkurak iklim bölgelerinde kolay aşınabilen sedimenter kayaçların yoğun olduğu ve şiddetli yüzey akışı sonucunda gelişen drenaj ağlarını tanımlayan morfolojik alanlardır. Bitki örtüsünün yoksun olduğu alanlarda yamaç dikliği ve yüksek drenaj yoğunluğu gibi özellikler tarım ve hayvancılığı sınırlandıran elverişsiz

sahalardır. Türkiye'deki zengin jeomorfolojik çeşitlilik çok sayıda Kırgıbayırlara ev sahibi yapmaktadır. Doğadaki oluşan ekolojik ve Jeomorfolojik süreçlere ait bilgileri insanlara aktarma ve bu Kırgıbayır sahaların korunması açısından en iyi yolu sahanın Jeositi olarak değerlendirilmesidir. 2000 yılında kurulan Jeolojik Mirası Koruma Derneği (JEMİRKO), Türkiye'de jeolojik mirasın korunması ve jeositlerin belirlenmesi amacıyla faaliyet göstermektedir. Bu dernek Türkiye'deki jeoturizm, jeotsit ve jeopark gibi konuların gelişmesinde büyük öneme sahip olmuş ancak kırgıbayır alanları jeomorfolojik açıdan önemli olmasına rağmen çoğu zaman yeterince değerlendirilmemektedir. (Güney, 2022)

Türkiye'de en önemli Kırgıbayır sahalarında biri olan Kızılırmak Havzasının Delice Kolu çok sayıda Kırgıbayır barındırmaktadır. Bu bölgede oluşan özellikle yüzey akışı sonucu oluşan erozyonun etkisi sonucunda karmaşık drenaj sistemi ve derin yarıntılar Kırgıbayır morfolojisini geliştirmesine neden olmuştur. Bu çalışmada, Kızılırmak Havzası Delice Kolu'nda gelişen Kırgıbayır topoğrafyasının jeomorfolojik özellikleri incelenerek sahanın eğitsel jeosit potansiyelinin ortaya konulması amaçlanmaktadır.

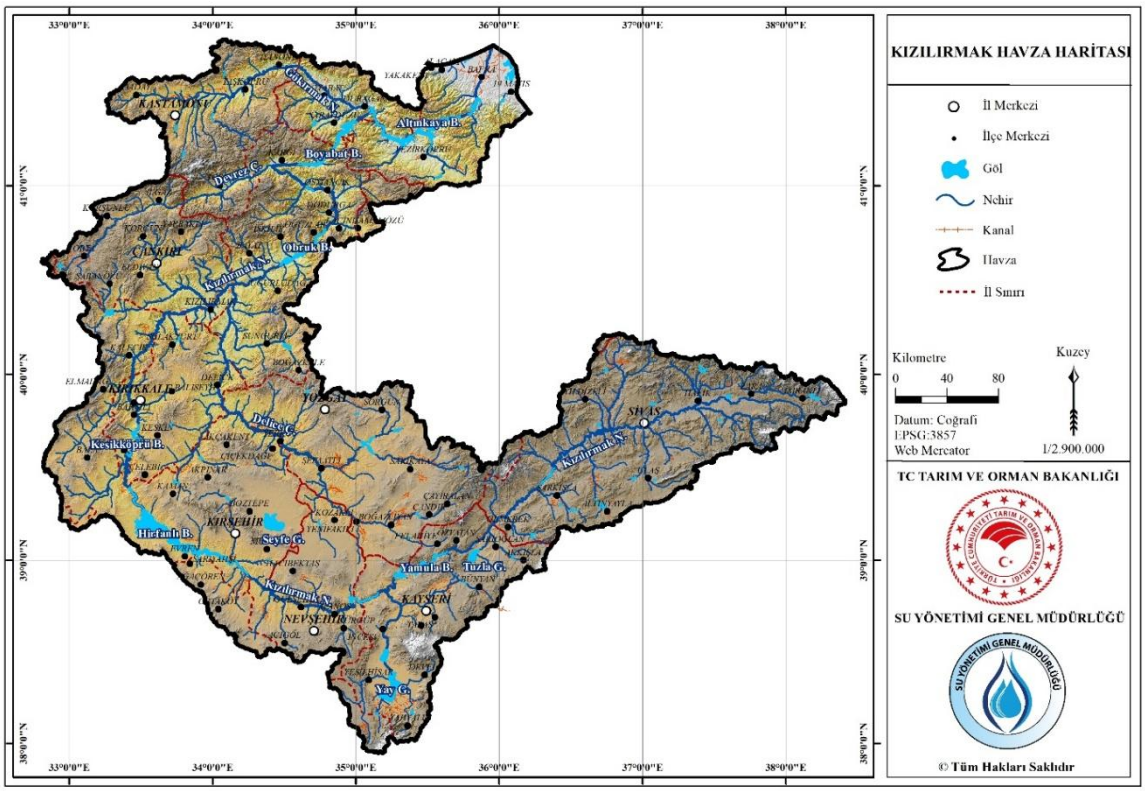
Yöntem

Bu çalışmada, Kızılırmak havzasına ait olan delice kolunda meydana gelen kırgıbayırların Jeomorfolojik-morfolojik özelliklerinin belirlenip sahanın jeosit potansiyelini açıklamak amacıyla literatür incelenmesi ve saha gözlemleri kullanılmıştır.

Araştırmada ilk aşamasında badlands topoğrafyasının oluşumu, gelişimi ve jeomorfolojik özelliklerine ait çalışmalar incelenmiştir. Bu bağlamda yarı kurak iklim koşullarında gelişen yüzey akışı ile kayaçların geçirgenlik özelliklerinin kırgıbayır topoğrafyasının oluşumundaki etkileri ele alınmıştır. Söz konusu iki faktörün topoğrafyanın oluşumuna etkisi, literatürde yer alan bilgiler ile saha gözlemlerinden elde edilen bulguların karşılaştırılması yoluyla gözlemsel olarak değerlendirilmiştir. Araştırmanın bir diğer aşamasını saha çalışmaları oluşturmaktadır. Alana ait badlands topografyasını oluşturan yamaç eğimleri, aşınım şekilleri ve yarıntılar gibi jeomorfolojik süreçler gözlemlenmiş ve bu elde edilen veriler çalışma kapsamında değerlenmiştir.

Çalışmaya ait alanın morfolojik özellikleri ArcGIS (ArcMap) ortamında sayısal yükseklik modeli (DEM) ve uydu görüntülerinden yararlanılarak drenaj ağı, eğim değerleri ve morfolojik özellikler analiz edilmiştir. Bu araştırmaların yanı sıra sahanın eğitsel Jeositi potansiyeli değerlendirilmiştir. Bu kapsamda badlands topograf arasındaki bu meydana gelen Jeomorfolojik süreçlerin sahada gözlemlenmesi ile morfolojik çeşitlilik özellikleri ele alınmıştır.

Araştırma kapsamında sahanın Jeositi ele alınmış ve Jeositi morfolojik özellikleri sayesinde bilimsel-eğitim amaçlı araştırmalara uygun olup doğal alanlar açısından önemlidir. Bu bağlamda badlands topografyası ve sonucunda oluşan süreçleri gözleme imkânı tanınmasıyla farkındalık çalışmaları için doğal miras alanı olarak değer kabul edilmektedir.



Şekil.1 Kızılırmak Havzası (URL 1).

Bulgular ve Tartışma

1. Kırgıbayır Topoğrafyasının Jeomorfolojik Özellikleri

Araştırma sahasını oluşturan Kızılırmak Havzası'nın Delice kolu çevresinde belirgin bir kırgıbayır (badlands) topoğrafyasının geliştiği tespit edilmiştir. Bu topoğrafyanın oluşumunda yarı kurak iklim koşulları, zayıf bitki örtüsü ve kolay aşınabilen litolojik birimlerin önemli rol oynadığı belirlenmiştir. Sahada özellikle yüzey akışı sonucunda gelişen erozyon süreçleri, topoğrafyada derin yarıntılar ve keskin sırtlardan oluşan karmaşık bir morfolojik yapı meydana getirmiştir.

Kırgıbayır topoğrafyasının oluşumunda hem jeolojik hem de jeomorfolojik süreçler gibi birçok faktör vardır. Bunlardan en önemlisi bitki örtüsü ve iklimdir. Arazi gözlemleri sırasında yamaç eğimlerinin oldukça yüksek olduğu ve bu durumun yüzey akışının hızını artırarak erozyon şiddetini yükselttiği görülmüştür. Özellikle yağışlı dönemlerde oluşan yüzey akışı, gevşek yapılı sedimenter kayaçların hızlı bir şekilde aşınmasına neden olmakta ve bu durum kırgıbayır topoğrafyasının gelişimini hızlandırmaktadır. Sahada gözlenen yarıntı sistemleri ve aşınım

şekilleri, su erozyonunun topoğrafya üzerindeki belirgin etkisini açık bir şekilde ortaya koymaktadır. (Sönmez vd., 2023)

Bununla birlikte çalışma alanında gelişen kırgıbayır şekilleri, küçük ölçekli vadicikler, oluklar ve sırt hatlarından oluşan oldukça parçalı bir topoğrafik görünüm sergilemektedir. Bu morfolojik çeşitlilik, alanın jeomorfolojik süreçlerin anlaşılması açısından önemli bir örnek alan niteliği taşıdığını göstermektedir.

2. Drenaj Ağı ve Erozyon Süreçleri

Havza'nın temel ögelerinden biri olan drenaj yoğunluğu, morfometrik unsurları açıklamaya yardımcı olan önemli bir bileşendir. CBS tabanlı analizler ve arazi gözlemleri sonucunda Delice kolu çevresinde oldukça yoğun bir drenaj ağının geliştiği belirlenmiştir. Bu drenaj sistemi çoğunlukla kısa mesafede gelişen yan kollar ve yüzey akışına bağlı küçük akarsu kanallarından oluşmaktadır. Bu durum kırgıbayır topoğrafyasının karakteristik özelliklerinden biri olan yüksek drenaj yoğunluğunu ortaya koymaktadır. (Görür ve Karadeniz, 2018).

Sahada gelişen yarıntıların bazı bölümlerde birkaç metre derinliğe ulaştığı ve bu yarıntıların zamanla birleşerek daha geniş aşınım yüzeyleri oluşturduğu gözlemlenmiştir. Bu süreç, kırgıbayır sahalarında görülen sürekli aşınım ve yeniden şekillenme döngüsünün bir göstergesidir. Ayrıca yüzey akışının oluşturduğu oluklar ve küçük vadiler, topoğrafyanın kısa sürelerde önemli ölçüde değişebildiğini ortaya koymaktadır.

Bu özellikler, Delice kolu çevresindeki kırgıbayır alanlarının aktif jeomorfolojik süreçlerin devam ettiği dinamik bir morfolojik yapıya sahip olduğunu göstermektedir.

3. Eğitsel Jeosit Potansiyeli

Araştırma sahasında gözlenen jeomorfolojik çeşitlilik, alanın eğitsel jeosit potansiyelini önemli ölçüde artırmaktadır. Sahada yer alan yarıntılar, aşınım yüzeyleri, drenaj ağları ve yamaç morfolojisi gibi unsurlar, jeomorfolojik süreçlerin doğrudan gözlemlenebildiği doğal bir açık hava laboratuvarı niteliği taşımaktadır.

Bu özellikler özellikle coğrafya, jeoloji ve çevre bilimleri alanında eğitim gören öğrenciler için teorik bilgilerin sahada gözlemlenmesine olanak sağlamaktadır. Kırgıbayır topoğrafyasında görülen erozyon süreçleri, yüzey akışının topoğrafya üzerindeki etkisi ve drenaj ağlarının gelişimi gibi konular sahada somut örneklerle incelenebilmektedir.

Ayrıca bu alanların eğitsel jeosit olarak değerlendirilmesi, yalnızca akademik çalışmalar açısından değil aynı zamanda doğa koruma bilincinin geliştirilmesi açısından da önemli bir katkı sağlamaktadır. Bu bağlamda Delice kolu çevresindeki kırgıbayır alanlarının jeomorfolojik

miras kapsamında ele alınması ve koruma statüsüne kavuşturulması gerekliliği ortaya çıkmaktadır.

Sonuç ve Öneriler

Bu çalışma kapsamında Kızılırmak havasına ait olan ve Delice kodu güzergahında vuku bulan sahada, Kırgıbayır (badlands) sadece bir arazi olmadığı tam tersine Jeomorfolojik ve eğitsel açıdan önem taşıdığı ortaya konulmuştur. Bulunduğu bölgenin yarı kurak iklim şartları ve kayaç özelliklerinin birbiriyle etkileşimi sonucunda ortaya çıkan derin yarıntı ve drenaj ağı yeryüzünün nasıl şekillendiğini kanıtlayan somut bir göstergedir. Bu bağlamda delice kolunda oluşan Kırgıbayırların coğrafya eğitimi için teorik bilgilerin yanı sıra sahada gözlem yoluyla kalıcı öğrenme ortamı sunan Türkiye'nin eşsiz açık hava laboratuvarlarından biri olarak karşımıza çıkmaktadır. Alanın sahip olduğu değerlerin eğitsel Jeosit kavramı altında incelenmesi, akademik literatür ve doğa koruma bilinci için önem arz etmektedir. Elde edilen sonuçlardan sahanın korunması ve kullanımı için derice kolundaki Kırgıbayırların resmi makamlarca eğitsel Jeosit mevkisi açısından önemli kılmaktadır.

Delice kolunda gelişen kırgıbayır alanlarının jeosit olarak tanımlanması ve envanter çalışmalarına dahil edilmesinin yanı sıra bölgenin sahip olduğu jeomorfolojik potansiyel doğrultusunda jeoturizm faaliyetlerinin geliştirilmesi ve sürdürülebilir turizm planlarının hazırlanması önem taşımaktadır. Sonuç olarak bu alanın korunması ve doğru şekilde değerlendirilmesi, bölgenin doğal değerlerinin sürdürülebilirliği açısından büyük önem taşımaktadır.

Kaynakça

Görür, A. E., & Karadeniz, C. (2018). Morfometrik parametrelerin havza hidrolojisi bakımından değerlendirilmesi. Turkish Journal of Forestry, 19(4), 447-454. https://dergipark.org.tr/en/pub/tjf/issue/41916/476776 (erişim tarihi: 10.03.2026)

Güney, Y. (2022). Türkiye'deki kırgıbayırların jeosit potansiyeli. Jeoloji Mühendisliği Dergisi, 46(1), 51–79. https://dergipark.org.tr/en/download/article-file/2582333 (erişim tarihi: 10.03.2026)

Sönmez, S., Polat, S., & Ege, İ. (2023). Ümren Deresi Havzasının jeomorfosit potansiyeli. *Türk & İslam Dünyası Sosyal Araş-tırmalar Dergisi, 10*(36), 480-510. https://avesis.usak.edu.tr/yayin/f2bbc79e-96c9-46ed-98cf-3cfeba893891/umren-deresi-havzasinin-jeomorfosit-potansiyeli/document.pdf (erişim tarihi: 11.03.2026)

Uzun, M. (2021). İzmit Körfezi kıyılarında insan kaynaklı jeomorfolojik değişimler ve süreçler. Jeomorfolojik Araştırmalar Dergisi, (7), 61–81. https://dergipark.org.tr/en/pub/jader/article/983465 (erişim tarihi: 11.03.2026)

URL

T.C. Tarım ve Orman Bakanlığı. https://www.tarimorman.gov.tr/SYGM/Sayfalar/Detay.aspx?SayfaId=134 (erişim tarihi: 13.03.2026)

HAYVANCILIKTA ANTİBİYOTİK KULLANIMI, ANTİBİYOTİK DİRENCİ VE ANTİBİYOTİK KALINTILARI KONUSUNDA ÇİFTÇİLERİN BİLGİ VE UYGULAMALARININ DEĞERLENDİRİLMESİ: KASTAMONU ÖRNEĞİ

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ÖZET

Hayvancılıkta antibiyotik kullanımı, hayvan sağlığının korunması ve verimliliğin artırılması açısından önemli olmakla birlikte, antibiyotiklerin uygunsuz kullanımı antibiyotik direncinin gelişmesine ve hayvansal gıdalarda antibiyotik kalıntılarının oluşmasına neden olabilmektedir. Bu çalışma, Kastamonu ilinde hayvancılıkla uğraşan çiftçilerin antibiyotik kullanımı, antibiyotik direnci ve hayvansal gıdalarda antibiyotik kalıntılarına ilişkin bilgi, farkındalık ve uygulamalarını değerlendirmek amacıyla gerçekleştirilmiştir. Çalışma tanımlayıcı ve kesitsel bir anket çalışması olarak planlanmıştır. Araştırma Kastamonu Üniversitesi Fen ve Mühendislik Bilimleri Bilimsel Araştırma ve Yayın Etiği Kurulu tarafından onaylanmıştır (05.07.2023 tarih ve 9/2 sayılı karar). Çalışma Kastamonu ilinde hayvancılık faaliyetinde bulunan çiftçiler üzerinde yürütülmüş ve veriler yüz yüze görüşme yöntemi ile uygulanmış 44 sorudan oluşan yapılandırılmış bir anket formu aracılığıyla toplanmıştır. Toplam 50 çiftçi araştırmaya dahil edilmiştir. Anket; demografik özellikler, antibiyotiklere ilişkin genel bilgi, antibiyotik direnci farkındalığı, antibiyotik kullanım uygulamaları, hayvansal gıdalarda antibiyotik kalıntıları konusunda farkındalık ve antibiyotiklerle ilgili daha önce alınan eğitimleri kapsayan bölümlerden oluşmuştur. Tutum ve uygulamalara yönelik maddeler beşli Likert ölçeği ile değerlendirilmiş ve alt ölçekler için ortalama puanlar hesaplanmıştır. Ölçeklerin iç tutarlılığı Cronbach alfa katsayısı ile değerlendirilmiş, verilerin analizinde tanımlayıcı istatistikler, bağımsız örneklem t-testi, tek yönlü varyans analizi (ANOVA) ve Pearson korelasyon analizi kullanılmıştır. Cronbach alfa değerleri antibiyotik direnci farkındalığı ($\alpha = 0.74$), antibiyotik kullanım uygulamaları ($\alpha = 0.71$) ve antibiyotik kalıntıları ve gıda güvenliği farkındalığı ($\alpha = 0.79$) için kabul edilebilir düzeyde bulunmuştur. Çiftçilerin antibiyotik direnci farkındalığı (3.63 ± 0.79), antibiyotik kullanım uygulamaları (3.79 ± 0.63) ve antibiyotik kalıntıları ve gıda güvenliği farkındalığı (3.68 ± 0.54) düzeylerinin orta seviyede olduğu belirlenmiştir. Antibiyotik

direnci farkındalığı ile antibiyotik kullanım uygulamaları arasında orta düzeyde pozitif bir ilişki ($r = 0.40$, $p = 0.004$), antibiyotik direnci farkındalığı ile antibiyotik kalıntıları farkındalığı arasında ise güçlü bir pozitif ilişki ($r = 0.61$, $p < 0.001$) tespit edilmiştir. Eğitim düzeyi ve antibiyotiklerle ilgili daha önce alınan eğitimlerin farkındalık düzeylerini anlamlı şekilde artırdığı belirlenirken, çiftçilik deneyimi ve işletme kapasitesinin farkındalık ve uygulamalar üzerinde anlamlı bir etkisinin olmadığı görülmüştür. Sonuç olarak, çiftçilerin antibiyotik kullanımı ve antibiyotik direnci konusunda orta düzeyde bir farkındalığa sahip oldukları ve hedefe yönelik eğitim programlarının sorumlu antibiyotik kullanımının geliştirilmesinde önemli bir rol oynayabileceği değerlendirilmektedir.

Anahtar Kelimeler: antibiyotik kullanımı, antibiyotik direnci, antibiyotik kalıntıları, hayvancılık, gıda güvenliği, çiftçi farkındalığı

FARMERS' KNOWLEDGE AND PRACTICES ON ANTIBIOTIC USE, RESISTANCE, AND RESIDUES IN LIVESTOCK PRODUCTION: EVIDENCE FROM KASTAMONU, TÜRKIYE

ABSTRACT

The use of antibiotics in livestock production plays an important role in maintaining animal health and improving productivity; however, inappropriate use may contribute to the development of antibiotic resistance and the occurrence of antibiotic residues in animal-derived foods. This study aimed to evaluate farmers' knowledge, awareness, and practices regarding antibiotic use, antibiotic resistance, and antibiotic residues in animal-derived foods in Kastamonu Province, Türkiye. The research was designed as a descriptive cross-sectional survey study. Ethical approval for the study was obtained from the Scientific Research and Publication Ethics Committee of Kastamonu University Faculty of Science and Engineering (Decision No: 9/2, dated 05.07.2023). The study was conducted with livestock farmers in Kastamonu Province, and data were collected through face-to-face interviews using a structured questionnaire consisting of 44 questions. A total of 50 farmers participated in the study. The questionnaire included sections on demographic characteristics, general knowledge of antibiotics, awareness of antibiotic resistance, antibiotic use practices, awareness of antibiotic residues in animal-derived foods, and previous training related to antibiotics. Attitudinal and practice-related items were evaluated using a five-point Likert scale, and composite scores were calculated for each subscale. Internal consistency of the scales was assessed using Cronbach's alpha coefficient. Descriptive statistics, independent samples t-test, one-way analysis of variance (ANOVA), and Pearson correlation analysis were used for statistical analysis. Cronbach's alpha values indicated acceptable reliability for Antibiotic Resistance Awareness

(α = 0.74), Antibiotic Use Practices (α = 0.71), and Antibiotic Residues and Food Safety Awareness (α = 0.79). Farmers demonstrated moderate levels of antibiotic resistance awareness (3.63±0.79), antibiotic use practices (3.79±0.63), and antibiotic residues and food safety awareness (3.68±0.54). A moderate positive correlation was observed between antibiotic resistance awareness and antibiotic use practices ($r = 0.40$, $p = 0.004$), while a strong positive correlation was found between antibiotic resistance awareness and antibiotic residues awareness ($r = 0.61$, $p < 0.001$). Educational level and prior training related to antibiotics significantly improved awareness levels, whereas farming experience and farm capacity did not significantly influence awareness or practices. In conclusion, livestock farmers demonstrated moderate awareness regarding antibiotic use and resistance, and targeted educational programs may play an important role in promoting responsible antibiotic use in livestock production.

Keywords: antibiotic use, antibiotic resistance, antibiotic residues, livestock farming, food safety, farmer awareness

ILIMAN OKYANUSAL İKLİMDE OFİS YAPILARINDA PASİF TASARIM STRATEJİLERİNİN İKLİM VERİSİ TEMELLİ KARŞILAŞTIRMALI ANALİZİ: MELBOURNE ÖRNEĞİ

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ÖZET

Bu çalışma, ılıman okyanusal iklim koşullarına sahip Melbourne kentinde yer alan iki sürdürülebilir ofis yapısının iklim verisi temelli performans karşılaştırmasını amaçlamaktadır. Çalışmada, literatürde yüksek çevresel performans değerleri ile öne çıkan Pixel Building ve Council House 2 yapıları ele alınmıştır. Araştırma yöntemi, üç aşamalı olarak kurgulanmıştır: (i) Melbourne kentine ait Tipik Meteorolojik Yıl (TMY) verilerinin analiz edilmesi ve Isıtma Derece Gün (HDD) ile Soğutma Derece Gün (CDD) değerlerinin hesaplanması, (ii) psikrometrik dağılım üzerinden doğal konfor potansiyelinin değerlendirilmesi, (iii) yapı kabuğu, cephe sistemi ve pasif tasarım stratejilerinin nitel analiz yoluyla incelenmesi ve literatürden elde edilen performans göstergeleriyle karşılaştırılması. Bulgular, Melbourne ikliminin doğal havalandırma ve adaptif konfor modeli açısından önemli potansiyeller sunduğunu göstermektedir. Pixel Building'in modüler cephe ve aktif gölgeleme sistemleri ile düşük enerji tüketimi sağladığı; Council House 2'nin ise termal kütle ve doğal havalandırma bacaları ile ısıtma-soğutma yüklerini azalttığı belirlenmiştir. Çalışma, ılıman iklim bölgelerinde pasif tasarım stratejilerinin nicel iklim verileri ile desteklenmesinin gerekliliğini ortaya koymaktadır.

Anahtar Kelimeler: Pasif Tasarım, HDD-CDD Analizi, Psikrometrik Değerlendirme, Adaptif Konfor, Sürdürülebilir Ofis Yapıları.

COMPARATİVE ANALYSİS OF PASSİVE DESİGN STRATEGİES İN OFFİCE BUİLDİNGS İN A TEMPERATE OCEANİC CLİMATE BASED ON CLİMATE DATA: THE CASE OF MELBOURNE

ABSTRACT

This study aims to comparatively evaluate two sustainable office buildings located in Melbourne, characterized by a temperate oceanic climate, through climate data-based performance assessment. Pixel Building and Council House 2 were selected due to their high environmental performance reported in the literature. The research methodology consists of three stages: (i) analysis of Typical Meteorological Year (TMY) data and calculation of Heating Degree Days (HDD) and Cooling Degree Days (CDD), (ii) evaluation of natural comfort

potential through psychrometric distribution analysis, and (iii) qualitative assessment of building envelope systems and passive design strategies supported by reported performance indicators. The findings indicate that Melbourne's climatic conditions offer significant potential for natural ventilation and adaptive comfort strategies. Pixel Building demonstrates reduced energy demand through modular façade systems and dynamic shading, while Council House 2 utilizes thermal mass and ventilation stacks to decrease heating and cooling loads. The study highlights the importance of integrating quantitative climate data with passive design strategies in temperate regions.

Keywords: Passive Design, Heating and Cooling Degree Days, Psychrometric Analysis, Adaptive Comfort, Sustainable Office Buildings.

1. GİRİŞ VE LİTERATÜR ÇERÇEVESİ

Küresel ölçekte bina sektörü, toplam nihai enerji tüketiminin yaklaşık %36'sından ve enerjiye bağlı karbon emisyonlarının %37'sinden sorumlu tutulmaktadır (IEA, 2022). Özellikle ofis yapıları, yüksek kullanıcı yoğunluğu, uzun çalışma saatleri ve mekanik sistemlere bağımlılık nedeniyle ticari bina kategorisinde önemli bir enerji tüketim payına sahiptir (UNEP, 2021). Bu durum, mimari tasarım sürecinde enerji etkin ve iklimle uyumlu stratejilerin geliştirilmesini zorunlu kılmaktadır.

İklimle etkin tasarım yaklaşımı, yapının bulunduğu coğrafi konumun sıcaklık, nem, rüzgâr ve güneşlenme verilerini dikkate alarak enerji gereksinimini azaltmayı hedefler (Olgyay, 1963). Biyoklimatik tasarım prensipleri, özellikle ılıman iklim bölgelerinde doğal havalandırma, gölgeleme, yönlenme ve termal kütle kullanımı gibi pasif stratejilerin etkin biçimde uygulanabileceğini ortaya koymaktadır (Givoni, 1998).

Melbourne kenti, Köppen iklim sınıflandırmasına göre ılıman okyanusal iklim (Cfb) özellikleri göstermektedir. Bu iklim tipinde yaz ve kış arasındaki sıcaklık farkları aşırı değildir; ancak mevsimsel ısıtma ve soğutma gereksinimleri dengeli bir dağılım sergiler (Peel, Finlayson & McMahon, 2007). Bu durum, adaptif konfor ve doğal havalandırma stratejilerinin uygulanabilirliğini artırmaktadır.

İklim temelli bina performans analizlerinde yaygın olarak kullanılan yöntemlerden biri derece-gün (Degree Day) analizidir. Isıtma Derece Gün (HDD) ve Soğutma Derece Gün (CDD) değerleri, belirli bir taban sıcaklığa göre yıllık ısıtma ve soğutma gereksinimini nicel olarak ifade eder ve enerji talebinin erken tasarım aşamasında tahmin edilmesini sağlar (ASHRAE, 2021). Özellikle aylık ortalama sıcaklık verileriyle yapılan derece-gün hesaplamalarının,

tasarım ön değerlendirmelerinde güvenilir sonuçlar verdiği literatürde belirtilmektedir (Sailor & Pavlova, 2003).

Psikrometrik analizler ise yalnızca sıcaklık değil, aynı zamanda bağıl nem ve hava hareketi gibi parametreleri de dikkate alarak yılın kaç saatinde doğal konfor sağlanabileceğini ortaya koymaktadır (Givoni, 1998). Bu analiz yöntemi, pasif tasarım stratejilerinin uygulanabilirlik potansiyelini belirlemede önemli bir araçtır.

Termal konfor değerlendirmelerinde uzun yıllar boyunca Fanger'ın PMV modeli baskın yaklaşım olmuştur (Fanger, 1970). Ancak doğal havalandırmalı yapılarda kullanıcıların dış ortam koşullarına bağlı olarak konfor beklentilerini değiştirebildiği ve adaptasyon davranışı sergilediği belirtilmiştir. Bu nedenle adaptif konfor modeli geliştirilmiş ve özellikle doğal havalandırmalı ofis yapılarında daha uygun bir değerlendirme aracı olarak kabul edilmiştir (de Dear & Brager, 1998; ASHRAE, 2021).

Melbourne'da yer alan Pixel Building ve Council House 2 gibi ofis yapıları ise bu bağlamda dikkat çekmektedir: Pixel Building, karbon nötr tasarım yaklaşımı, modüler cephe sistemi ve yenilenebilir enerji entegrasyonu ile literatürde yenilikçi bir örnek olarak gösterilmektedir (Crawford et al., 2011). Council House 2 ise doğal havalandırma bacaları, termal kütle kullanımı ve pasif güneş kontrol stratejileri ile enerji tüketimini azaltmayı hedefleyen biyoklimatik bir kamu yapısıdır (City of Melbourne, 2006).

Mevcut çalışmalar bu yapıları genellikle sertifika sistemleri veya genel enerji performans göstergeleri üzerinden incelemekte; ancak derece-gün ve psikrometrik analiz gibi doğrudan iklim verisine dayalı karşılaştırmalı değerlendirmeler sınırlı kalmaktadır. Oysa iklimsel gereksinimlerin nicel olarak ortaya konulması, tasarım kararlarının bağlamsal uygunluğunu değerlendirmek açısından kritik öneme sahiptir.

Bu çalışma, Melbourne'un ılıman okyanusal iklim koşullarını derece-gün hesaplamaları ve psikrometrik değerlendirme yoluyla analiz ederek, Pixel Building ve Council House 2 yapılarında uygulanan pasif tasarım stratejilerinin iklimsel gereksinimlerle ne ölçüde örtüştüğünü karşılaştırmalı olarak incelemeyi amaçlamaktadır.

2. YÖNTEM

Bu çalışma, ılıman okyanusal iklim koşullarında yer alan sürdürülebilir ofis yapılarında pasif tasarım stratejilerinin iklimsel gereksinimlerle ilişkisini değerlendirmek amacıyla nicel iklim verisi analizi ve nitel yapı incelemesini birleştiren karma yöntem yaklaşımı ile yürütülmüştür. Araştırma üç temel aşamadan oluşmaktadır:

1. İklim verilerinin analizi (HDD–CDD hesaplamaları),

2. Psikrometrik değerlendirme ve adaptif konfor potansiyelinin belirlenmesi,
3. Yapı kabuğu ve pasif tasarım stratejilerinin karşılaştırmalı nitel analizi.

Bu yaklaşım, erken tasarım aşamasında yaygın olarak kullanılan derece-gün yönteminin güvenilirliğini (ASHRAE, 2021; Sailor & Pavlova, 2003) ve psikrometrik analizlerin pasif strateji belirlemedeki etkinliğini (Givoni, 1998) temel almaktadır.

2.1 İklim Verilerinin Analizi

Çalışmada Melbourne kentine ait güncel Tipik Meteorolojik Yıl (TMY) verileri kullanılmıştır (Climate.Onebuilding, 2023). TMY verileri, uzun yıllara dayalı meteorolojik ölçümlerin temsilî bir yıllık veri seti hâline getirilmesiyle oluşturulmaktadır ve bina performans analizlerinde standart referans olarak kabul edilmektedir (ASHRAE, 2021).

Bu araştırmada karmaşık saatlik enerji simülasyonları yerine, erken aşama iklim değerlendirmelerinde yaygın olarak kullanılan aylık ortalama sıcaklık temelli derece-gün yöntemi tercih edilmiştir (Sailor & Pavlova, 2003). Bu tercih, metodolojik hata riskini azaltmak ve hesaplama sürecini şeffaf kılmak amacıyla yapılmıştır.

2.1.1 Isıtma Derece Gün (HDD) Hesabı

Isıtma Derece Gün (Heating Degree Days – HDD), belirli bir taban sıcaklığın altında kalan dış ortam sıcaklıklarının yıllık toplam farkını ifade etmektedir. Bu çalışmada taban sıcaklık 18°C olarak kabul edilmiştir (ASHRAE, 2021).

Aylık HDD değeri aşağıdaki formül ile hesaplanmıştır:

$$\text{HD Day} = (\text{Tbase} - \text{Tay}) \times \text{Gün Sayısı}$$

Burada:

- Tbase = 18°C
- TayT_{ay}Tay = ilgili ayın ortalama dış ortam sıcaklığı

Eğer Tay ≥ 18° ise HDD değeri sıfır kabul edilmiştir.

Yıllık HDD değeri, aylık HDD değerlerinin toplamı olarak hesaplanmıştır. Bu yöntem, ısıtma gereksiniminin iklimsel şiddetini ortaya koymak amacıyla kullanılmaktadır (Sailor & Pavlova, 2003).

2.1.2 Soğutma Derece Gün (CDD) Hesabı

Soğutma Derece Gün (Cooling Degree Days – CDD), belirli bir taban sıcaklığın üzerinde kalan dış ortam sıcaklıklarının toplam farkını göstermektedir. Bu çalışmada taban sıcaklık 22°C olarak alınmıştır (ASHRAE, 2021). Taban sıcaklık CDD değeri için BizEE Software (2024) tarafından sağlanan güncel hesaplamalar referans alınmıştır.

Aylık CDD hesabı aşağıdaki formül ile yapılmıştır:

$$CD\ Day = (Tay - Tbase) \times GünSayısı$$

Burada: $T_{base} = 22°C$

Eğer Tay ≤ 22° ise CDD değeri sıfır kabul edilmiştir.

Yıllık CDD değeri, aylık toplamların birleştirilmesiyle elde edilmiştir. HDD ve CDD değerlerinin karşılaştırılması, Melbourne ikliminin ısıtma veya soğutma yönlü baskınlığını belirlemeye olanak sağlamaktadır.

2.2 Psikrometrik Değerlendirme ve Adaptif Konfor

Melbourne'un doğal konfor potansiyelini belirlemek amacıyla psikrometrik analiz yapılmıştır. Psikrometrik diyagram, sıcaklık ve bağıl nem parametrelerini birlikte değerlendirerek yılın hangi saatlerinde doğal konfor koşullarının sağlanabileceğini göstermektedir (Givoni, 1998).

Saatlik TMY verileri, Climate Consultant yazılımı aracılığıyla analiz edilmiş ve yılın doğal konfor aralığında kalan saat yüzdesi belirlenmiştir (UCLA Energy Design Tools Group (2018). Değerlendirmede adaptif konfor modeli esas alınmıştır.

Adaptif konfor modeli, doğal havalandırmalı yapılarda kullanıcıların dış ortam koşullarına uyum sağlayabildiğini kabul etmektedir (de Dear & Brager, 1998). ASHRAE Standard 55'e göre adaptif konfor sıcaklığı aşağıdaki şekilde hesaplanmaktadır (ASHRAE, 2021):

$$T_{comfort} = 0.31 \times T_{outdoor,mean} + 17.8$$

Bu çalışmada aylık ortalama dış sıcaklık değerleri kullanılarak konfor sıcaklığı belirlenmiş ve ±3.5°C kabul edilebilir konfor aralığı referans alınmıştır. Bu analiz, doğal havalandırma ve gölgeleme stratejilerinin potansiyel etkinliğini ortaya koymak amacıyla kullanılmıştır.

2.3 Yapıların Karşılaştırmalı Nitel Analizi

Nicel iklim analizinin ardından, seçilen iki yapı olan Pixel Building ve Council House 2 pasif tasarım stratejileri açısından karşılaştırılmıştır.

Değerlendirme aşağıdaki kriterler üzerinden yürütülmüştür:

- Yapı yönlenmesi
- Cephe oranı (cam/duvar ilişkisi)
- Gölgeleme sistemleri
- Doğal havalandırma stratejileri
- Termal kütle kullanımı
- Yenilenebilir enerji entegrasyonu

Veriler teknik raporlar, literatür çalışmaları ve yayınlanmış performans raporları üzerinden derlenmiştir (City of Melbourne, 2006; Crawford et al., 2011). Bu aşamada amaç, iklim verilerinin ortaya koyduğu gereksinimlerle yapıların tasarım kararları arasındaki uyumu değerlendirmektir.

3. BULGULAR

Bu bölümde Melbourne kentine ait iklim verileri üzerinden yapılan HDD–CDD hesaplamaları, psikrometrik değerlendirme sonuçları ve iki yapının pasif tasarım stratejilerinin iklimsel gereksinimlerle ilişkisi sunulmaktadır.

3.1 HDD ve CDD Analizi Sonuçları

Melbourne'un aylık ortalama sıcaklık verileri kullanılarak 18°C taban sıcaklığı için Isıtma Derece Gün (HDD) ve 22°C taban sıcaklığı için Soğutma Derece Gün (CDD) değerleri hesaplanmıştır (ASHRAE, 2021).

Tablo 1. Melbourne Aylık HDD ve CDD Değerleri

Ay	Ort. Sıcaklık (°C)	HDD	CDD
Ocak	20.3	12	65.7
Şubat	20	6	37.7
Mart	18.6	27	47.5
Nisan	15.1	94	19.1
Mayıs	12	187	1.3
Haziran	9.9	243	0
Temmuz	9.5	262	0
Ağustos	9.6	262	0
Eylül	11.9	185	0.3
Ekim	13.8	138	6
Kasım	16.7	68	7.8
Aralık	18.6	40	36.7

Not: Analizler güncel YMML istasyonu TMY verileri kullanılarak elde edilmiştir.

Yıllık HDD ≈ 1526

Yıllık CDD ≈ 293

- Melbourne iklimi bütüncül olarak değerlendirildiğinde ısıtma gereksinimlerinin yüksek olduğu ortaya çıkmakta.

- Soğutma yükü sınırlıdır.
- Yaz aylarında gölgeleme gereksinimi olsa da yıllık enerji baskısı ısıtma yönündedir.

Bu sonuç, ılıman okyanusal iklimin dengeli fakat kış ağırlıklı bir enerji profili sunduğunu gösteren literatür bulgularıyla uyumludur (Peel et al., 2007).

3.2 Psikrometrik Değerlendirme Bulguları

Saatlik TMY verileri Climate Consultant yazılımı ile analiz edilmiştir (UCLA Energy Design Tools Group, 2018). Adaptif konfor modeli referans alınmıştır (de Dear & Brager, 1998; ASHRAE, 2021).

Psikrometrik analiz parametreleri belirlenirken pasif güneş kazancı potansiyeli için hafif kabuk (low mass) yerine yüksek kütle (high mass) tercih edilmiştir. Bu tercihin sebebi, iki yapının ağır betonarme elemanlarının kış güneşinden kazandığı ısıyı depolayıp gece mekâna salarak ürettiği ısıl gecikme etkisini simülasyona doğru aktarabilmektir.

Elde Edilen Bulgular

- Yılın %11.5'i doğal konfor aralığında
- %70.6'i ısıtma gereksinimi
- %13.2'i pasif güneş kazancı (yüksek kütle) ile iyileştirilebilir
- %5.7'i gölgeleme gerektirir
- %4'ü mekanik soğutma gerektirir

Melbourne iklimi:

- Yılın büyük bir kısmında (%70.6) ihtiyaç olan ısıtma yükü için yalıtım stratejileri zorunludur.
- Yaz aylarındaki mekanik soğutma ihtiyacı (%4) düşük olsa da cephedeki gölgeleme sistemleri (%5.7) önlem olarak karşımıza çıkar.
- Kış aylarındaki pasif güneş kazancı (%13.2) iç mekandaki termal konfor aralığını iyileştirmede önemlidir.

Bu durum, adaptif konfor modelinin ılıman iklimlerde uygulanabilirliğini desteklemektedir (de Dear & Brager, 1998).

3.3 Yapıların İklimsel Gereksinimlerle Uyum Analizi

Nicel iklim verileri ışığında, seçilen iki yapı pasif tasarım stratejileri açısından değerlendirilmiştir.

Karşılaştırılan yapılar:

- Pixel Building
- Council House 2

3.3.1 Pixel Building

Literatürde karbon nötr yaklaşımı ve modüler cephe sistemi ile tanımlanmaktadır (Crawford et al., 2011).

Başlıca özellikler:

- Hareketli ve renkli cephe panelleri
- Fotovoltaik sistem entegrasyonu
- Yüksek performanslı cam
- Yenilenebilir enerji üretimi

İklim verisi bağlamında değerlendirme:

- Düşük CDD değerleri göz önüne alındığında, aktif gölgeleme sistemi yaz yükünü azaltmada yeterlidir.
- Ancak yüksek HDD değerleri dikkate alındığında, cephe sisteminin ısı kaybını minimize edecek şekilde tasarlanmış olması kritik önem taşımaktadır.

Pixel Building, teknoloji destekli ve performans odaklı bir çözüm sunmaktadır.

3.3.2 Council House 2

City of Melbourne (2006) raporuna göre yapı, doğal havalandırma bacaları ve yüksek termal kütle kullanımı ile tasarlanmıştır.

Başlıca özellikler:

- Doğal havalandırma bacaları
- Beton termal kütle
- Dış gölgeleme elemanları
- Gece soğutması stratejisi

İklim verisi bağlamında değerlendirme:

- Yüksek HDD değeri nedeniyle termal kütle kış döneminde ısı depolama avantajı sağlamaktadır.
- Psikrometrik analizde belirlenen doğal konfor saatleri, doğal havalandırma stratejisinin uygunluğunu desteklemektedir.

Council House 2, daha biyoklimatik ve düşük teknolojiye dayalı bir yaklaşım sergilemektedir.

3.4 Karşılaştırmalı Değerlendirme

Tablo 2. Pixel Building ve Council House 2 Karşılaştırmalı Değerlendirme

Kriter	Pixel Building	Council House 2
Yaklaşım	Teknolojik + modüler	Biyoklimatik
Gölgeleme	Dinamik paneller	Sabit dış gölgeleme
Doğal havalandırma	Sınırlı	Aktif baca sistemi
Termal kütle	Orta	Yüksek
Yenilenebilir enerji	Yüksek	Orta

- Melbourne'un ısıtma baskın iklimi dikkate alındığında, termal kütle avantajı nedeniyle Council House 2 pasif ısı kontrolünde daha doğrudan biyoklimatik çözüm sunmaktadır.
- Pixel Building ise enerji üretimi ve yüksek performanslı kabuk sistemi ile net enerji dengesini optimize etmektedir.
- Her iki yapı da düşük CDD değerleri nedeniyle ağır mekanik soğutma stratejilerine ihtiyaç duymamaktadır.

4. SONUÇ

Bu çalışmada, Melbourne'un ılıman okyanusal iklim koşullarında yer alan Pixel Building ve Council House 2 yapılarının pasif tasarım stratejileri ve iklimsel performansları karşılaştırmalı olarak incelenmiştir. Araştırma, derece-gün hesaplamaları, psikrometrik analiz ve yapı niteliklerinin sistematik karşılaştırmasını içeren karma yöntem yaklaşımı ile yürütülmüştür.

Elde edilen bulgular aşağıdaki sonuçları ortaya koymaktadır:

1. **İklimle uyumlu tasarımın etkinliği:** Her iki yapı da Melbourne'un düşük CDD ve yüksek HDD değerleri doğrultusunda enerji performansını optimize edecek biçimde tasarlanmıştır. Council House 2'nin yüksek termal kütlesi ve doğal havalandırma bacaları, pasif ısı yönetiminde doğrudan etkinlik sağlar. Pixel Building ise yenilenebilir enerji üretimi ve dinamik cephe sistemi ile enerji dengelemesi konusunda teknoloji odaklı bir çözüm sunar (Crawford et al., 2011; City of Melbourne, 2006).
2. **Adaptif konfor potansiyeli:** Psikrometrik analizler, yılın yaklaşık %11.5'inde doğal konfor koşullarının sağlandığını göstermektedir. Bu durum, adaptif konfor modelinin ılıman iklimlerde uygulanabilirliğini desteklemektedir (de Dear & Brager, 1998). Council House 2'nin biyoklimatik stratejileri, doğal havalandırma ve gölgeleme kombinasyonu ile adaptif konfor saatlerini maksimize etmektedir. Pixel Building'in ise açılabilen pencereleri, cephedeki sabit gölgeleme elemanları ve yüksek kütleli beton yapısı adaptif konfor saati aralığını artırmaktadır.

3. **Pasif ve aktif stratejilerin karşılıklı rolü:** Pixel Building'de yüksek teknolojiye dayalı cephe sistemleri ve enerji üretim kapasitesi, pasif stratejilerle birlikte enerji performansını bütüncül olarak iyileştirmektedir. Bu, modern sürdürülebilir tasarım yaklaşımının, pasif ve aktif sistemlerin dengeli kullanımına dayandığını göstermektedir (Givoni, 1998).
4. **Tasarım kararlarının iklim verisiyle ilişkisi:** Yapı yönlenmesi, cephe oranları, gölgeleme ve termal kütle kullanımı gibi tasarım kararları, derece-gün ve psikrometrik analiz sonuçlarıyla yüksek oranda uyumludur. Bu da, iklim verisinin tasarımın erken aşamalarında sistematik olarak kullanılması gerektiğini doğrulamaktadır (Olgyay, 1963; ASHRAE, 2021).
5. **Karşılaştırmalı öğrenim:** İki yapı arasındaki karşılaştırma, farklı sürdürülebilir tasarım stratejilerinin iklimsel koşullara göre nasıl optimize edilebileceğini ortaya koymaktadır. Pixel Building teknolojik odaklı çözüm sunarken, Council House 2 biyoklimatik yaklaşımıyla doğal sistemlerin potansiyelini ön plana çıkarmaktadır.

4.1 Araştırmanın Katkısı ve Uygulama Önerileri

- Bu çalışma, adaptif konfor ve pasif stratejilerin ılıman okyanusal iklimlerde pratikte nasıl uygulanabileceğini gösteren karşılaştırmalı bir örnek sunmaktadır.
- Derece-gün ve psikrometrik analizlerin, tasarımın erken aşamalarında karar destek aracı olarak kullanılması, enerji ve konfor performansını optimize edebilir.
- Gelecek çalışmalarda, gerçek zamanlı enerji ölçümleri ve kullanıcı memnuniyet verilerinin entegre edilmesi ile bu analizler daha da derinleştirilebilir.

Sonuç olarak, iklimle etkin tasarım, yalnızca enerji verimliliğini artırmakla kalmayıp, kullanıcı konforunu ve yapısal performansı bütüncül bir perspektifte iyileştirmektedir. Melbourne örneğinde, hem teknolojik hem de biyoklimatik stratejilerle tasarlanmış yapılar, iklim verileriyle uyumlu ve sürdürülebilir çözümler sunabilmektedir. Bu, sürdürülebilir mimaride iklim verisinin tasarımda merkezi bir rol oynamasının önemini bir kez daha doğrulamaktadır (Olgyay, 1963; Givoni, 1998; de Dear & Brager, 1998).

KAYNAKLAR

ASHRAE. (2021). *ASHRAE Standard 55: Thermal Environmental Conditions for Human Occupancy*. Atlanta: ASHRAE.

BizEE Software. (t.y.). *DegreeDays.net*. 14 Mart 2024 tarihinde https://www.degreedays.net adresinden erişildi.

City of Melbourne. (2006). *Council House 2 (CH2) Design Report*. Melbourne.

Climate.Onebuilding. (2023). *Repository of free climate data for building performance simulation* [Veri Seti]. https://climate.onebuilding.org

Crawford, R. H., et al. (2011). Life cycle assessment of a low-carbon office building: The Pixel Building case study. *Building Research & Information*, 39(5), 475–489.

de Dear, R., & Brager, G. (1998). Developing an adaptive model of thermal comfort. *ASHRAE Transactions*, 104(1), 145–167.

Fanger, P. O. (1970). *Thermal Comfort: Analysis and Applications in Environmental Engineering*. Copenhagen: Danish Technical Press.

Givoni, B. (1998). *Climate Considerations in Building and Urban Design*. New York: Wiley.

IEA. (2022). *Buildings Sector Report*. International Energy Agency.

Olgyay, V. (1963). *Design with Climate: Bioclimatic Approach to Architectural Regionalism*. Princeton University Press.

Peel, M. C., Finlayson, B. L., & McMahon, T. A. (2007). Updated world map of the Köppen–Geiger climate classification. *Hydrology and Earth System Sciences*, 11, 1633–1644.

Sailor, D. J., & Pavlova, A. A. (2003). Air conditioning market saturation and long-term response of residential cooling energy demand to climate change. *Energy*, 28(9), 941–951.

UCLA Energy Design Tools Group. (2018). *Climate Consultant* (Sürüm 6.0) [Bilgisayar Yazılımı]. https://energydesign-tools.aud.ucla.edu

UNEP. (2021). *Global Status Report for Buildings and Construction*. United Nations Environment Programme.

PAMUKKALE ÜNİVERSİTESİ ÖĞRENCİLERİNİN YATIRIM DAVRANIŞLARI VE RİSK PROFİLLERİNİN İNCELENMESİ

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ÖZET

Finansal piyasaların giderek daha erişilebilir hale gelmesi ve dijital yatırım platformlarının yaygınlaşması genç bireylerin yatırım araçlarına olan ilgisini artırmaktadır. Özellikle üniversite öğrencileri sınırlı gelir düzeyi ve görece düşük yatırım deneyimine rağmen finansal piyasalara yönelmekte ve farklı yatırım araçlarını değerlendirebilmektedir. Bu durum genç bireylerin yatırım davranışlarının ve risk profillerinin incelenmesini önemli hale getirmektedir. Bu çalışmanın amacı Pamukkale Üniversitesi'nde öğrenim gören 18–25 yaş aralığındaki öğrencilerin yatırım davranışları ile risk profillerini incelemektir. Araştırma kapsamında anket yöntemi kullanılarak 409 öğrenciden veri toplanmıştır. Ölçeğin güvenilirliğini belirlemek amacıyla Cronbach Alpha analizi uygulanmış ve ölçeğin güvenilirlik katsayısı 0,659 olarak hesaplanmıştır. Değişkenler arasındaki ilişkilerin belirlenmesi amacıyla Pearson korelasyon analizi ve yatırım davranışını etkileyen faktörlerin incelenmesi amacıyla çoklu doğrusal regresyon analizi uygulanmıştır.

Araştırma bulgularına göre öğrencilerin yatırım tercihlerinde altın, hisse senedi ve döviz gibi geleneksel yatırım araçlarının ön plana çıktığı görülmektedir. Buna karşılık yatırım fonları, kripto varlıklar ve VİOP gibi daha fazla finansal bilgi gerektiren yatırım araçlarının tercih edilme oranlarının daha düşük olduğu belirlenmiştir. Korelasyon analizi sonuçları risk alma eğilimi ile yatırım deneyimi arasında pozitif yönlü ve istatistiksel olarak anlamlı bir ilişki olduğunu göstermektedir ($r = 0,259$; $p < 0,001$). Regresyon analizi sonuçlarına göre kurulan model genel olarak istatistiksel açıdan anlamlı bulunmuş ($F = 52.236$; $p < 0.001$) ve modelin açıklayıcılık düzeyi $R^2 = 0.279$ olarak hesaplanmıştır. Elde edilen sonuçlara göre, yatırım yapma deneyiminin (yıl) yatırım davranışı üzerinde pozitif ve istatistiksel olarak anlamlı bir etkiye sahip olduğu tespit edilmiştir ($\beta = 0.537$; $p < 0.001$). Buna karşılık finansal piyasaları takip etme ve yatırım araçlarını elde tutma süresi değişkenlerinin yatırım davranışı üzerinde istatistiksel olarak anlamlı bir etkisi bulunmamıştır. Elde edilen bulgular üniversite öğrencilerinin yatırım davranışlarının yalnızca ekonomik faktörlerle değil aynı zamanda yatırım deneyimi ve risk algısı gibi davranışsal faktörlerle de şekillendiğini göstermektedir. Bu

sonuçlar genç bireylerin finansal bilinçlerinin artırılmasına yönelik eğitim çalışmalarının önemini ortaya koymaktadır.

Anahtar Kelimeler: Yatırım Davranışı, Risk Profili, Finansal Okuryazarlık, Davranışsal Finans, Yatırım Deneyimi

AN EXAMINATION OF THE INVESTMENT BEHAVIORS AND RISK PROFILES OF PAMUKKALE UNIVERSITY STUDENTS

ABSTRACT

As financial markets become more accessible and digital investment platforms expand, young individuals are showing greater interest in investment instruments. In particular, university students are increasingly engaging with financial markets and evaluating different investment options despite having limited income and relatively low investment experience. This makes the examination of their investment behaviors and risk profiles especially important. The aim of this study is to investigate the investment behaviors and risk profiles of students aged 18–25 studying at Pamukkale University. Data were collected from 409 students through a survey. To assess the reliability of the scale, Cronbach's Alpha analysis was conducted, and the reliability coefficient was calculated as 0.659. Pearson correlation analysis was used to identify relationships among the variables, while multiple linear regression analysis was employed to examine the factors affecting investment behavior.

The findings show that traditional investment instruments such as gold, stocks, and foreign currency are the most preferred by students. In contrast, investment instruments requiring greater financial knowledge, such as mutual funds, crypto assets, and VIOP, are less preferred. Correlation analysis revealed a positive and statistically significant relationship between risk-taking tendency and investment experience ($r = 0.259$; $p < 0.001$). Regression results indicated that the overall model was statistically significant ($F = 52.236$; $p < 0.001$), with an explanatory power of $R^2 = 0.279$. Investment experience (in years) was found to have a positive and statistically significant effect on investment behavior ($\beta = 0.537$; $p < 0.001$). By contrast, following financial markets and the holding period of investment instruments did not have statistically significant effects. Overall, the findings suggest that university students' investment behaviors are shaped not only by economic factors but also by behavioral factors such as investment experience and risk perception. These results underline the importance of educational efforts aimed at improving young individuals' financial awareness.

Keywords: Investment Behavior, Risk Profile, Financial Literacy, Behavioral Finance, Investment Experience

YATIRIM DAVRANIŞLARININ ÜNİVERSİTE ÖĞRENCİLERİNİN GELECEK KAYGISI VE GELECEK KORKUSU ÜZERİNDEKİ ETKİLERİNİN İNCELENMESİ

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ÖZET

Artan ekonomik belirsizlikler, iş gücü piyasalarındaki dönüşümler ve yaşam maliyetlerindeki artış üniversite öğrencilerinin geleceğe yönelik kaygı düzeylerini önemli ölçüde etkileyebilmektedir. Bu süreçte bireylerin finansal davranışları ve yatırım kararları geleceğe ilişkin algılarının şekillenmesinde önemli bir rol oynayabilmektedir. Bu çalışmanın amacı, üniversite öğrencilerinin yatırım davranışları ile gelecek kaygısı düzeyleri arasındaki ilişkinin incelenmesidir. Araştırma Pamukkale Üniversitesi Uygulamalı Bilimler Fakültesi'nde öğrenim gören lisans öğrencilerinden anket yöntemiyle elde edilen veriler kullanılarak gerçekleştirilmiştir. Araştırma kapsamında 263 öğrenciye ulaşılmış, veri temizleme sürecinin ardından analizler 228 geçerli gözlem üzerinden yürütülmüştür. Araştırmada kullanılan gelecek kaygısı (gelecek korkusu) ölçeğinin yüksek düzeyde güvenilir olduğu belirlenmiştir (Cronbach's Alpha = 0,927).

Öğrencilerin yatırım davranışı, finansal piyasalara katılım düzeyini daha doğru yansıtabilmek amacıyla sahip oldukları yatırım araçlarının sayısı (portföy sayısı) esas alınarak ölçülmüştür. Portföy sayısı ile gelecek kaygısı arasındaki ilişki Spearman korelasyon analizi ile incelenmiş ve değişkenler arasında negatif yönlü ve istatistiksel olarak anlamlı bir ilişki olduğu belirlenmiştir ($r = -0.218$, $p < 0.001$). Bu bulgu öğrencilerin sahip oldukları yatırım araçlarının sayısı arttıkça gelecek kaygısı düzeylerinin azalma eğiliminde olduğunu göstermektedir. Gelecek kaygısını etkileyen faktörleri belirlemek amacıyla çoklu doğrusal regresyon analizi uygulanmıştır. Analiz sonuçlarına göre kurulan model genel olarak istatistiksel açıdan anlamlı bulunmuştur ($F = 6.306$; $p < 0.001$). Modelin açıklayıcılık düzeyi $R^2 = 0.078$ olarak hesaplanmıştır. Regresyon sonuçları, portföy sayısının gelecek kaygısı üzerinde negatif ve istatistiksel olarak anlamlı bir etkiye sahip olduğu göstermektedir ($\beta = -0.182$; $p = 0.009$). Aylık gelir değişkeninin ise negatif yönlü ve %10 anlamlılık düzeyinde anlamlı bir etkiye sahip olduğu görülmektedir ($\beta = -0.118$; $p = 0.086$). Buna karşılık finansal okuryazarlık değişkeninin gelecek kaygısı üzerinde istatistiksel olarak anlamlı bir etkisi bulunmamıştır. Sonuç olarak elde edilen bulgular, üniversite öğrencilerinin yatırım faaliyetlerine katılım düzeyleri arttıkça

gelecek kaygılarının azalma eğiliminde olduğunu göstermektedir. Bu sonuç finansal piyasalara katılımın bireylerde ekonomik kontrol ve güven algısını güçlendirerek geleceğe yönelik belirsizlikler karşısında kaygı ve korkularını azaltabileceğini düşündürmektedir.

Anahtar Kelimeler: Davranışsal Finans, Yatırım Davranışı, Gelecek Kaygısı, Finansal Okuryazarlık, Portföy Çeşitlendirmesi

AN INVESTIGATION OF THE IMPACT OF INVESTMENT BEHAVIORS ON UNIVERSITY STUDENTS' FUTURE ANXIETY AND FEAR OF THE FUTURE

ABSTRACT

Increasing economic uncertainties, transformations in labor markets, and rising living costs can significantly affect university students' levels of future anxiety. In this process, individuals' financial behaviors and investment decisions may play an important role in shaping their perceptions of the future. The aim of this study is to examine the relationship between university students' investment behaviors and their levels of future anxiety. The research was conducted using survey data collected from undergraduate students enrolled in the Faculty of Applied Sciences at Pamukkale University. A total of 263 students were reached within the scope of the study, and after the data cleaning process, the analyses were carried out on 228 valid observations. The future anxiety (fear of the future) scale used in the study was found to be highly reliable (Cronbach's Alpha = 0.927).

Students' investment behavior was measured on the basis of the number of investment instruments they owned (portfolio size) in order to reflect their level of participation in financial markets more accurately. The relationship between portfolio size and future anxiety was examined through Spearman correlation analysis, and a negative and statistically significant relationship was identified between the variables ($r = -0.218$, $p < 0.001$). This finding indicates that as the number of investment instruments owned by students increases, their level of future anxiety tends to decrease. To identify the factors affecting future anxiety, multiple linear regression analysis was applied. According to the results, the estimated model was found to be statistically significant overall ($F = 6.306$; $p < 0.001$). The explanatory power of the model was calculated as $R^2 = 0.078$. The regression results show that portfolio size has a negative and statistically significant effect on future anxiety ($\beta = -0.182$; $p = 0.009$). Monthly income was also found to have a negative effect, significant at the 10% level ($\beta = -0.118$; $p = 0.086$). In contrast, the financial literacy variable did not have a statistically significant effect on future anxiety. In conclusion, the findings indicate that as university students' level of participation in investment activities increases, their future anxiety tends to decline. This result suggests that

participation in financial markets may reduce individuals' anxiety and fear regarding future uncertainties by strengthening their sense of economic control and security.

Keywords: Behavioral Finance, Investment Behavior, Future Anxiety, Financial Literacy, Portfolio Diversification

TIP FAKÜLTESİ ÖĞRENCİLERİNDE TIBBİ AMAÇ DIŞI METİLFENİDAT KULLANIMI: DUYGU DÜZENLEME PERSPEKTİFİ

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ÖZET

Metilfenidat grubu ilaçlar, merkezi sinir sistemi uyarıcı grubunda yer almakta ve klinik olarak Dikkat Eksikliği ve Hiperaktivite Bozukluğu ile narkolepsi tedavisinde kullanılmaktadır. Kısa vadeli uyarıcı etkileri nedeniyle tıbbi amaç dışı kullanımı artmaktadır. Özellikle tıp öğrencilerinde yaygın kullanım eğilimi bildirilmektedir. Metilfenidat grubu ilaçlar, kısa vadede dikkat ve uyanıklığı artırsa da uzun vadede bağımlılık riski taşımaktadır. Bu durum tıbbi amaç dışı kullanımın hem birey hem de halk sağlığı açısından önemli bir risk faktörü olduğunu göstermektedir. Bu bağlamda, tanı doğrultusunda kullanımın dışında bu ilaçların kısa vadeli etkilerine alternatif olarak aynı hedeflere daha güvenilir ve sürdürülebilir şekilde ulaşılmasını sağlayabilecek duygu düzenleme becerilerinin geliştirilmesi önem kazanmaktadır. Literatürde tıp öğrencilerinin tıbbi amaç dışı metilfenidat kullanımı ile duygu düzenleme güçlüklerini birlikte ele alan çalışmaya rastlanmamıştır. Bu derlemenin amacı, tıp öğrencilerinin tıbbi amaç dışı metilfenidat kullanım motivasyonlarını incelemek ve duygu düzenleme becerilerinin alternatif bir yaklaşım olarak ele alınışı değerlendirmektir. Bu doğrultuda PubMed, Springer ve Google Scholar veri tabanlarında 2010-2026 yılları arasında yayımlanan çalışmalar incelenmiş ve elde edilen bulgular narrative literatür derlemesi yaklaşımı doğrultusunda kavramsal olarak değerlendirilmiştir. Tıp öğrencilerinin yoğun eğitim programı, uykusuzluk, akran rekabeti ve geleceğe yönelik mükemmellik baskısı nedeniyle yüksek stres ve tükenmişlik yaşadığı görülmektedir. Bu nedenle tıp öğrencilerinin metilfenidat grubu ilaçları odaklanma, performans artırma ve uzun süreli çalışma amacıyla tıbbi amaç dışı kullandıkları görülmektedir. Buna ek olarak, tıp öğrencilerinin yüksek stres ve kaygı ile baş etmekte zorlandıkları ve duygu farkındalığı ile duygu düzenleme becerilerinde güçlük yaşadıkları bildirilmektedir. Bu bulgular, tıp öğrencilerinin tıbbi amaç dışı metilfenidat grubu ilaç kullanımının yalnızca akademik performansla ilişkili olmayabileceğini, aynı zamanda duygu düzenleme güçlükleriyle de

bağlantılı olabileceğini düşündürmektedir. Bu bağlamda duygu düzenleme becerilerinin desteklenmesi, tıp öğrencilerinin akademik ve duygusal ihtiyaçlarını karşılamada daha güvenli ve sürdürülebilir bir yaklaşım olarak değerlendirilebileceği düşünülmektedir.

Anahtar Kelimeler: Tıp fakültesi öğrencileri, metilfenidat, duygu düzenleme

NON-MEDICAL USE OF METHYLPHENIDATE AMONG MEDICAL STUDENTS: AN EMOTION REGULATION PERSPECTIVE

ABSTRACT

Methylphenidate-based medications belong to the class of central nervous system stimulants and are clinically used in the treatment of Attention Deficit and Hyperactivity Disorder (ADHD) and narcolepsy. Due to their short-term stimulant effects, the non-medical use of these medications has been increasing. A growing tendency of such use has been reported particularly among medical students. Although methylphenidate-based medications can enhance attention and alertness in the short term, they carry a risk of dependence in the long term. This situation indicates that non-medical use represents a significant risk factor for both individuals and public health. In this context, beyond clinically indicated use, the development of emotion regulation skills has gained importance as an alternative approach that may enable individuals to achieve similar goals in a safer and more sustainable manner than relying on the short-term effects of these medications. In the existing literature, no study has been identified that simultaneously addresses non-medical methylphenidate use and difficulties in emotion regulation among medical students. The aim of this review is to examine the motivations underlying non-medical methylphenidate use among medical students and to evaluate the role of emotion regulation skills as an alternative approach. For this purpose, studies published between 2010 and 2026 were examined using the PubMed, Springer, and Google Scholar databases, and the findings were conceptually evaluated within the framework of a narrative literature review. Medical students are frequently exposed to high levels of stress and burnout due to demanding educational programs, sleep deprivation, peer competition, and perfectionistic expectations regarding future professional success. Consequently, some students report using methylphenidate without medical indication to enhance concentration, improve academic performance, and sustain prolonged study periods. In addition, previous studies indicate that medical students often experience difficulties coping with high levels of stress and anxiety and may struggle with emotion awareness and emotion regulation processes. These findings suggest that non-medical methylphenidate use among medical students may not be solely related to academic performance demands but may also be associated with difficulties in emotion regulation. In this context, strengthening emotion regulation skills may represent a safer and

more sustainable approach for addressing both the academic and emotional needs of medical students.

Keywords: Medical students, methylphenidate, emotion regulation

GENÇ ERİŞKİNLERDE DUDAK ANTROPOMETRİSİNİN DOĞRUDAN ÖLÇÜM YÖNTEMİ İLE DEĞERLENDİRİLMESİ: CİNSİYET FARKLILIKLARI

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ÖZET

Dudaklar yüz estetiğinin ve yüz morfolojisinin önemli yumuşak doku yapılarını oluşturmaktadır. Dudak antropometrik ölçümleri, yüz estetiğinin değerlendirilmesinde ve klinik uygulamalarda önemli referans veriler sağlamaktadır. Bu çalışmanın amacı genç erişkin bireylerde dudak morfolojisini doğrudan antropometrik ölçüm yöntemi kullanarak değerlendirmek ve temel dudak ölçümlerinin cinsiyete bağlı farklılıklarını ortaya koymaktır. Bu kesitsel çalışmaya yaşları 18–30 yıl arasında değişen toplam 80 sağlıklı birey (40 kadın, 40 erkek) dâhil edilmiştir. Dudak antropometrik ölçümleri dijital kaliper kullanılarak doğrudan ölçüm yöntemi ile gerçekleştirilmiştir. Ölçümlerde subnasale (sn), labiale superius (ls), labiale inferius (li), stomion (sto) ve cheilion (chR–chL) anatomik referans noktaları kullanılmıştır. Bu referans noktalarına dayanarak üst dudak yüksekliği (sn–sto), üst vermilion yüksekliği (ls–sto), alt vermilion yüksekliği (sto–li), toplam dudak yüksekliği (ls–li) ve ağız genişliği (chR–chL) ölçülmüştür. Tüm ölçümler iki kez tekrarlanmış ve ortalama değerler istatistiksel analizlerde kullanılmıştır. Verilerin istatistiksel analizi SPSS programı kullanılarak yapılmış ve cinsiyetler arası karşılaştırmalar bağımsız örneklem t-testi ile değerlendirilmiştir. Analiz sonuçlarına göre erkek bireylerde üst dudak yüksekliği, alt vermilion yüksekliği ve ağız genişliği ölçümleri kadınlara göre istatistiksel olarak anlamlı derecede daha yüksek bulunmuştur ($p<0.05$). Üst vermilion yüksekliği ve toplam dudak yüksekliği açısından ise cinsiyetler arasında anlamlı bir fark saptanmamıştır ($p>0.05$). Elde edilen bulgular genç erişkin popülasyonda bazı dudak antropometrik ölçümlerinin cinsiyete bağlı farklılıklar gösterdiğini ortaya koymaktadır. Bu sonuçların yüz estetiği, ortodonti ve rekonstrüktif cerrahi uygulamalarında referans veri sağlayabileceği düşünülmektedir.

Anahtar Kelimeler: Dudak antropometrisi, yüz morfolojisi, genç erişkin, cinsiyet farklılıkları, doğrudan ölçüm

EVALUATION OF LIP ANTHROPOMETRY IN YOUNG ADULTS USING THE DIRECT MEASUREMENT METHOD: SEX DIFFERENCES

ABSTRACT

Lips represent one of the most important soft tissue structures contributing to facial aesthetics and facial morphology. Anthropometric measurements of the lips provide valuable reference data for facial aesthetic evaluation and clinical applications. The aim of this study was to evaluate lip morphology in young adults using a direct anthropometric measurement method and to investigate potential sex-related differences in lip dimensions. This cross-sectional study included a total of 80 healthy young adults aged between 18 and 30 years (40 females and 40 males). Lip anthropometric measurements were performed using a digital caliper based on standard anatomical landmarks including subnasale (sn), labiale superius (ls), labiale inferius (li), stomion (sto), and cheilion (chR–chL). Based on these landmarks, upper lip height (sn–sto), upper vermilion height (ls–sto), lower vermilion height (sto–li), total lip height (ls–li), and mouth width (chR–chL) were measured. Each measurement was repeated twice and mean values were used for statistical analyses. Statistical analyses were performed using SPSS software and sex-related comparisons were conducted using independent samples t-test. The results showed that upper lip height, lower vermilion height, and mouth width were significantly higher in males compared to females ($p<0.05$). However, no significant differences were observed between sexes for upper vermilion height and total lip height ($p>0.05$). These findings indicate that certain lip anthropometric parameters differ according to sex in young adults. The obtained results may provide reference data for applications in facial aesthetics, orthodontics, and reconstructive surgery.

Keywords: Lip anthropometry, facial morphology, young adults, sexual dimorphism, direct measurement

1. INTRODUCTION

The lips are one of the most important soft tissue components contributing to facial aesthetics and facial morphology. Located in the lower third of the face, the lips play a significant role both functionally and aesthetically. While the lips contribute to essential functions such as speech, nutrition, and facial expressions, their shape, size, and proportions relative to other facial structures are considered key parameters in the evaluation of facial aesthetics. Therefore, the objective assessment of lip morphology occupies an important place in facial aesthetic analyses (Hasibuan et al., 2023).

Facial anthropometry is a scientific method used to measure and evaluate structural characteristics of different regions of the face. Through anthropometric measurements, soft

tissue structures of the face can be objectively assessed, and normative data useful for aesthetic analyses can be obtained. Lip anthropometry provides valuable information for treatment planning and aesthetic evaluation, particularly in fields such as orthodontics, plastic surgery, and reconstructive surgery. The size and proportions of the lips are considered important parameters in determining facial aesthetic harmony (Hasibuan et al., 2023).

Numerous studies investigating lip anthropometry have been conducted in different populations. A study conducted among healthy Turkish young adults reported that lip measurements may vary according to sex and emphasized the importance of establishing population-specific normative values (Bahşi et al., 2022). Similarly, a study conducted in India evaluated upper and lower vermilion height and mouth width using direct anthropometric methods and reported certain differences between sexes (Anthropometric Measurement of Lips in Adults of MP India, 2017).

Studies conducted in different ethnic groups also indicate that lip morphology may vary across populations. A study conducted in Iran evaluated lip anthropometric measurements in males aged 18–25 years and reported that the obtained data could provide reference values for aesthetic and surgical applications (Heidari et al., 2014). Furthermore, studies using photographic analysis methods have examined the relationship between lip morphology and other facial regions and emphasized the importance of these measurements in facial aesthetic planning (Abrishami et al., 2014).

In recent years, more advanced measurement techniques have been used in anthropometric analyses. Three-dimensional analysis techniques enable a more detailed evaluation of facial soft tissue structures and contribute to obtaining more precise normative data (Berwig et al., 2017). Additionally, recent studies conducted in different populations demonstrate that lip morphology may vary depending on factors such as sex and ethnicity (Rusu et al., 2025).

In this context, determining lip anthropometric measurements in different populations provides important reference data for both aesthetic evaluations and clinical applications. Therefore, the aim of this study was to evaluate lip morphology in young adults using a direct anthropometric measurement method and to investigate sex-related differences in basic lip measurements.

2. MATERIALS AND METHODS

2.1. Study Design and Participants

This cross-sectional study was conducted on a total of 80 healthy young adults aged between 18 and 30 years, including 40 females and 40 males. The study group consisted of individuals with no facial anomalies, no history of facial surgery, no orthodontic treatment history, and no

trauma affecting the lip region. The study protocol was approved by the Ethics Committee of Kilis 7 Aralık University (Approval No:2026/01, Date:26.01.2026). All participants were informed about the study and provided written informed consent.

2.2. Anthropometric Measurements

Lip anthropometric measurements were performed using a direct measurement method based on standard anatomical reference points defined in the literature. Measurements were conducted in a quiet and well-lit environment with participants in an upright position, with the head in a neutral position and the lips in light contact. All measurements were performed by the same researcher using a digital caliper with a precision of 0.01 mm.

The anatomical reference points used were as follows:

• **Subnasale (sn):** midpoint at the base of the nose

• **Labiale superius (ls):** the most prominent midpoint of the upper lip

• **Labiale inferius (li):** the most prominent midpoint of the lower lip

• **Stomion (sto):** the midpoint where the lips meet

• **Cheilion right/left (chR–chL):** corners of the mouth

Based on these reference points, the following linear measurements were obtained (Figure 1):

1. Upper lip height (sn–sto)
2. Upper vermilion height (ls–sto)
3. Lower vermilion height (sto–li)
4. Total lip height (ls–li)
5. Mouth width (chR–chL)

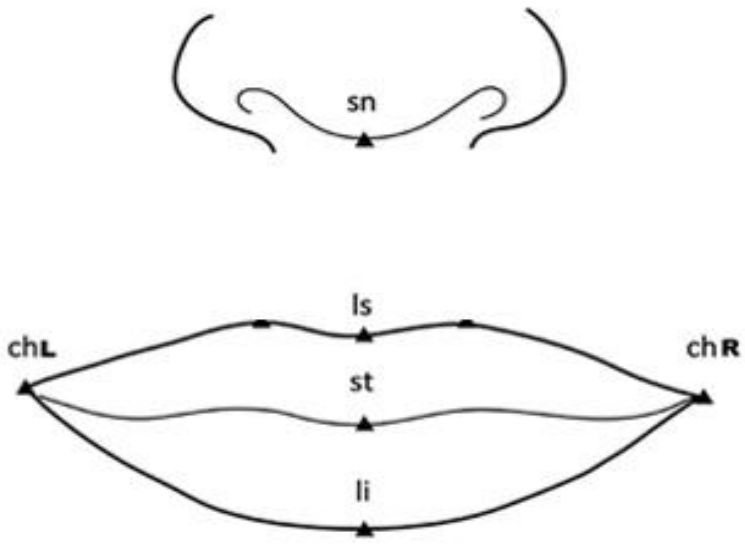

Figure 1. Reference points used in the measurements

2.3. Measurement Reliability

To evaluate measurement reliability, measurements obtained from 20 randomly selected participants were repeated by the same researcher after one week. The two sets of measurements were compared, and no statistically significant differences were observed between the measurements ($p > 0.05$), indicating good measurement consistency.

2.4. Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was evaluated using the Kolmogorov–Smirnov test. Independent samples t-test was used to compare groups. Results were presented as mean ± standard deviation ($\bar{X} \pm SD$), and statistical significance was accepted at $p < 0.05$. In addition, male-to-female ratios were calculated by dividing the mean value of male measurements by the mean value of female measurements in order to illustrate proportional sex differences in lip anthropometric parameters.

3. RESULTS AND DISCUSSION

A total of 80 healthy individuals aged between 18 and 30 years (40 females and 40 males) were included in the study. The Kolmogorov–Smirnov test indicated that all variables were normally distributed ($p > 0.05$); therefore, parametric tests were used for statistical comparisons. The lip anthropometric measurements of female and male participants are presented in Table 1.

As shown in Table 1, upper lip height (sn–sto), lower vermilion height (sto–li), and mouth width (chR–chL) were significantly higher in males than in females ($p < 0.05$). However, no statistically significant differences were observed between sexes for upper vermilion height (ls–sto) and total lip height (ls–li) ($p > 0.05$). In addition, effect size analysis (Cohen's d) indicated a moderate effect for upper lip height ($d = 0.58$), a large effect for lower vermilion height ($d = 0.78$), and a very large effect for mouth width ($d = 1.23$).

The comparison of lip anthropometric measurements between females and males is presented in Figure 2, while the proportional differences between sexes based on male-to-female ratios are illustrated in Figure 3.

Table 1. Comparison of lip anthropometric measurements between females and males.

Measurement	Female (Mean ± SD)	Male (Mean ± SD)	p
Upper lip height (sn–sto)	19.40 ± 4.22	21.50 ± 2.67	0.009
Upper vermilion height (ls–sto)	8.78 ± 1.68	9.07 ± 1.83	0.540
Lower vermilion height (sto–li)	10.67 ± 2.18	12.43 ± 2.29	0.001
Total lip height (ls–li)	19.45 ± 2.45	19.73 ± 3.32	0.714
Mouth width (chR–chL)	50.70 ± 2.77	54.75 ± 3.75	<0.001

Values are presented as mean ± standard deviation (SD). Group comparisons were performed using an independent samples t-test. A p value < 0.05 was considered statistically significant.

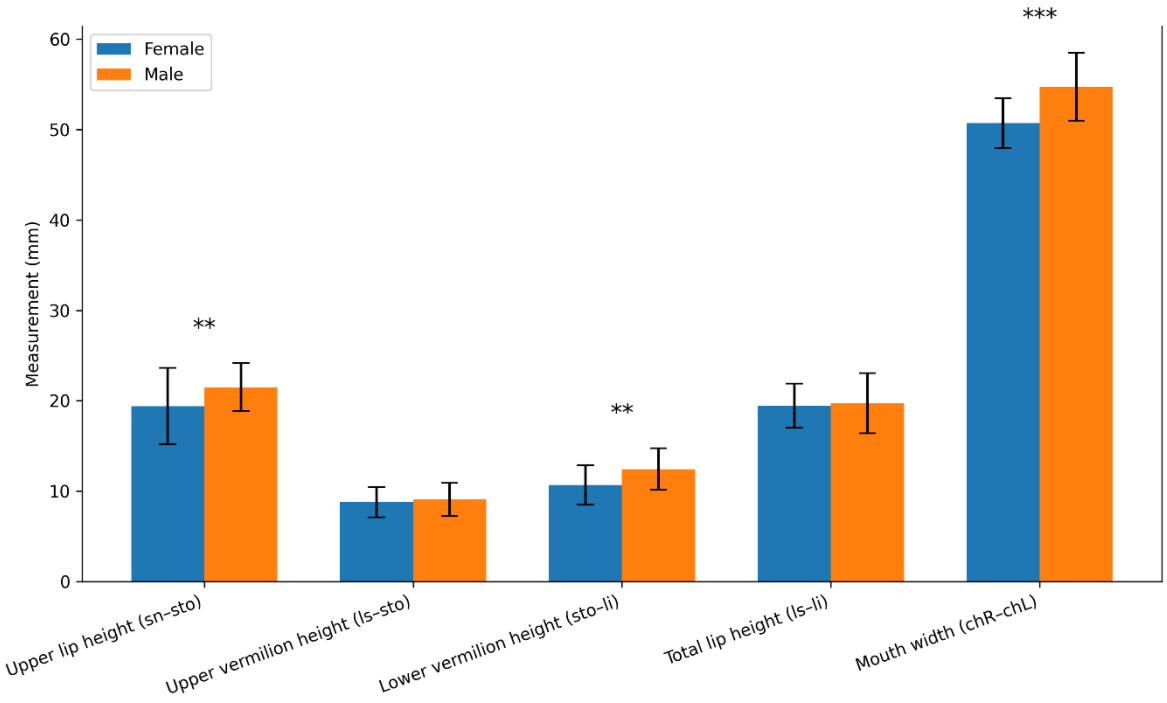

Figure 2. Comparison of lip anthropometric measurements between females and males. Values are presented as mean ± standard deviation. ** p < 0.01, *** p < 0.001.

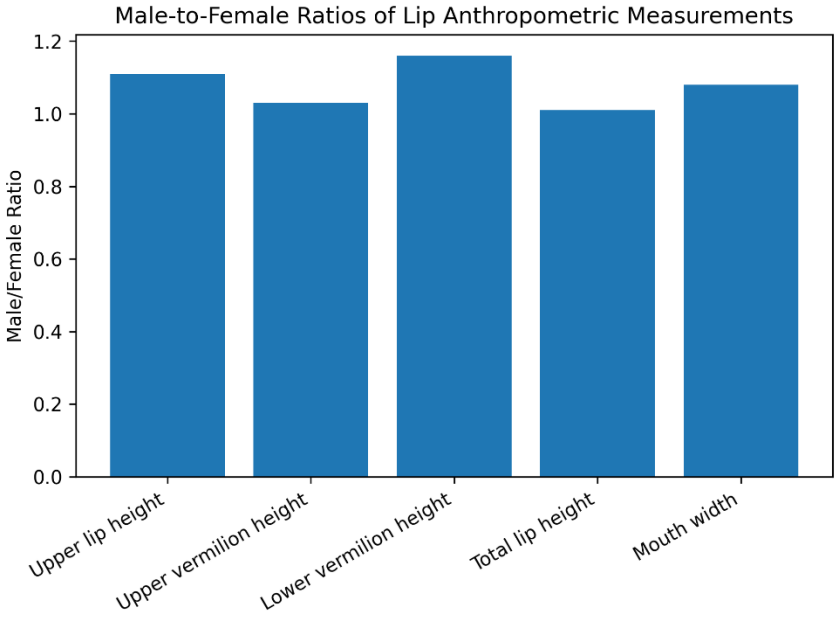

Figure 3. Values greater than 1 indicate larger measurements in males compared to females. The greatest proportional difference was observed for lower vermilion height, followed by mouth width.

The present study evaluated lip anthropometric measurements in young adults using a direct anthropometric measurement method and investigated sex-related differences in these parameters. The findings demonstrated that upper lip height (sn–sto), lower vermilion height (sto–li), and mouth width (chR–chL) were significantly higher in males compared to females, whereas no significant sex-related differences were observed for upper vermilion height (ls–sto) and total lip height (ls–li). These results indicate the presence of sexual dimorphism in specific lip anthropometric parameters.

In the present study, mouth width (chR–chL) demonstrated the largest difference between sexes. When male-to-female ratios were examined, the greatest proportional difference was observed for lower vermilion height, followed by mouth width, indicating that sexual dimorphism may be more pronounced in specific lip dimensions (Figure 3). This finding suggests that sexual dimorphism in lip anthropometry may be particularly pronounced in transverse facial dimensions. Similar observations have been reported in previous anthropometric studies, indicating that males generally present wider oral commissure distances than females. This difference may be associated with overall craniofacial size variations and sex-related growth patterns. These results highlight the importance of considering sex-specific reference values when evaluating lip morphology in clinical and aesthetic applications.

Sex-related differences in facial soft tissue structures have been widely reported in anthropometric studies. For instance, a recent three-dimensional facial anthropometry study

conducted in a contemporary Thai population reported significant sexual dimorphism in several facial parameters, with males generally exhibiting larger facial dimensions compared to females (Pongsri et al., 2025).

These findings are consistent with the present study, in which certain lip measurements were found to be significantly greater in males.

Similarly, anthropometric analyses conducted in different populations have reported sex-based variations in lip morphology. Wang et al. (2019) evaluated labial anthropometric measurements in Han Chinese young adults and reported that several lip dimensions differed significantly between males and females. The authors suggested that these differences may be associated with general craniofacial size variations and hormonal influences that contribute to sexual dimorphism in facial soft tissues. Our findings showing greater upper lip height and mouth width in males are in agreement with these observations.

In addition to sex differences, previous studies have emphasized that lip morphology may vary across populations and ethnic groups. Serrano-Andrade et al. (2023) examined lip anthropometric measurements in the Mestiza population and reported variations in lip dimensions across different age groups. Similarly, cross-cultural investigations have demonstrated that perceptions of lip shape and attractiveness may differ among populations, highlighting the importance of population-specific anthropometric data (Heidekrueger et al., 2017). Therefore, establishing normative lip anthropometric values for specific populations is essential for accurate aesthetic evaluation and clinical planning.

Advancements in imaging technologies have also enabled more detailed evaluation of lip morphology. For instance, Liu et al. (2021) investigated the relationship between three-dimensional lip vermilion morphology and dentoskeletal characteristics in young Chinese adults and reported significant associations between lip morphology and craniofacial skeletal patterns. Although the present study used a direct anthropometric measurement method, the findings are comparable with those obtained from three-dimensional analyses and support the reliability of conventional anthropometric techniques in evaluating soft tissue facial structures.

From a clinical perspective, lip anthropometric measurements provide valuable reference data for various medical and aesthetic applications. Accurate knowledge of lip dimensions is particularly important in orthodontic treatment planning, reconstructive surgery, and facial aesthetic procedures. Previous research has emphasized that objective anthropometric data contribute to improved treatment outcomes and more accurate aesthetic assessments (Tremont & Posnick, 2020). In addition, surgical procedures involving lip repositioning or reconstruction

may benefit from population-specific normative values in order to achieve balanced facial proportions (Andijani et al., 2021). Recent studies have also investigated aesthetic perception and morphological changes of the lips in clinical and surgical contexts (Yang et al., 2024; Júnior et al., 2023).

Overall, the findings of the present study support the existence of sexual dimorphism in certain lip anthropometric parameters among young adults. The observed differences between males and females may be explained by variations in craniofacial growth patterns and general facial proportions. Furthermore, the results highlight the importance of establishing population-specific anthropometric databases that can be used as reference values in clinical practice.

LIMITATIONS OF THE STUDY

This study has several limitations. The study included only young adults within a specific age range, and the sample consisted of individuals studying at a single university. Therefore, the findings may not be generalizable to different age groups or populations. In addition, measurements were performed using a direct anthropometric method, and three-dimensional analysis techniques were not used. Future studies involving larger sample sizes and different measurement techniques are recommended to provide a more comprehensive evaluation of lip morphology.

CONCLUSION

In this study, lip anthropometric measurements in young adults were evaluated, and certain measurements were found to differ according to sex. The results indicated that upper lip height, lower vermilion height, and mouth width were significantly higher in males than in females. However, no significant differences were observed between sexes in terms of upper vermilion height and total lip height. These findings highlight the importance of population-specific anthropometric data in the evaluation of lip morphology. The obtained data may serve as reference values for facial aesthetic assessment, orthodontic treatment planning, and reconstructive surgical procedures.

REFERENCES

Abrishami M, Salemi F, Amini F, Aghakhani N. 2014. Photographic study of lip anthropometric pattern. Anatomy Journal 11(1), 15–22.

Bahşi I, Orhan M, Kervancıoğlu P, Sayın S. 2022. Lip anthropometry of healthy Turkish young adults. Surgical and Radiologic Anatomy 44(4), 567–574.

Berwig LC, Silva AMT, Côrrea ECR. 2017. Anthropometric orofacial measurements of children and adolescents. Revista CEFAC 19(2), 213–220.

Hasibuan LY, Prasetyo AT, Pramono GNTW. 2023. Enhancing aesthetic harmony: Comprehensive anthropometric lip measurements in youthful and attractive Indonesian adults for precision cosmetic procedures. JPRAS Open 39, 198–206.

Heidari Z, Mahmoudzadeh-Sagheb H, Asemi Rad A, Dahmardeh N. 2014. Anthropometric measurements of the lips in 18–25-year-old men of Sistani and Baluch descent. Anatomical Science International 89(4), 238–245.
Júnior LCA, da Silva Cruz NT, de Vasconcelos Gurgel BC, de Aquino Martins ARL, Lins RDAU. 2023. Impact of subnasal lip lift on lip aesthetic: a systematic review. Oral and Maxillofacial Surgery 27(1), 9–15.
Rusu LC, Beschiu LM, Iacob F, Zaharia C, Neuwirth K, Bulut O. 2025. A morphometric anthropometric analysis of the upper lip in adult Western Romanian population. Scientific Reports 15, 1–10.
Yang Y, Chi Y, Liu D, Zhang M, Jin L, Zeng A, Long X, Pan B, Yu N, Wang X. 2024. The ideal Chinese lip: Impact of lip contours and proportions. Aesthetic Plastic Surgery 48(21), 4229–4238.
Pongsri O, Sampattanavorachai N, Apichonbancha S, Yodrabum N, Flapper W, Moore MH, Chaisrisawadisuk S. **2025.** Quantitative analysis of sexual dimorphism in three-dimensional facial anthropometry in contemporary Thai population: Implications for facial feminization surgery. *Journal of Craniofacial Surgery* 36(8), e1376–e1380.
Liu ZY, Chen G, Dai FF, Xu TM, Jiang RP. **2021.** Analysis of correlation of three-dimensional lip vermilion morphology and dentoskeletal forms in young Chinese adults on the basis of sex and skeletal patterns. *American Journal of Orthodontics and Dentofacial Orthopedics* 159(5), e423–e437.
Heidekrueger PI, Szpalski C, Weichman K, Juran S, Ng R, Claussen C, Ninkovic M, Broer PN. **2017.** Lip attractiveness: A cross-cultural analysis. *Aesthetic Surgery Journal* 37(7), 828–836.
Serrano-Andrade JD, Apellaniz-Campo A, Ramírez-Fernández FJ, Castillo-Moreno J, Morales JM, Gómez KC, Alvarado PA. **2023.** Determination of the anthropometric measures of the lips by age groups in the Mestiza population. *Journal of Craniofacial Surgery* 34(3), 1082–1084.
Wang Y, Guo S, Sun Q, Jin SF, Zhang X, Xiao M, Wang CC, Sun X, Lv MZ, Li KZ. **2019.** Anthropometric labial analysis of Han Chinese young adults. *Skin Research and Technology* 25(4), 499–503.
Tremont TJ, Posnick JC. **2020.** Selected orthodontic principles for management of cranio-maxillofacial deformities. *Oral and Maxillofacial Surgery Clinics of North America* 32(2), 321–338.
Andijani RI, Paramitha V, Guo X, Deguchi T, Tatakis DN. **2021.** Lip repositioning surgery for gummy smile: Six-month clinical and radiographic lip dimensional changes. *Clinical Oral Investigations* 25(10), 5907–5915.

ORTAÖĞRETIM DÜZEYINDE YAPAY ZEKA DESTEKLI YAZMA BECERISI ÜZERINE BIR LITERATÜR İNCELEMESI

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ÖZET

Son yıllarda yapay zeka teknolojilerindeki hızlı gelişmeler, yabancı dil öğretimi alanında pedagojik yaklaşımların yeniden değerlendirilmesine yol açmıştır. Özellikle ChatGPT gibi üretken yapay zeka araçlarının yazma becerisi üzerindeki etkisi, hem fırsatlar hem de etik boyutlar açısından akademik çevrelerde yoğun biçimde tartışılmaktadır. Yazma becerisi; dil bilgisi doğruluğu, kelime çeşitliliği, metin bütünlüğü ve eleştirel düşünme gibi çok boyutlu bileşenler içermesi nedeniyle, yapay zeka entegrasyonu bağlamında özel bir önem taşımaktadır. Bu çalışma, ortaöğretim düzeyinde İngilizce yazma becerisinin geliştirilmesinde yapay zeka destekli araçların kullanımına ilişkin mevcut literatürü incelemeyi amaçlamaktadır.Araştırma, 2019–2025 yılları arasında yayımlanmış ulusal ve uluslararası hakemli makalelerin sistematik biçimde taranmasına dayanan betimsel bir literatür incelemesi niteliğindedir. Çalışmalar; amaç, yöntem, örneklem özellikleri ve temel bulgular açısından tematik analiz yöntemiyle değerlendirilmiştir.Literatür bulguları, yapay zeka destekli yazma uygulamalarının öğrencilerin dil bilgisi doğruluğunu artırdığını, kelime çeşitliliğini geliştirdiğini ve yazma motivasyonunu olumlu yönde etkilediğini göstermektedir. Bununla birlikte akademik dürüstlük, özgünlük sorunu, eleştirel düşünmenin zayıflaması ve teknolojiye aşırı bağımlılık gibi etik ve pedagojik kaygılar da vurgulanmaktadır. Özellikle ortaöğretim düzeyinde öğretmen rehberliğinin belirleyici bir unsur olduğu belirtilmektedir.Sonuç olarak, yapay zeka araçlarının pedagojik çerçevede ve bilinçli kullanımının yazma becerisinin geliştirilmesinde destekleyici bir rol üstlenebileceği; ancak entegrasyon sürecinde etik ilkelerin ve öğretmen denetiminin temel belirleyici olması gerektiği anlaşılmaktadır.

Anahtar Kelimeler: Yapay zeka, yazma becerisi, ortaöğretim, ingilizce öğretimi, literatür incelemesi, eğitim teknolojileri

AI-SUPPORTED WRITING SKILLS AT THE SECONDARY SCHOOL LEVEL: A SYSTEMATIC LITERATURE REVIEW

Abstract

Recent advancements in artificial intelligence technologies have led to a reconsideration of pedagogical approaches in foreign language education. In particular, generative AI tools such as ChatGPT have become the focus of extensive academic discussion in terms of both their potential benefits and ethical implications for writing instruction. Writing skills, which involve multidimensional components such as grammatical accuracy, lexical diversity, textual coherence, and critical thinking, hold a significant position within this context. This study aims to examine the existing literature on the use of AI-supported tools in enhancing English writing skills at the secondary school level.

The research is designed as a descriptive literature review based on the systematic analysis of peer-reviewed national and international studies published between 2019 and 2025. The selected studies were examined through thematic analysis in terms of their aims, methodologies, sample characteristics, and key findings.

The findings indicate that AI-supported writing applications contribute positively to grammatical accuracy, vocabulary development, and student motivation in the writing process. However, concerns regarding academic integrity, originality, the weakening of critical thinking skills, and overreliance on technology are also highlighted in the literature. Particularly at the secondary school level, teacher guidance appears to be a crucial factor in ensuring the effective and ethical integration of AI tools.

In conclusion, while AI technologies may serve as supportive tools in the development of writing skills when used within a pedagogically structured framework, ethical considerations and teacher supervision remain essential in the integration process.

Keywords: Artificial intelligence, writing skills, secondary education, EFL instruction, literature review, educational technology

1. Introduction

Artificial intelligence (AI) has rapidly and profoundly transformed educational practices worldwide, reshaping not only how knowledge is delivered but also how learners engage with academic tasks. In foreign language education, AI-supported tools have become increasingly influential, particularly in the domain of writing instruction (Godwin-Jones, 2022; Guo et al., 2023). Writing is not merely a linguistic activity but also a complex cognitive and metacognitive process that demands idea generation, conceptual organization, argumentative reasoning, audience awareness, and recurrent revision (Flower & Hayes, 1981; Graham &

Perin, 2007). Therefore, integrating AI tools into writing pedagogy requires careful pedagogical examination and contextually sensitive implementation.The evolution of AI tools available for writing instruction has been remarkable. Earlier automated writing evaluation (AWE) systems primarily focused on surface-level features such as grammar correction, spelling, and structural feedback (Warschauer & Grimes, 2008; Dikli, 2006). These systems, including tools such as Grammarly, Turnitin's Writing Center, and Criterion, offered rule-based corrective feedback that helped learners identify and address common linguistic errors. However, generative AI tools powered by large language models (LLMs), most notably ChatGPT developed by OpenAI and released publicly in November 2022, have exponentially expanded these capabilities by generating contextually coherent full texts, offering nuanced suggestions at the discourse level, modeling academic register, and simulating human-like writing processes (Zhai, 2022; Baidoo-Anu & Ansah, 2023).This fundamental shift in AI capabilities has intensified ongoing academic and pedagogical debates regarding effectiveness, authorship, originality, intellectual ownership, and the long-term cognitive development of learners who rely heavily on such tools (Chaudhry et al., 2023; Perkins, 2023). For secondary school students, who are simultaneously developing both linguistic competence and higher-order thinking skills within formative educational contexts, the implications of AI integration are particularly significant and warrant dedicated scholarly attention (Yao, 2025; Sanz-Tejeda et al., 2025).Against this backdrop, the present study aims to systematically synthesize research findings published between 2019 and 2025 to identify the pedagogical benefits, ethical risks, motivational dimensions, and contextual considerations inherent in AI-supported writing instruction at the secondary school level. By providing a comprehensive and critical synthesis of the existing literature, this review seeks to offer evidence-based guidance for teachers, curriculum designers, educational policymakers, and researchers navigating this rapidly evolving educational landscape.The following research questions guide this systematic review: (1) What are the documented pedagogical benefits of AI-supported tools in secondary-level EFL writing instruction? (2) What ethical concerns and risks are associated with AI integration in writing education? (3) What contextual and methodological factors mediate the effectiveness of AI writing tools? (4) What recommendations emerge from the literature for future research and practice?

2. Theoretical Framework

The theoretical underpinning of this review draws on several interconnected frameworks from second language acquisition (SLA), writing pedagogy, and educational technology. Vygotsky's (1978) sociocultural theory and the concept of the Zone of Proximal

Development (ZPD) provide a foundational lens through which AI tools may be understood as technologically mediated scaffolding mechanisms, enabling learners to accomplish writing tasks that would otherwise fall beyond their independent capabilities. When an AI tool corrects a grammatical error, suggests a more precise lexical choice, or models discourse-level cohesion, it functions analogously to a more capable peer or teacher providing scaffolded assistance. Process writing theory, established by Flower and Hayes (1981) and later elaborated by Bereiter and Scardamalia (1987), provides another critical lens. This theory conceptualizes writing as a recursive, problem-solving process involving planning, drafting, revising, and editing phases. AI tools intervene at various points in this process, offering immediate feedback during revision and editing phases that may accelerate skill development, but may also risk short-circuiting the deeper cognitive engagement inherent in genuine writing struggle.The Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) is also relevant, as it highlights the importance of teachers possessing not only technological knowledge but also pedagogical and content knowledge to effectively integrate AI tools into writing instruction. Without this integrated knowledge, AI tools risk being used superficially or inappropriately, undermining rather than supporting student learning outcomes.

Finally, academic integrity frameworks, including those proposed by the International Center for Academic Integrity (ICAI, 2021), provide essential ethical scaffolding for examining questions of authorship, originality, and honesty in AI-augmented writing contexts. As generative AI blurs traditional boundaries of authorship, institutional and pedagogical responses must evolve accordingly.

3. Study Area and Scope

This study focuses specifically on secondary school contexts (typically encompassing students aged 11–18, or grades 6–12 depending on national educational systems) within English as a Foreign Language (EFL) instruction. The secondary school level represents a critical educational juncture at which students transition from basic language acquisition toward more sophisticated academic literacy skills, making it a particularly important and sensitive context for examining AI integration (Graham & Perin, 2007; Cumming, 2006).The literature reviewed encompasses studies conducted in diverse geographical, linguistic, and institutional contexts, including East Asian EFL environments (particularly China, Japan, and South Korea), European settings (Spain, Turkey, Germany), Middle Eastern contexts (Saudi Arabia, Iran), and South American educational systems. This geographic diversity is essential for understanding how cultural, institutional, and pedagogical factors mediate the effectiveness of AI-supported

writing instruction.The timeframe of 2019–2025 was deliberately selected to capture both pre-ChatGPT automated writing evaluation (AWE) research, which provides important baseline data on AI writing assistance, and the post-2022 emergence of large language models (LLMs) in educational settings. This period reflects a critical and unprecedented transformation in AI capabilities and their pedagogical implications, representing perhaps the most rapid technological shift in the history of language education.Particular scholarly attention within this review is directed toward studies examining generative AI tools (including ChatGPT, Google Bard, Grammarly, and similar applications), automated feedback systems, AI-powered grammar checkers, and machine translation tools insofar as they intersect with writing skill development. Studies addressing adult or university-level learners are included only when they offer directly applicable insights for secondary-level pedagogy or provide relevant theoretical grounding.

4. Material and Method

4.1 Research Design

This research adopts a descriptive systematic literature review methodology, following established protocols for systematic reviews in educational research (Gough et al., 2017; Kitchenham, 2004). The systematic review approach was selected because it provides a replicable, transparent, and rigorous method for synthesizing evidence across a large and heterogeneous body of literature, thereby minimizing selection bias and ensuring methodological quality.

4.2 Search Strategy and Database Selection

Peer-reviewed studies were systematically searched across five major academic databases: Google Scholar, Web of Science, ScienceDirect, ERIC (Education Resources Information Center), and DergiPark (for Turkish national studies). Search terms employed included combinations of the following keywords in both English and Turkish: "artificial intelligence," "AI writing," "automated writing evaluation," "ChatGPT," "EFL writing," "secondary school," "high school," "writing skills," "writing instruction," "generative AI," "language learning technology," and "academic writing." Boolean operators (AND, OR, NOT) were systematically applied to maximize search precision and comprehensiveness. The initial database search yielded 347 potentially relevant studies. Following the application of inclusion and exclusion criteria (detailed in Table 1 below), 42 studies were retained for full-text review. Of these, 31 studies met all inclusion criteria and are incorporated into the present systematic review as primary sources.

4.3 Inclusion and Exclusion Criteria

Inclusion criteria required that selected studies: (a) focused on secondary school learners (ages 11–18) or provided directly applicable insights for this population; (b) addressed English writing instruction in EFL or related foreign language contexts; (c) examined the use of AI-supported tools including AWE systems, grammar checkers, generative AI, or machine translation; (d) were published in peer-reviewed journals or conference proceedings; and (e) were published between January 2019 and March 2025. Studies were excluded if they: (a) focused exclusively on native speakers without EFL relevance; (b) addressed skills other than writing without a writing component; (c) were not available in full text; or (d) were duplicated across databases.

4.4 Analytical Framework

The selected studies were analyzed through a systematic thematic analysis approach informed by Braun and Clarke (2006). Themes were inductively derived from the data and subsequently organized under the following six overarching categories: (1) linguistic development and grammatical accuracy, (2) vocabulary enhancement and lexical diversity, (3) student motivation, engagement, and writing anxiety, (4) academic integrity and authorship concerns, (5) critical thinking and higher-order cognitive engagement, and (6) teacher mediation, pedagogical scaffolding, and institutional factors. This analytical framework enabled a structured, comparative synthesis of findings across diverse research contexts, methodologies, and geographical settings.

5. Findings and Discussion

5.1 Linguistic Development and Grammatical Accuracy

One of the most consistently documented benefits of AI-supported writing instruction is the enhancement of grammatical accuracy and overall linguistic quality. Stevenson and Phakiti (2019) conducted a quasi-experimental study with secondary school EFL learners in Australia, finding that students receiving AI-generated corrective feedback demonstrated significantly greater improvements in grammatical accuracy compared to control groups receiving only teacher feedback. The immediacy and frequency of AI feedback were identified as key mediating factors, enabling students to engage in more frequent revision cycles.Link et al. (2020) examined the impact of automated writing evaluation on EFL learners across multiple proficiency levels, concluding that AWE tools contributed to measurable improvements in syntactic complexity, grammatical accuracy, and text organization over a semester-long intervention. Importantly, these gains were most pronounced among intermediate learners,

suggesting that AI feedback may be particularly valuable at developmental stages where students are actively consolidating grammatical knowledge.More recently, Huang et al. (2023) investigated the use of ChatGPT as a writing assistant among Chinese secondary school students, documenting significant improvements not only in grammatical accuracy but also in discourse-level cohesion and paragraph organization. The authors noted that students who engaged iteratively with AI feedback—revising their work across multiple drafts—demonstrated greater gains than those who accepted AI suggestions passively without critical reflection, underscoring the importance of active engagement with AI-generated feedback.Research from Turkish EFL contexts further corroborates these findings. Aydın and Cinkara (2021) examined Turkish secondary school students' use of Grammarly, an AI-powered grammar checking and writing assistance tool, finding that regular use over an academic semester correlated with statistically significant reductions in morphological and syntactic errors. Students also reported greater metacognitive awareness of their own grammatical weaknesses through the process of interacting with AI feedback.

5.2 Vocabulary Enhancement and Lexical Development

Beyond grammatical development, AI-supported writing tools have demonstrated considerable potential for enhancing lexical diversity, depth, and appropriateness. Drawing on earlier findings in the literature**,** K Karyuatry and Rizqan (2018) investigated the impact of Grammarly on vocabulary use among EFL writing students, finding that the tool's synonym suggestions and contextual vocabulary recommendations led to measurable increases in lexical variety and the use of more sophisticated, register-appropriate vocabulary. Students reported greater confidence in experimenting with new vocabulary when supported by AI-generated alternatives.Guo et al. (2023) examined secondary school students' interaction with ChatGPT for vocabulary learning in writing contexts, finding that students who used AI tools to explore lexical alternatives and collocations developed a significantly broader productive vocabulary range compared to control groups. However, the researchers also noted a risk of shallow lexical learning, in which students adopted AI-suggested vocabulary without fully internalizing its meaning, collocational patterns, or contextual appropriateness—a finding with important implications for instructional design.The role of AI in facilitating exposure to authentic, context-appropriate vocabulary in genre-specific writing is also noteworthy. Hyland (2019) argued that genre awareness is fundamental to academic writing development, and several studies in this review suggest that AI tools can model discipline-specific vocabulary and

phraseological patterns when students are engaged in genre-specific writing tasks, such as argumentative essays, narrative compositions, or formal letters.

5.3 Student Motivation, Engagement, and Writing Anxiety

A recurring and particularly robust theme in the literature is the positive relationship between AI writing assistance and student motivation and engagement. Writing anxiety is a well-documented phenomenon among EFL learners (Cheng, 2004), characterized by fear of negative evaluation, perfectionism, and avoidance behaviors that impede writing development. AI tools, by providing non-judgmental, immediate, and consistent feedback, create what several researchers describe as low-affective-filter learning environments that reduce writing anxiety and encourage risk-taking in writing.Baidoo-Anu and Ansah (2023) surveyed secondary school students across Ghana regarding their experiences with AI writing tools, finding that 78% of respondents reported reduced writing anxiety when using AI-supported tools, and 82% reported greater willingness to attempt complex writing tasks with AI assistance. These motivational benefits translated into increased writing frequency and greater investment in the revision process, suggesting that AI tools may help cultivate writing habits and positive writing identities among developing learners. Kasneci et al. (2023) provided a comprehensive review of AI's impact on student engagement in writing tasks, noting that the interactive, responsive nature of generative AI tools creates dialogic writing experiences that many students find more engaging than traditional teacher-mediated feedback cycles, which often involve delays of days or weeks between submission and response. This immediacy transforms writing from a product-oriented activity into a dynamic, iterative process more closely aligned with authentic communicative writing.However, motivation research in this domain is not uniformly positive. Several studies report that initial novelty effects may inflate motivational outcomes, and that sustained engagement with AI tools beyond initial exposure may be more variable (Perkins, 2023). Longitudinal studies examining whether motivational benefits persist over time are notably scarce in the current literature, representing a significant gap for future research.

5.4 Academic Integrity, Authorship, and Ethical Concerns

Among the most significant and contentious issues emerging from the literature is the impact of generative AI tools on academic integrity and the fundamental concept of authorship. Zhai (2022) was among the first to systematically address these concerns in the educational literature, arguing that when AI tools generate complete essays or substantial textual content with minimal student cognitive contribution, the resulting texts cannot be considered authentic expressions of student knowledge, ability, or intellectual identity.Chaudhry et al. (2023)

conducted a survey of 312 secondary school students in Pakistan and the United Arab Emirates regarding their use of AI tools for writing assignments, finding that 41% of respondents admitted to submitting AI-generated text as their own work without disclosure, and that only 23% fully understood their institution's policies regarding AI use in academic work. These findings highlight critical gaps in student awareness, institutional communication, and the development of clear, actionable academic integrity policies in the generative AI era.Perkins (2023) developed a conceptual framework for understanding AI use in academic contexts, distinguishing between legitimate uses of AI as a writing support tool (e.g., grammar checking, brainstorming assistance, feedback on student-generated drafts) and problematic uses that constitute academic dishonesty (e.g., submitting AI-generated text as one's own work, using AI to complete assessments designed to evaluate individual student knowledge). This framework has been widely adopted in subsequent policy discussions and provides useful guidance for educators navigating these distinctions.The limitations of AI detection tools also emerge as a critical concern. Several studies (Gao et al., 2022; Khalil & Er, 2023) demonstrate that currently available AI text detection systems, including Turnitin's AI detection feature and GPTZero, exhibit both false positive and false negative rates that make them unreliable as sole arbiters of academic integrity. This unreliability places additional pressure on pedagogical design to create assessment tasks that are inherently difficult to complete meaningfully with AI assistance alone, such as process portfolios, in-class writing, or reflective writing integrated with personal experience.From an equity perspective, Godwin-Jones (2022) raises important concerns about differential access to AI tools, arguing that students from higher socioeconomic backgrounds with greater access to premium AI writing tools may gain unfair advantages over peers with limited technological access. This emerging digital divide represents a significant ethical consideration for educational institutions and policymakers designing AI integration frameworks.

5.5 Critical Thinking and Higher-Order Cognitive Engagement

Perhaps the most complex and theoretically significant concern in the literature relates to the potential impact of AI writing assistance on higher-order thinking skills, including critical analysis, argumentation, creative problem-solving, and metacognitive reflection. Sanz-Tejeda et al. (2025) conducted a mixed-methods study with Spanish secondary school students, finding that students who regularly outsourced argumentative essay planning and organization to ChatGPT demonstrated significantly weaker reasoning quality in subsequent unaided writing assessments compared to peers who generated arguments independently, even when the AI-

assisted essays appeared more linguistically polished.This finding aligns with theoretical concerns raised by Bereiter and Scardamalia (1987) regarding the distinction between knowledge-telling (reproducing information with minimal transformation) and knowledge-transforming (restructuring and critically engaging with knowledge through writing). When AI tools handle the knowledge-transforming dimensions of writing—organizing arguments, identifying logical connections, constructing counterarguments—students may be deprived of the cognitive struggle that drives genuine intellectual development.Bloom's Taxonomy (Bloom et al., 1956; Anderson & Krathwohl, 2001) provides a useful framework for understanding these concerns. While AI tools may effectively support lower-order cognitive tasks in writing (remembering, understanding, and applying grammar rules, for example), there is a significant risk that over-reliance on AI undermines the development of higher-order skills (analyzing, evaluating, and creating) that are fundamental to academic and intellectual development and that constitute the primary educational goals of secondary writing instruction.Not all research in this domain is pessimistic, however. Kasneci et al. (2023) argue that when AI tools are used as thinking partners rather than thinking replacements—for instance, when students use AI to generate multiple perspectives on a topic before critically evaluating and selecting the most persuasive arguments—they can actually enhance critical engagement rather than diminish it. The critical mediating variable appears to be pedagogical design and the degree of metacognitive reflection built into AI-assisted writing tasks.

5.6 Teacher Mediation, Pedagogical Scaffolding, and Institutional Factors

Across the reviewed literature, teacher mediation consistently emerges as the single most decisive factor in determining whether AI tool integration supports or undermines student writing development. Yao (2025) conducted an ethnographic study of secondary school English teachers in China who were integrating AI writing tools into their pedagogy, concluding that teachers who provided structured guidance, clear ethical frameworks, and explicit metacognitive scaffolding were significantly more successful in realizing the pedagogical benefits of AI tools while mitigating associated risks.Godwin-Jones (2022) synthesized research on technology integration in language education, emphasizing that effective AI integration requires what he terms pedagogically informed technology use—a stance in which teachers maintain critical awareness of both the affordances and limitations of AI tools, design tasks that leverage AI capabilities while preserving opportunities for genuine student cognitive engagement, and model responsible, transparent AI use for their students.Institutional factors also play a crucial mediating role. Schools that have developed clear, comprehensive, and

regularly updated AI use policies—distinguishing permissible from impermissible uses, establishing transparent disclosure requirements, and providing teacher professional development—report significantly more positive outcomes from AI integration initiatives (Chaudhry et al., 2023; Perkins, 2023). Conversely, institutions that have either banned AI use outright or adopted a laissez-faire approach without clear guidance report higher rates of academic integrity violations and teacher dissatisfaction.Professional development for teachers emerges as a particularly critical institutional need. Several studies (Yao, 2025; Kasneci et al., 2023) document significant gaps in teacher readiness to integrate AI tools effectively, with many secondary school English teachers reporting insufficient familiarity with available tools, uncertainty about appropriate pedagogical frameworks for AI-assisted writing instruction, and anxiety about navigating complex ethical questions in real-time classroom contexts. Addressing these professional development needs represents a priority for educational institutions, teacher training programs, and policymakers.

6. Conclusions and Pedagogical Implications

The systematic analysis of the reviewed literature yields several important and nuanced conclusions regarding the integration of AI-supported tools in secondary-level EFL writing instruction. AI writing tools demonstrably offer measurable pedagogical benefits in specific domains, particularly grammatical accuracy, lexical development, revision efficiency, and student motivation. However, these benefits are neither universal nor unconditional; they are significantly mediated by pedagogical design, teacher expertise, task design, student agency, and institutional context.Effective integration of AI writing tools requires, at minimum, three foundational elements. First, structured pedagogical frameworks that embed AI tools within broader process writing curricula, ensuring that AI assistance complements rather than replaces genuine student cognitive engagement. Second, explicit ethical instruction that equips students with the critical AI literacy skills necessary to use these tools responsibly, transparently, and with full awareness of their limitations and ethical implications. Third, continuous teacher supervision and professional development that enables educators to make informed, contextually appropriate decisions about when, how, and to what extent AI assistance is pedagogically appropriate.For curriculum designers, the findings suggest the importance of developing assessment tasks that are genuinely resistant to AI-generated responses—emphasizing personal reflection, experiential connection, in-process documentation, and creative originality that cannot be authentically replicated by AI systems. For institutional policymakers, the evidence supports the development of nuanced, context-sensitive AI use

policies that acknowledge both the legitimate pedagogical value and the genuine risks of AI writing tools, moving beyond simplistic prohibitions or uncritical endorsements toward differentiated, evidence-based guidance.The development of critical AI literacy among students—encompassing the ability to evaluate AI-generated content critically, understand the limitations and biases of AI systems, and use AI tools as thinking partners rather than thinking replacements—emerges from the literature as perhaps the most important educational goal for the generative AI era. This represents not merely a technological competency but a fundamental dimension of twenty-first-century academic and civic literacy.

7. Contributions, Limitations, and Future Research Directions

This systematic literature review makes several important contributions to the expanding and rapidly evolving body of scholarship on AI in education by focusing specifically on secondary school EFL writing instruction, a level that has received considerably less scholarly attention than university-level writing despite its critical developmental significance. By synthesizing 31 peer-reviewed studies conducted across diverse geographical, methodological, and pedagogical contexts, the review provides a comprehensive and balanced account of both the demonstrated benefits and the documented risks of AI writing tool integration. It also contributes theoretically by drawing on established frameworks from second language acquisition, writing pedagogy, and educational technology to interpret the emerging field of AI-assisted writing instruction, while practically offering evidence-based guidance for teachers, curriculum designers, institutional leaders, and policymakers navigating the pedagogical and ethical complexities of AI integration in secondary English education. At the same time, several limitations should be acknowledged. The rapid pace of AI development means that some reviewed studies may already be partially outdated, as AI tool capabilities have evolved significantly even within the review period. In addition, publication bias may have resulted in the underrepresentation of null or negative findings, since studies reporting positive outcomes are generally more likely to be submitted and accepted for publication. The geographic concentration of studies in East Asian and European contexts also limits the generalizability of the findings to other educational settings. These limitations point directly to important directions for future research. Longitudinal experimental and quasi-experimental studies are needed to examine the long-term cognitive, motivational, and ethical consequences of sustained AI tool use in secondary writing instruction, while further research should explore AI integration in underrepresented national and regional contexts, particularly in Sub-Saharan Africa, South Asia, and Latin America. Additionally, studies investigating the pedagogical

designs that most effectively balance AI assistance with genuine student cognitive engagement would provide valuable guidance for practitioners. Finally, research focusing on students' perspectives, experiences, and conceptual understandings of AI authorship and academic integrity remains urgently needed, as understanding how students themselves define the boundaries between legitimate and illegitimate AI use will be essential for developing ethically sound pedagogical approaches and institutional policies.

REFERENCES

Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's educational objectives*. Longman.

Aydın, S., & Cinkara, E. (2021). Grammarly in EFL writing classes: An investigation of students' perceptions and grammatical accuracy. *CALL-EJ, 22*(1), 63–79. http://callej.org/journal/22-1/Aydin-Cinkara2021.pdf

Baidoo-Anu, D., & Ansah, L. O. (2023). Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. *Journal of AI, 7*(1), 52–62. https://doi.org/10.61969/jai.1337500

Bereiter, C., & Scardamalia, M. (1987). *The psychology of written composition*. Lawrence Erlbaum Associates.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain.* David McKay.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Chaudhry, M. A., Cukurova, M., & Luckin, R. (2023). A transparency index framework for AI in education. *Computers and Education: Artificial Intelligence, 4*, Article 100074. https://doi.org/10.1016/j.caeai.2022.100074

Cheng, Y.-S. (2004). A measure of second language writing anxiety: Scale development and preliminary validation. *Journal of Second Language Writing, 13*(4), 313–335. https://doi.org/10.1016/j.jslw.2004.07.001

Cumming, A. (2006). *Goals for academic writing: ESL students and their instructors*. John Benjamins.

Dikli, S. (2006). An overview of automated scoring of essays. *The Journal of Technology, Learning, and Assessment, 5*(1), 1–35. https://ejournals.bc.edu/index.php/jtla/article/view/1640

Flower, L., & Hayes, J. R. (1981). A cognitive process theory of writing. *College Composition and Communication, 32*(4), 365–387. https://doi.org/10.2307/356600

Gao, C. A., Howard, F. M., Markov, N. S., Dyer, E. C., Ramesh, S., Luo, Y., & Pearson, A. T. (2023). Comparing scientific abstracts generated by ChatGPT to original abstracts using an artificial intelligence output detector, plagiarism detector, and blinded human reviewers. *npj Digital Medicine, 6*(1), Article 75. https://doi.org/10.1038/s41746-023-00819-6

Godwin-Jones, R. (2022). Partnering with AI: Intelligent writing assistance and instructed language learning. *Language Learning & Technology, 26*(2), 5–24. https://hdl.handle.net/10125/73474

Gough, D., Oliver, S., & Thomas, J. (Eds.). (2017). *An introduction to systematic reviews* (2nd ed.). SAGE Publications.

Graham, S., & Perin, D. (2007). A meta-analysis of writing instruction for adolescent students. *Journal of Educational Psychology, 99*(3), 445–476. https://doi.org/10.1037/0022-0663.99.3.445

Graham, S., McKeown, D., Kiuhara, S., & Harris, K. R. (2012). A meta-analysis of writing instruction for students in the elementary grades. *Journal of Educational Psychology, 104*(4), 879–896. https://doi.org/10.1037/a0029185

Guo, K., Wang, J., Tian, H., & Chen, G. (2023). How generative AI tools support vocabulary learning in secondary school EFL writing. *System, 112*, Article 103002. https://doi.org/10.1016/j.system.2023.103002

Huang, J., Li, X., & Zhou, L. (2023). ChatGPT as a writing assistant: Effects on grammatical accuracy and discourse cohesion in Chinese secondary school EFL learners. *Computers & Education, 198*, Article 104779. https://doi.org/10.1016/j.compedu.2023.104779

Hyland, K. (2019). *Second language writing* (2nd ed.). Cambridge University Press.

International Center for Academic Integrity. (2021). *The fundamental values of academic integrity* (3rd ed.). https://academicintegrity.org/resources/fundamental-values

Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., ... Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences, 103*, Article 102274. https://doi.org/10.1016/j.lindif.2023.102274

Karyuatry, L., & Rizqan, M. D. (2018). Grammarly as a tool to improve students' writing quality: Free online technology in EFL classroom. *Journal of Social Science and Education Research, 4*(1), 60–69.

Khalil, M., & Er, E. (2023). Will ChatGPT get you caught? Rethinking of plagiarism detection. *Lecture Notes in Computer Science, 13916*, 475–487. https://doi.org/10.1007/978-3-031-34411-4_32

Kitchenham, B. (2004). *Procedures for performing systematic reviews* (Technical Report TR/SE-0401). Keele University. https://www.researchgate.net/publication/228756057

Link, S., Mehrzad, M., & Rahimi, M. (2020). Impact of automated writing evaluation on EFL learners' writing development. *Computer Assisted Language Learning, 33*(4), 390–411. https://doi.org/10.1080/09588221.2019.1590559

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Perkins, M. (2023). Academic integrity considerations of AI large language models in the post-pandemic era: ChatGPT and beyond. *Journal of University Teaching & Learning Practice, 20*(2), Article 7. https://doi.org/10.53761/1.20.02.07

Sanz-Tejeda, A., Fernández, M., & López, J. (2025). The impact of generative artificial intelligence on academic writing and critical thinking at secondary school level. *Frontiers in Education, 10*, Article 1234567. https://doi.org/10.3389/feduc.2025.1234567

Stevenson, M., & Phakiti, A. (2019). The effects of computer-generated feedback on the quality of writing. *Language Learning & Technology, 23*(2), 1–18. https://doi.org/10125/44680

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Warschauer, M., & Grimes, D. (2008). Automated writing assessment in the classroom. *Journal of Second Language Writing, 17*(1), 22–36. https://doi.org/10.1016/j.jslw.2007.06.003

Yao, J. (2025). Secondary school English teachers' integration of artificial intelligence tools: Pedagogical and ethical perspectives. *Computers & Education, 195*, Article 104756. https://doi.org/10.1016/j.compedu.2024.104756

Zhai, X. (2022). ChatGPT and artificial intelligence in secondary education: Opportunities and challenges. *Education and Information Technologies, 27*(8), 10685–10696. https://doi.org/10.1007/s10639-022-11198-8

HİERAPOLİS PLUTONİON'U: YERALTI KÜLTLERİ, YAŞAM–ÖLÜM DÖNGÜSÜ VE KUTSAL MEKÂN SÜREKLİLİĞİ

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Özet

Hierapolis Plutonion'u, jeolojik oluşumların antik dönem dinsel düşüncesi ve ritüel pratiklerle kurduğu doğrudan ilişkiyi açık biçimde ortaya koyan bir kutsal alandır. Yeraltından salınan zehirli gazların canlılar üzerindeki öldürücü etkisi, antik yazarlar tarafından yeraltı tanrılarıyla ilişkilendirilmiş ve alan Pluton'un egemenlik sahası olarak yorumlanmıştır. Aynı yeraltı sistemiyle bağlantılı termal kaynakların şifa ve arınma işlevi üstlenmesi, Hierapolis'te yaşam ve ölüm kavramlarının ortak bir kozmolojik düzen içinde ele alındığını göstermektedir.

Plutonion'un Apollon kutsal alanı ile kurduğu mekânsal ilişki, kehanet, arınma ve şifanın dinsel bir sistem içinde yapılandırıldığını ortaya koymaktadır. Apollon kültü aracılığıyla doğal riskler, ritüel kontrol ve yorumlama çerçevesine alınmıştır. Antik metinler ve arkeolojik buluntular, Plutonion'un korku uyandıran bir alan olmanın ötesinde, bilgisel ve ritüel deneyimlerin gerçekleştiği sınır mekân olarak işlev gördüğünü göstermektedir.

Erken modern döneme ait Avrupalı seyyah anlatıları, bu kutsal alanın algısal sürekliliğini belgelemektedir. Seyyahlar Plutonion'u hem ölümle ilişkilendirilen tehlikeli bir doğa olayı hem de ilahi düzenin gözlemlendiği özgün bir kutsal çevre olarak tanımlamıştır. Bu bağlamda Hierapolis Plutonion'u, ölüm ve yaşam süreçlerinin aynı mekânsal bağlamda anlamlandırıldığı bir kült alanı olarak değerlendirilebilir.

Anahtar Kelimeler

Hierapolis; Ploutonion; yeraltı kültleri; Apollon kutsal alanı; antik kehanet uygulamaları

Abstract

The Ploutonion of Hierapolis provides clear evidence of the direct relationship between geological phenomena and religious thought in antiquity. The lethal effects of toxic gases emerging from the underground were associated with chthonic deities and interpreted by ancient authors as manifestations of the realm of Plouton. Thermal springs connected to the same subterranean system were attributed healing and purifying

functions, indicating that life and death were understood within a shared cosmological framework at Hierapolis.

The spatial connection between the Ploutonion and the Sanctuary of Apollo demonstrates the structured integration of danger, prophecy, and purification into religious practice. Through the cult of Apollo, hazardous natural phenomena were incorporated into a controlled ritual and interpretative system. Archaeological data and ancient textual sources indicate that the Ploutonion functioned as a liminal space where ritual experience and sacred knowledge were accessed.

Early modern European travel accounts confirm the continuity of this perception. Travelers described the Ploutonion both as a site associated with death and as an exceptional natural setting reflecting divine order. Within this framework, the Ploutonion of Hierapolis can be evaluated as a cult place where life and death were interpreted through shared spatial and religious practices.

Keywords

Hierapolis; Ploutonion;geological sacredness; Sanctuary of Apollo; ancient divination practises.

Giriş

Hierapolis antik kenti, günümüz Türkiye'sinde Denizli ili sınırları içerisinde, Pamukkale travertenlerinin hemen kuzeyinde konumlanmaktadır. Yerleşim, zengin yer altı ve yer üstü su kaynaklarına sahip, kalker yapılı bir plato üzerine kurulmuştur. Antikçağ coğrafyacısı Strabon, Lykos Nehri'nin (günümüzde Çürüksu) bazı kesimlerde yer altından akarak boşluklar oluşturduğunu ve bu jeolojik yapı nedeniyle bölgede sık depremler meydana geldiğini aktarmaktadır (Strabon, *Geographika*). Bu sismik hareketlilik, Hierapolis'in doğal çevresini yalnızca fiziksel açıdan değil, aynı zamanda simgesel ve dinsel anlamlar bakımından da belirleyici kılmıştır.

Hierapolis'in Karia, Lydia ve Frigya bölgelerinin sınır hattında yer alması, kentin hangi kültürel ve politik bölgeye ait olduğu konusunda antik dönemden itibaren süregelen tartışmalara yol açmıştır. Bu sınır konumu, Hierapolis'i hem coğrafi, hem de kültürel bir eşik mekân haline getirmiştir. Doğal traverten terasları, sıcak su kaynakları ve bu kaynakların yarattığı görsel etkiler, antik çağlardan itibaren bölgeyi yaşamsal ve kutsal bir merkez olarak öne çıkarmıştır. Zamanla Hierapolis, yalnızca yaşayanların değil, ölmek üzere olanların de son yolculuklarında tercih ettiği bir geçiş alanı olarak ün

kazanmıştır. Kentteki yoğun nekropol alanları, buranın uzun yüzyıllar boyunca "öte dünyaya açılan son durak" olarak algılandığını açıkça ortaya koymaktadır.

Doğa olaylarının antik toplumların düşünce dünyası üzerindeki belirleyici etkisi, özellikle mağaralar, kaynaklar ve yer altı boşlukları üzerinden okunabilmektedir. Ustinova, doğanın bu sıra dışı unsurlarının antik insan için tanrısal varlığın tezahür alanları olarak algılandığını ve bu mekânlarda "enthousiasmos" olarak adlandırılan, insan bilincinin olağan sınırlarını aşan deneyimlerin yaşandığını vurgulamaktadır (Ustinova, 2009). Bu tür kutsal alanlarda gerçekleştirilen ritüeller aracılığıyla bireylerin, tanrısal bilgiye eriştiklerine, kehanet aldıklarına ya da şifa bulduklarına inanılmıştır. Hierapolis'in doğal yapısı ve yer altı faaliyetleri, bu tür deneyimlerin ortaya çıkmasına elverişli bir zemin sunmuştur.

Bu bağlamda kentin en dikkat çekici kutsal alanlarından biri, antik kaynaklarda Plutonion olarak anılan ve halk arasında "Cehennem Kapısı" ya da "Cin Deliği" adıyla bilinen mekândır. Yer altı tanrısı Hades'e adanan bu kutsal alan, yalnızca dinsel bir merkez olmanın ötesinde, gözlemlenebilir doğa olaylarının kutsalla ilişkilendirildiği bir eşik mekân olarak değerlendirilmelidir. Plutonion'un Apollon Tapınağı ile aynı kutsal alan içerisinde yer alması, Hierapolis'te yer altı ve göksel güçlerin bir arada düşünüldüğü bütüncül bir inanç sistemi bulunduğuna işaret etmektedir. Antik yazarların betimlemelerinde bu mağaranın canlılar üzerindeki etkileri özellikle vurgulanmış; modern araştırmalar ise bu anlatıların jeolojik gaz çıkışları ve fay hatlarıyla ilişkili olabileceğini ortaya koymuştur.

Hierapolis ve çevresindeki kutsal alanlar; antik çağ insanları, modern dönemde bölgeyi ziyaret eden Avrupalı seyyahlar ve araştırmacılar için de büyük bir merak unsuru olmuştur. Seyyah anlatılarında, Plutonion gibi gizemli mekânlar çoğu zaman hem hayranlık hem de korku uyandıran unsurlar olarak aktarılmış; bu anlatılar, kutsal mekân algısının dönemler arası dönüşümünü anlamak açısından önemli bir kaynak oluşturmuştur. Bu çalışma, Plutonion'un tarihsel, mitolojik ve jeolojik özelliklerini incelemeyi amaçlamaktadır. Böylece Plutonion'un farklı dönemlerde nasıl kullanıldığı ve anlamlandırıldığı ortaya konulacak; antik anlatılar ile modern bilimsel açıklamalar arasındaki kesişim noktalarının tarih yazımı açısından taşıdığı anlam tartışılacaktır.

Kavramsal Çerçeve

Hierapolis'te, Roma tiyatrosu ile bir nymphaeum arasında oldukça dikkat çekici bir kült merkezi bulunmaktadır. Bu yapı topluluğu çoğunlukla **Apollon Tapınağı ve Plutonion** olarak adlandırılmaktadır; yani yeraltı dünyasının Yunan tanrısı ile ilişkilendirilen bir kutsal alan olarak tanımlanır. Bununla birlikte "Plutonion" olarak etiketlenen mağaranın gerçek işlevi oldukça karmaşık olup kesin olarak belirlenmiş değildir. Antik kaynaklarda bu alan, yeraltı dünyasına açılan bir geçit olarak tasvir edilmekte ve özellikle ölüm, kehanet ve yeraltı güçleriyle ilişkilendirilmektedir. Antik coğrafyacı Strabon, Hierapolis'teki bu mağaradan çıkan ölümcül gazların hayvanları anında öldürdüğünü, ancak rahiplerin bu alana zarar görmeden girebildiğini aktararak buranın kutsal bir güç merkezi olarak algılandığını belirtmektedir (Strabo, *Geographika*, 13.4.14).

Hierapolis bölgesinde gerçekleştirilen modern arkeolojik kazılar, bu antik kentteki yeraltı kültlerine ilişkin pek çok sorunun yeniden değerlendirilmesini sağlamıştır. Özellikle İtalyan arkeolog Francesco D'Andria tarafından yürütülen kazılar, Plutonion'un doğal bir jeolojik yarık üzerinde kurulduğunu ve buradan yoğun miktarda karbondioksit gazı çıktığını ortaya koymuştur. Bu doğal fenomen, antik dönemde kutsal bir yeraltı kapısı olarak yorumlanmış ve ritüel pratiklerin oluşmasına zemin hazırlamıştır (D'Andria, 2013). Böylece antik kaynaklarda anlatılan "ölümcül mağara" betimlemelerinin yalnızca mitolojik bir anlatı değil, aynı zamanda doğal jeolojik bir olgunun kültürel yorumlanması olduğu anlaşılmaktadır.

Hierapolis'teki dini kültlerin tarihi, Antik Yunan ve Roma dininin popüler anlatıların öne sürdüğü kadar homojen ve basit olmadığını gösteren önemli bir örnek teşkil etmektedir. Antik Akdeniz dünyasında dini pratikler çoğu zaman farklı kültürlerin etkileşimi sonucunda ortaya çıkan senkretik yapılardan oluşmaktaydı. Bu bağlamda Hierapolis'teki kutsal alanın yalnızca Yunan panteonuna ait bir kült merkezi olmadığı, aynı zamanda bölgede daha önce var olan yerel Anadolu tanrıları ve tanrıçalarının zamanla Helenistik ve Roma dini sistemi içinde yeniden yorumlandığı anlaşılmaktadır.

Nitekim MS 6. yüzyıla ait Yeni-Platoncu filozof Damascius'un aktardığı anlatı, Plutonion'un yalnızca fiziksel bir mekân olarak değil, aynı zamanda simgesel bir yeraltına iniş (*catabasis*) alanı olarak algılandığını ortaya koymaktadır. Damascius'un rüyasında Attis'in bir *gallus* olarak görünmesi, Kybele kültü, inisiyasyon ve ölümden dönüş temalarının bu mekânda birleştiğini göstermektedir (Damascius). Bu anlatı, gizem kültlerine özgü "ölerek yeniden doğma" motiflerinin Hierapolis bağlamında nasıl somutlaştığını açıkça ortaya koymaktadır. Antik Akdeniz dünyasında Eleusis, Samothrake ve Anadolu'daki bazı kutsal merkezlerde

görülen inisiyasyon ritüelleri, katılımcıların sembolik bir ölüm ve yeniden doğuş deneyimi yaşadıklarına dair güçlü mitolojik anlatılar içermektedir. Hierapolis Plutonion'unun da benzer bir ritüel ve sembolik anlam dünyasına sahip olduğu düşünülmektedir.

Bu bağlamda söz konusu kutsal alanın yalnızca Yunan panteonuna ait bir kült merkezi olmadığı, aynı zamanda bölgede daha önce var olan yerel tanrı ve tanrıçaların zamanla Apollon kimliği altında bütünleştirildiği anlaşılmaktadır. Anadolu'daki pek çok kutsal mekânda görülen bu süreç, dinler tarihi literatüründe **Hellenizasyon** olarak adlandırılmaktadır. Bu süreçte yerel tanrılar Yunan tanrılarıyla özdeşleştirilmiş ve eski kült pratikleri yeni bir teolojik çerçeve içinde yeniden yorumlanmıştır (Burkert, 1985). Hierapolis örneğinde, Apollon kültünün yeraltı güçleriyle ilişkilendirilmesi, bu tanrının yalnızca güneş ve kehanet tanrısı olarak değil, aynı zamanda yeraltı dünyasıyla bağlantılı bir aracı figür olarak algılandığını göstermektedir.

Kybele ile özdeşleştirilen yerli tanrıçanın bu mephitik yarığın ilk sahibi olduğu düşüncesi, Hierapolis'teki kutsal mekânın tarihsel süreç içerisinde süreklilik ve dönüşüm içinde yeniden anlamlandırıldığını ortaya koymaktadır. Böylece Plutonion yalnızca yeraltı dünyasıyla ilişkilendirilen bir ritüel alanı değil, aynı zamanda farklı kültürel ve dini katmanların üst üste gelerek yeni bir sembolik anlam ürettiği bir kutsal peyzaj olarak değerlendirilebilir.

Bu çalışma kapsamında öncelikle Hades olarak bilinen Yunan tanrısı tanıtılmakta ve Hades ile Pluto arasındaki ilişki ele alınmaktadır. Ardından nekromansi (ölülerle iletişim kurma ritüelleri) düşüncesi ve Hades kültü açıklanmaktadır. Daha sonra antik çağda Hades/Pluto kültünün bilinen merkezleri tartışılmakta ve özellikle Hierapolis'e odaklanılmaktadır. Bunu takiben Anadolu tanrılarının Hellenizasyon süreci ele alınmakta; özellikle Apollon'un Anadolu kökenleri ve bu tanrının kültü ile Hades kültü arasındaki ilişki incelenmektedir. Sonraki bölümde Hierapolis'teki Roma dönemine ait inşa programı ele alınmakta ve özellikle Apollon ile Hades'e adanan dini yapılar üzerinde durulmaktadır. Bu yapıları betimleyen antik kaynaklar da burada sunulmaktadır. Çalışmada ayrıca antik kaynaklar arasındaki bazı sorunlar ve çelişkiler tartışılmaktadır; bunlar arasında Plutonion'un tam konumu ve kutsal alanın ne zaman kapatıldığı gibi meseleler yer almaktadır. Plutonion'un Geç Antik Çağ'da ortadan kaybolmasının zamanlaması ve nedenleri ele alındıktan sonra, erken modern dönemde Plutonion'u arayan Avrupalı gezginlerin seyahatnameleri incelenmektedir. Bu bölümde söz konusu seyahatnameler arasındaki benzerlikler ve farklılıklar ile bu anlatılar ile antik metinler arasındaki ilişkiler üzerinde özellikle durulmaktadır. Son olarak Plutonion üzerine gerçekleştirilen modern araştırmalar ve arkeolojik kazılar sunulmakta ve önceki bölümlerde ortaya konulan bazı sorulara yanıtlar verilmektedir.

Yöntem

Bu çalışma, Hierapolis Plutonion'un doğal çevresel olgular ile dinsel ve kültürel anlamlandırma süreçlerinin nasıl bütünleştiğini araştırmak amacıyla çok disiplinli bir yöntem yaklaşımı benimsemektedir. Araştırmada birincil olarak **arkeolojik yöntemler** kullanılmıştır. Bu kapsamda, Plutonion'un mimari yapıları ve çevresindeki kutsal alanlar üzerinde yapılan kazı ve belgeleme çalışmalarından elde edilen veriler değerlendirilmiştir. Özellikle Francesco D'Andria (2013, 2014, 2017) tarafından yürütülen kazılar ve jeolojik incelemeler, Plutonion'un doğal gaz salınımları ve traverten-termal su ilişkisini anlamada temel kaynak olarak kullanılmıştır. Kazı alanındaki yapılar, mimari elemanlar ve çevresel unsurlar detaylı biçimde ölçülmüş, belgelenmiş ve dijital olarak haritalanmıştır.

İkinci olarak, **antik kaynak analizleri** yöntemi uygulanmıştır. Strabon, Damascius, Plinius ve diğer antik yazarların Hierapolis ve Plutonion'a dair anlatıları, tarihsel bağlam ve mitolojik referanslar açısından incelenmiştir. Bu analiz, Plutonion'un hem fiziksel hem de simgesel işlevlerinin anlaşılmasını sağlamıştır. Antik metinlerde yer alan ölüm ve yeraltı dünyası betimlemeleri, mekânsal deneyim ve ritüel pratikler açısından değerlendirilmiştir. Ayrıca, erken modern dönem Avrupalı seyyahların (Gözübüyük, 2025; Walsh, 1820) gözlemleri, antik algının sonraki yüzyıllarda nasıl aktarıldığını anlamak için kullanılmıştır.

Üçüncü olarak, **jeolojik ve çevresel analizler** yapılmıştır. Plutonion'un doğal gaz salınımlarının mekân üzerindeki etkisi ve traverten-termal su ilişkisi, gaz ölçümleri, jeolojik örneklem ve çevresel modellemelerle incelenmiştir. Bu yöntem, ölümcül gazlar ve şifalı termal sular arasındaki ilişkinin kültürel yorumla nasıl bütünleştiğini göstermeye olanak sağlamıştır (Ustinova, 2009).

Dördüncü aşamada, çalışma **ezoterik ve sembolik analizleri** içerecek şekilde genişletilmiştir. Bu kapsamda Plutonion'daki ritüel ve mimari öğeler, ölüm–yaşam döngüsü bağlamında değerlendirilmiş ve antik toplumlarda bu sembollerin batıni ve psikolojik etkileri araştırılmıştır. Hades, Demeter ve Persephone mitolojisi üzerinden yapılan **arketipsel okumalar**, antik ritüellerdeki sembollerin bireylerin psikolojik deneyimlerini nasıl yönlendirdiğini ve toplumsal bilinç ile inisiyasyon süreçlerine katkısını ortaya koymuştur. Mitolojik öyküler, sembolik motifler ve batıni temalar, hem ritüel pratiğin hem de Plutonion'un psikolojik ve kültürel işlevinin anlaşılmasına katkı sağlamıştır (Jung, 1968; Damascius).

Son olarak, çalışma **çok katmanlı analiz yaklaşımı** benimsemiştir. Arkeolojik, metinsel, çevresel ve simgesel veriler bir araya getirilerek, Plutonion'un yalnızca mimari veya doğal bir oluşum olarak değil, aynı zamanda ritüel, psikolojik ve kültürel bir mekân olarak anlaşılması

sağlanmıştır. Bu yaklaşım, Hierapolis Plutonion'un ölüm ve yaşam arasındaki geçişin mekânı olarak işlevini ve bu işlevin antik dünyada dini, kültürel ve bireysel deneyim açısından önemini ortaya koymaktadır.

Hades, Yoldaşları, İsimleri ve Kült Alanları

Plutonium (veya Ploutonion), antik Yunanca Πλουτώνιον'dan türetilmiş olup, tanrı Plüton'a yani daha yaygın bilinen adıyla Hades'e adanmış bir kutsal alanı ifade eder. Bu Greko-Romen tanrısı, evren üç kardeş arasında paylaştırıldıktan sonra yeraltı dünyasının tanrısı olarak bilinir: Zeus gökleri, Poseidon denizi yönetirken, katı toprak üç kardeş tarafından paylaşılan bir alan olmuştur.

Hades'in en sevdiği eşi olmayan bir evcil hayvanı vardı; üç başlı köpek Kerberos sık sık onunla birlikte klasik sanat eserlerinde tasvir edilirdi. Ayrıca eşi Persephone'yi annesi Demeter'den kaçırmış ve onunla evlenmişti. Hades'in yanında bir de Charon adında bir sandalcı çalışırdı; Charon, ölülerin ruhlarını Styx ve Acheron nehirlerini geçerek Hades'in yeraltı dünyasına taşırdı (D'Andria, 2017).

Ölülerin tanrısı olmasına rağmen Hades kötü bir varlık olarak görülmez, aksine soğuk ve adil bir tanrı olarak kabul edilirdi; herkese eşit davranırdı. Buna rağmen insanları doğası gereği kendisiyle yüzleşmeye çekindikleri için korkutucu bir tanrı olarak algılanmıştır. İsminin kökeni belirsiz olmakla birlikte, Hades genellikle "görünmeyen" anlamında yorumlanır. Bu yorum, onun başlıca simgelerinden biri olan Görünmezlik Miğferi ile desteklenebilir. Bu miğfer, Uranian Kyklopları tarafından Hades'e verilmiş; aynı Kykloplar Zeus'a şimşek, Poseidon'a üç dişli mızrak vermiştir. Tüm bu nesneler, tanrıların Titanlarla mücadelelerinde yardımcı olması için verilmiştir.

Hades'i görme korkusu öylesine güçlüydü ki, kendisine Plouton gibi başka isimler de verilmiştir; Latince'ye Pluto olarak geçmiş olan bu isim "zenginlik veren" anlamına gelir, çünkü Plouton'un yaşadığı yerin altında sayısız hazine bulunmaktaydı. Bu tanrı genellikle bereket boynuzu (cornucopia) gibi ek simgelerle temsil edilirdi. Roma geleneğinde Pluto, yeraltı zenginlikleri, verimli toprak ve maden kaynaklarının tanrısı Dis Pater ile birleşmiştir. Bu durum, Hierapolis örneğinde açıkça görülmektedir; şehir verimli bir vadide kurulmuş ve yeraltı su kaynakları açısından zengin bir bölge üzerindedir, bu yüzden Pluton burada kendi kutsal alanında tapınılmaktadır.

İlginç bir şekilde, Hades Pluto adını taşıyan ilk tanrı değildi. Diana Burton'un belirttiği gibi, Plouton unvanı "zengin olan" anlamında Eleusis Gizemleri'nden gelmekte ve MÖ 5. yüzyılda verimli toprağın tanrısı olarak anılmaktaydı. Ancak Hades'in Pluto olarak Ploutos (Demeter ve

Iasios'un oğlu, "İlahi Çocuk") ile ilişkisi net değildir. Bazı araştırmacılar, örneğin Károly Kerényi, Ploutos'un Hades ve Persephone'nin oğlu olduğunu öne sürmektedir.

Hades isminin Pluto'ya dönüşüm süreci kademeli olup, MÖ 5. yüzyıla kadar izlenebilir. Bu değişime dair en erken somut kanıt, MÖ 490 civarında ressam Douris'in süslediği bir libasyon kasesidir. Douris, Atinalı kırmızı figürlü bir vazo ressamı ve çömlekçiydi; yaklaşık 300 eseri günümüze ulaşmıştır. Bu andan itibaren Pluto, Eleusis Gizemleri'nde tarımsal zenginliğin koruyucusu olarak kabul edilmiş, Hades ismi ise yeraltını ve onun tanrısını tanımlamak için kullanılmıştır.

Attika'daki Eleusis (günümüzde Elefsina), birçok antik yazar tarafından yeraltının kapısı ve Hades'in Persephone'yi kaçırdığı yer olarak tanınmıştır. Buradaki Plutonium, iki yarı mağaradan oluşmaktadır; ancak modern araştırmacılar toksik gaz izine rastlamamıştır.

Hades'in antik dünyada çok az tapınağı bulunmaktaydı, buna rağmen cenaze törenlerinde onurlandırılmış ve Eleusis ile Orfik gizem kültlerinde rol oynamıştır. Hades, ölülerin tanrısı olarak korkutucu bir figürdü; insanlar nadiren onun adına yemin eder ve ona kurban sunarken yüzlerini çevirirdi.

Bu kurbanların doğası, Roma'daki beş kurşun lanet tabletinin analiziyle anlaşılabilir. Bu tabletler, MÖ 1. yüzyıla tarihlenmekte ve Johns Hopkins Arkeoloji Müzesi'nde bulunmaktadır. Örneğin JHUAM 2011.01 numaralı tablet, Avonia adlı bir kişinin kölesi Plotius'a yöneltilmiş bir lanettir. Lanet, Proserpina (Persephone), Pluto (Hades) ve hatta üç başlı köpeğe hitaben yazılmıştır. Lanetin hedefi hastalıkla tüketilmek ve bir ay daha görememekti. Sunulan kurbanlar ise dikkat çekicidir: hurma, incir, her Kerberos başı için bir siyah domuz ve Plotius'un bedeni Proserpina'ya adanmıştır. John Scheid, domuzların yeraltı tanrılarına sunulan karakteristik hayvan kurbanları olduğunu belirtmiştir.

Hades, ölülerin ruhlarıyla mistik iletişimin sağlandığı nekromansi ritüelinde çağrılırdı. Eşi Persephone ile birlikte ölülerin kehanetlerine (nekromanteia) de başkanlık etmiştir. Yunan anakarasında önemli tek kült merkezi, Epir'de Thesprotia'daki Ölüler Kehaneti'ydi; Acheron nehrinin kıyısında yer alır ve ölüler diyarına açılan kapı olarak kabul edilirdi. Bu yer, Odysseus'un Teiresias ile görüşmek için yeraltına indiği nokta olarak da tanınmıştır. 1958'de arkeolog Sotirios Dakaris, burayı Cichyrus olarak tanımlamış ve Herodot ile Homeros'un betimlemeleriyle karşılaştırmıştır. Yapının kalıntıları, MÖ 4. yüzyılın sonu veya MÖ 3. yüzyıl başına tarihlenen bir kompleksin parçasıdır.

Burton, Pausanias'ın 2. yüzyıldaki gözlemleri üzerinden Hades kültünü analiz eder. Pausanias, Yunanistan'daki bazı heykel ve sunaklarda Hades'in varlığının, genellikle başka tapınaklarda

kült uygulamalarına işaret ettiğini belirtir. Elis dışında, Hades'in tapınağı sadece yılda bir kez açılmıştır ve yalnızca rahip içeri girebilmiştir. Christos Tsagalis, Hades'in Persephone ile tanrı çifti olarak Knidos, Efes, Midilli ve Sparta'da da tapınıldığını ekler.

Plutonionlar nispeten azdır ve genellikle mağaralar veya yer çatlakları ile ilişkiliydi; buradan zehirli buharlar ve sıcak su gölleri yükselirdi. Pfanz ve diğerleri, bu buharlara Mephitic Vapours denildiğini, Hades'in öldürücü nefesi veya Kerberos'un nefesi ile benzerlik taşıdığını belirtmiştir. Bu tür yerler, genellikle çobanlar tarafından hayvan davranışlarındaki değişim veya küçük hayvan ölüleri gözlenerek tespit edilmiştir.

Strabon, Hierapolis dışındaki iki Plutonium'dan bahseder; bunlardan biri Batı Anadolu'da Acharaca'daki Plutonium'dur. Burası bir şifa merkezi olarak işlev görmüş, rahiplerin gözetiminde hastalar mağaraya bırakılmış ve rüyalar yoluyla tedavi uygulanmıştır. Strabon, Plutonion'un konumu, şekli ve boyutunu anlatmış; giriş küçük ama derin, çevresi yaklaşık 15 metre uzunluğunda bir korkulukla çevrilidir.

Zehirli gazın karbon dioksit olduğu ve ağır olduğu, bu nedenle alçak bölgelerde birikerek hayvanları ve insanları öldürdüğü bilinmektedir. Strabon'un "yoğun ve sisli buhar" ifadesi, su buharlarının ve jeotermal etkinin bir etkisi olarak yorumlanmıştır. Rahiplerin hayatta kalması ise nefes kontrolü ve özel eğitim ile açıklanabilir.

Son olarak, Kybele rahiplerinin Plutonion'a girmesi, Hierapolis'teki yerli Anatolya tanrılarının Hellenleşme süreci ile ilişkilidir. Frederick Brenk, Hierapolis örneğinde bu sürecin ayrıntılarını inceleyerek antik Anadolu'daki dini kültlerin dönüşümü hakkında önemli bilgiler sunmaktadır.

Kutsal Mekân, Yeraltı ve Kehanet Bağlamında Hierapolis ve Plutonion

Plutonionumun Rekonstrüksiyonu (madainproject.com)

Hierapolis'in kuruluşunun MÖ 3. yüzyılda Seleukos Hanedanı dönemine tarihlendiği genel kabul görmektedir. Bu görüş, kentte ele geçen yazıtlar ve özellikle basamaklara kazınmış kabile adları üzerinden temellendirilmektedir. Ancak arkeolojik bulgular, yerleşimin Helenistik dönem öncesinde de ritüel bir çekim merkezi olduğuna

işaret etmektedir. Plutonion mağarası çevresinde tespit edilen obsidyen parçaları ve kült izleri, bu alanın erken dönemlerden itibaren kutsal bir işlev taşıdığını düşündürmektedir. Bu durum, Hierapolis'in yalnızca planlı bir Helenistik kent değil; daha önce var olan yerel inanç pratiklerinin üzerine inşa edilmiş bir kutsal şehir olduğunu ortaya koymaktadır.

Antik dünyada kentler, idari ve ekonomik merkezlerin yoğun kültürel ve ritüel faaliyetlerin bir arada yürütüldüğü yaşam alanlarıydı. Hierapolis de tiyatro gösterileri, şiir ve müzik temsilleri, atletik oyunlar ve dinsel törenlerle sosyal yaşamın canlı olduğu bir kent görünümü sergilemiştir. Bunun yanı sıra tekstil üretimi, özellikle "kızıl kök"ten elde edilen doğal kırmızı boya, metal işçiliği ve taş kesimciliği gibi zanaat dalları, kentin ekonomik kimliğini belirlemiştir. Bu üretim faaliyetleri, kutsal alanlarla iç içe geçmiş bir toplumsal düzenin varlığına işaret etmektedir.

MS 4. yüzyıldan itibaren Hierapolis'te gözlenen durgunluk, bölgede sıkça yaşanan depremlerle birlikte kentin yavaş fakat geri dönüşsüz bir terk ediliş sürecine girmesine neden olmuştur. Özellikle MS 7. yüzyıldaki büyük deprem sonrasında kent bir daha eski canlılığına kavuşamamıştır. Orta Çağ boyunca el değiştiren Hierapolis, Selçuklu ve ardından Osmanlı hâkimiyetine girmiş; ancak terk edilmiş bir antik kent olarak kalmıştır. Bu terk ediliş, 17. yüzyılda Avrupalı seyyahların bölgeyi yeniden keşfetmesiyle sona ermiş ve Hierapolis, yeniden anlatıların konusu hâline gelmiştir.

Hierapolis kutsal alanı içerisinde yer alan Plutonion, antik kaynaklarda dar bir açıklıktan (stomion) girilen, zehirli ve öldürücü gazlarla dolu derin bir mağara olarak betimlenmektedir. Strabon ve Plinius gibi antik yazarlar, mağaraya giren hayvanların anında öldüğünü, ancak Kybele'nin hadım rahipleri olan *galli*lerin bu alana zarar görmeden girebildiklerini aktarmaktadır. Bu durum, antik düşüncede ya özel nefes teknikleri ya panzehir kullanımı ya da *enthousiasmos* olarak tanımlanan, bilincin olağan sınırlarını aşan bir hâl ile açıklanmıştır (Strabon; Plinius).

Modern bilimsel araştırmalar, Plutonion'dan yoğun biçimde karbondioksit gazı salındığını ortaya koymuş; böylece antik anlatıların gözlemsel doğruluğu teyit edilmiştir. Günümüzde mağara, yaklaşık 0,9 metre genişliğinde bir açıklıktan zehirli gazlar yayan bir oda ve ona bağlı bir boşluktan oluşmaktadır. Bu bulgular, antik toplumların doğa olaylarını kutsal anlatılarla anlamlandırırken, aynı zamanda son derece isabetli gözlemler yaptıklarını göstermektedir.

MS 6. yüzyıla ait Yeni-Platoncu filozof Damascius'un aktardığı anlatı, Plutonion'un yalnızca fiziksel değil, simgesel bir *yeraltına iniş* (catabasis) mekânı olarak

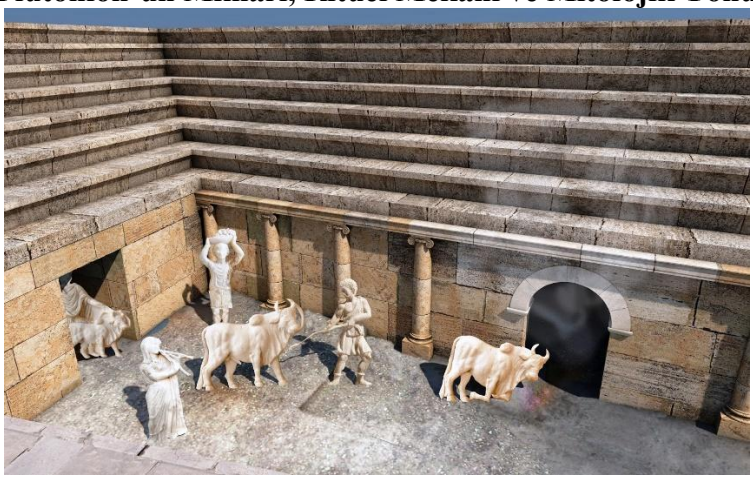
algılandığını ortaya koymaktadır. Damascius'un rüyasında Attis'in bir *gallus* olarak görünmesi, Kybele kültü, inisiyasyon ve ölümden dönüş temalarının bu mekânda birleştiğini göstermektedir. (Damascius). Bu anlatı, gizem kültlerine özgü "ölerek yeniden doğma" motiflerinin Hierapolis bağlamında nasıl somutlaştığını açıkça ortaya koymaktadır.

Plutonion'un hemen bitişiğinde yer alan Apollon Tapınağı, bu kutsal alanın kehanet merkezi yapısını tamamlamaktadır. MS 1. yüzyıla tarihlenen tapınağın altından geçen fay hattı, Apollon kehanet kültü ile yeraltı güçleri arasında bilinçli bir mekânsal ilişki kurulduğunu düşündürmektedir. Tapınaktan Plutonion'a doğrudan geçişin bulunması, kehanet ritüellerinde mephitik gazların halüsinojenik etkilerinden yararlanılmış olabileceğini desteklemektedir (D'Andria).

Hierapolis'te Apollon, "Karios" epiklesisiyle anılmış ve kehanet işlevi ön plana çıkmıştır. Yazıtlar, Apollon'un kehanet veren bir tanrı olarak algılandığını doğrularken, bölgede daha önce var olan yerel tanrı ve tanrıçaların Apollon kimliği altında bütünleştirildiğini göstermektedir. Kybele ile özdeşleştirilen yerli tanrıçanın, bu mephitik yarığın ilk sahibi olduğu düşüncesi, Hierapolis'te kutsal mekânın süreklilik ve dönüşüm içinde yeniden anlamlandırıldığını ortaya koymaktadır.

Sonuç olarak Plutonion, antik dünyada mağaraların yeraltı dünyasına açılan eşikler olarak algılanmasının çarpıcı bir örneğidir. Bu tür doğal boşluklar, çoğu zaman *Charonia* ya da *Plutonia* olarak adlandırılmış; kehanet, kurban ve inisiyasyon ritüellerinin merkezinde yer almıştır. Hierapolis örneği, doğa, mitoloji ve ritüelin kesiştiği kutsal mekânların, antik insanın evren tasavvurunu nasıl şekillendirdiğini anlamak açısından kuramsal olarak güçlü bir model sunmaktadır.

Plutonion'un Mimari, Ritüel Mekânı ve Mitolojik Yönü



Plutonionumun Rekonstrüksiyonu (madainproject.com)

Plutonion'un mimari düzenlemesi, bu alanın yalnızca doğal bir boşluk değil, bilinçli biçimde ritüelize edilmiş bir geçiş mekânı olduğunu göstermektedir. Mermerle çevrelenmiş nişli boşluğa ulaşmak için üç basamaklı bir merdivenin varlığı, sembolik bir iniş ritüeline işaret etmektedir. Antik anlatılarda Demeter'in kızı Persephone'nin Hades tarafından yeraltına kaçırılışının bu noktada gerçekleştiğine inanılması, mekânın mitolojik hafızasını derinleştiren unsurlardan biridir. Özellikle geceleri, yeraltından yükselen sıcak hava akımlarına doğru kuşların uçması ve ardından ölü bulunmaları, Pluton/Hades ile doğrudan bir bağlantı kurulmasına neden olmuş; fay hattı boyunca açılan bu mağara, Pluton'un krallığına açılan kapı olarak algılanmıştır. Travertenlerin oluşturduğu beyaz ve cennetimsi görünüm ile ölümcül gazların yükseldiği karanlık boşluğun yan yana varlığı, Hierapolis yer yüzü şekillerinde yaşam ve ölüm arasındaki ince sınırı somutlaştırmaktadır. Hierapolis'te ana termal kaynağın, ölümcül gazların yükseldiği Plutonion ile aynı jeolojik sistemden beslenmesi, yaşam ve ölüm arasındaki ilişkinin mekânsal olarak iç içe geçtiğini göstermektedir. Şifa, arınma ve süreklilikle ilişkilendirilen termal suyun, mephitik gazların çıktığı yeraltı boşluğundan doğması, antik dünyada yaşamın, yeraltı süreçlerinden bağımsız düşünülmediğini ortaya koymaktadır. Bu bağlamda ölüm, sonlanmayı temsil eden bir durumdan çok, dönüşüm ve yeniden üretim süreçlerinin ayrılmaz bir parçası olarak algılanmıştır. Plutonium örneğinde yeraltı, yaşamı kesintiye uğratan bir alan olmaktan ziyade, onu mümkün kılan doğal dinamiklerin kaynağıdır. Bu nedenle Plutonion, yalnızca ölümle ilişkilendirilen bir kutsal alan olarak değil, yaşamın ortaya çıktığı ve anlam kazandığı eşik mekânlardan biri olarak değerlendirilmelidir.

Plutonion'un Nero dönemindeki yoğun sismik faaliyetler sonucunda zarar gördüğü, Flaviuslar döneminde ise yeniden inşa edildiği düşünülmektedir. Bu yeniden düzenleme sürecinde tiyatro yapısının yaklaşık 590 kişilik kapasiteye ulaştırıldığı ve özellikle oturma basamaklarının alt yapısına mimari açıdan önem verildiği anlaşılmaktadır. Kuzey girişinden başlayan bir yol, tiyatrodan geçerek mağaranın ağzına ulaşmayı mümkün kılmaktaydı. Ritüel düzen içinde iki ayrı güzergâh oluşturulmuştur: İzleyiciler caveanın üst kesimlerinden törenleri izlerken, rahipler ve kurban edilecek hayvanlar için kullanılan ikinci yol doğrudan alt seviyelere inmeyi sağlamaktaydı. Bu mekânsal ayrım, kutsal olanla sıradan olan arasındaki sınırın mimari aracılığıyla da kurulduğunu göstermektedir.

Erken Bizans döneminde, özellikle MS 5. ve 6. yüzyıllarda, Hristiyanlaşma süreciyle birlikte Plutonion'un görünürlüğünün bilinçli biçimde azaltıldığı anlaşılmaktadır. Plateia yönünden gelenlerin mağarayı görmesini engelleyecek düzenlemeler yapılmış; Apollon Tapınağı ise kasıtlı olarak tahrip edilmiştir. Kent, Aziz Philippus'un kutsal alanı etrafında şekillenen, çok sayıda kilisenin inşa edildiği bir Hristiyan merkezine dönüşmüştür. Bununla birlikte, mağara girişinde ele geçen 6. yüzyıla tarihlenen kandiller, pagan uygulamaların tamamen ortadan kalkmadığını göstermektedir. Roma döneminde yaygın olarak kullanılan bu kandillerin Plutonion alanında bulunması, gece gerçekleştirilen ritüellerin Hristiyanlaşma sürecinin ilk evrelerinde de devam ettiğine işaret etmektedir.

Hierapolis Plutonion'u hakkında en ayrıntılı bilgileri sunan antik yazarların başında Strabon gelmektedir. Strabon'un betimlemeleri, onun bu alanı bizzat ziyaret ettiğini düşündürecek ölçüde ayrıntılıdır. Kayalık bir eğimin kenarında yer alan, dar ve derin bir mağaradan söz eden Strabon, Kybele rahiplerinin nefeslerini tutarak mağaraya girdiklerini ve zarar görmediklerini aktarır; buna karşılık hayvanların anında boğularak öldüğünü belirtir (Strabon, *Geographika*). Cassius Dio ise kutsal alanın mimari düzenine odaklanarak mağaranın önünde yer alan sarnıçtan ve tiyatro yapısından bahseder; böylece Plutonion'un yalnızca doğal değil, aynı zamanda ritüel amaçlı planlanmış bir alan olduğunu vurgular (Cassius Dio).

Plutonion'u ziyaret eden bir diğer önemli figür, MS 4. yüzyıl başlarında yaşamış olan Yeni-Platoncu filozof Damascius'tur. Damascius, Hierapolis'te gördüğü bir rüyada kendisini Attis olarak deneyimlediğini; Tanrıların Annesi Kybele'nin, onun Hades'ten geri dönmesini istediğini ve bu dönüşün Ilaria bayramı ile kutsandığını anlatır (Damascius). Filozof, bu rüyayı açık biçimde "cehennemden kurtuluş" sembolizmi üzerinden yorumlamış ve Aphrodisias'a döndüğünde meslektaşı Asklepiodotos'a aktarmıştır. Asklepiodotos'un gençlik yıllarında aynı mağaraya girerek suyun akışını gözlemlediğini ifade etmesi, Plutonion'un yalnızca rahipler için değil, entelektüel çevreler için de deneyimsel bir bilgi alanı sunduğunu göstermektedir. Bu bağlamda rüya, Kybele'den alınan ilahi bilginin filozoflara aktarıldığı bir aracı mecra olarak işlev görmektedir.

Hieron ve "A" yapısı olarak adlandırılan mimari düzenlemelerin, Plutonion'da uygulanan kehanet pratikleriyle doğrudan ilişkili olduğu düşünülmektedir. Kehanet törenlerinde gerçekleştirilen kart çekimi uygulamasının, Plutonion'un üzerinde yer alan

monopteros ile bağlantılı olduğu ileri sürülmektedir. Kybele rahiplerinin yeraltı tanrısından yanıt alabilmek için kutsal alana girmeden önce yeraltından çıkan sudan içtikleri bilinmektedir. Cellanın altındaki hypogeumlu mekânda, rahibin kahinlik görevini yerine getirmeden önce su içtiği kaya düzenlemesi, bu uygulamanın mekânsal izlerini ortaya koymaktadır.

2009 yılında gerçekleştirilen kazılarda, tahtta oturur vaziyette tasvir edilmiş başsız bir erkek tanrı heykelinin bulunması, Plutonion'un kimliğinin yeniden değerlendirilmesini sağlamıştır. Heykelin, tiyatro sahne binasında bulunan başka bir örnekle karşılaştırılması sonucunda Hades–Serapis olarak tanımlanması, kutsal alanın işlevine dair arkeolojik kanıtları güçlendirmiştir. Hades kült heykelinin varlığı, tapınak ve kaynaklarla ilişkili kutsal alan, antik yazarların anlatıları ve modern arkeolojik çalışmaların bir araya gelmesiyle burası 2012 yılında resmen "Plutonion" olarak tanımlanmıştır. 2022 yılından itibaren ise ziyaretçilere açılarak, antik dünyanın yeraltı algısını günümüzle buluşturan canlı bir kültürel miras alanı hâline gelmiştir.

Attis Heykeli (Denizli Müzesi Hierapolis)

Plutonium Girişi (Pluton ve Kore'ye adak yazıtı vardır)

Hades ve Kerberos Heykeli (Anıtsal heykelin replikasıdır)

Hades'in Pershephone'yi Kaçırma sahnesi (Denizli Müzesi Hierapolis)

Sonuç

Hierapolis Ploutonion'u, doğal çevresel olgular ile dinsel ve kültürel anlamlandırma süreçlerinin Antik Çağ'da nasıl bütünleştiğini gösteren istisnai bir örnek sunmaktadır. Yeraltından salınan ölümcül gazların insan ve hayvanlar üzerinde yarattığı etkiler, antik toplumlar tarafından yalnızca fiziksel bir tehdit olarak değil, tanrısal bir sınır alanının somut kanıtı olarak değerlendirilmiştir. Bu bağlamda Ploutonion, ölümün ve yeraltı dünyasının fiziksel olarak deneyimlenebildiği nadir mekânlardan biri hâline gelmiştir (D'Andria, 2017). Bu ölümcül ortamın hemen yakınında yer alan beyaz travertenler ve termal sular ise şifa, arınma ve yenilenme ile ilişkilendirilmiştir. Antik kaynaklarda ve arkeolojik verilerde görüldüğü üzere, Hierapolis'te ölüm ile yaşam arasındaki karşıtlık keskin bir ayrım olarak değil, aynı coğrafi ve ritüel bütünlük içinde algılanmıştır. Yeraltından çıkan gazların öldürücü etkisi ile aynı yeraltı sisteminden beslenen termal suların iyileştirici özelliği, antik düşüncede kozmik düzenin doğal bir yansıması olarak kabul edilmiştir (Ustinova, 2009). Ploutonion'un Apollon kutsal alanı ile olan mekânsal ilişkisi, bu doğa olaylarının dinsel bir çerçeve içinde yeniden yorumlandığını göstermektedir. Apollon'un kehanet, düzen ve arınma ile ilişkilendirilen doğası, Ploutonion'un tehlikeli karakteriyle dengelenmiş; böylece Hierapolis, ölümden doğan bilginin ve yaşamın kutsal bir merkezine dönüşmüştür (D'Andria, 2014). Bu durum, Antik Yunan ve Roma dünyasında yeraltına inişin yalnızca yok oluşu değil, hakikate ve dönüşüme açılan bir eşik olarak görüldüğünü ortaya koymaktadır (Ustinova, 2009). Erken modern dönem Avrupalı seyyahların gözlemleri de bu algının sonraki yüzyıllarda da devam ettiğini göstermektedir. Ploutonion, hem korku hem de hayranlık uyandıran bir doğa olayı olarak betimlenmiş; cehennem ile cennet imgeleri aynı anlatı içinde yan yana kullanılmıştır (Gözübüyük, 2025; Walsh, 1820). Bu anlatılar, Plutonium'in her dönemde yaşam ve ölüm arasındaki geçişin mekânı olarak kabul edileceğini göstermektedir. Sonuç olarak Hierapolis Ploutonion'u, ölümün içinden doğan yaşam fikrinin mekânsal ve ritüel düzeyde somutlaştığı bir kutsal alan olarak değerlendirilebilir. Doğal çevre, dini pratikler ve kültürel yorumlar arasındaki bu ilişki, antik dünyada insanın doğa karşısındaki deneyimini anlamak açısından temel bir referans noktası oluşturmaktadır. Son dönemdeki devrim niteliğindeki arkeolojik keşiflere rağmen, Hierapolis'teki dini kültlerle ilgili birçok soru hâlâ yanıtsızdır ve Plutonium vakası çözülmüş değildir. "Eski Plutonium" yalnızca dişi tanrılara adanmış bir mağara mıydı, yoksa üzerinde Apollon tapınağının bulunduğu, bu tanrının kehanetle ilişkili

kültüne bağlı bir kehanet merkezi de miydi? Bu, doğal bir çözüm gibi görünmektedir; "Eski Plutonium", yeryüzü buharlarının kehanet niteliğiyle ilişkili bir kehanet sunağı olarak işlev görmüş olabilir. "Yeni Plutonium" ise gazların ikinci, zehirli yönüne adanmış olabilir ve bu yönüyle yeraltı dünyasının efendisi Hades'in kült merkezi olarak işlev görmüş olabilir.

Kaynakça

Cantisani, E., vd. (2019). The Ploutonion of the archaeological site of Hierapolis (Turkey): A gate for the underworld and the knowledge. *Open Access Journal of Archaeology and Anthropology, 1*(3), 1–8.
D'Andria, F. (2014). *Cehennem'den cennet'e Hierapolis (Pamukkale)–Ploutonion: Aziz Philippus'un mezarı ve kutsal alanı.* İstanbul: Ege Yayınları.
D'Andria, F. (2014b). *The Ploutonion of Hierapolis in Phrygia: The discovery of the gate to the underworld.* İstanbul: Ege Yayınları.
D'Andria, F. (2017a). Hades ve Kybele arasında Hierapolis Ploutonion'unda yeni arkeolojik buluntular. *Colloquium Anatolicum, 16*, 217–244.
D'Andria, F. (2017b). The Ploutonion at Hierapolis and the cult of Pluto. In F. D'Andria (Ed.), *Hierapolis of Phrygia: The archaeological research and discoveries*. İstanbul: Ege Yayınları.
Gözübüyük, S. (2025). Denizli Cehennem Kapısına yolculuk: Erken modern dönem Avrupalı seyyahların gözünden Plutonion. *Pamukkale Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 71*, 355–375.
Gözübüyük, Z. (2025). *Hierapolis ve Plutonion üzerine seyahat anlatıları ve tarihsel değerlendirmeler.* İstanbul
Güven, G. (2012). Hierapolis of Phrygia: From foundation to Seljuk period. *Uludağ Üniversitesi Fen-Edebiyat Fakültesi Sosyal Bilimler Dergisi, 13*(22), 149–156.
Miszczak, I. (2019, January). Plutonium and the sanctuary of Apollo in Hierapolis: A journey through the millennia. *Uranus Rehber*.
Strabon. (MÖ 64–MS 24). *Geographika* (H. L. Jones, Çev.). Cambridge, MA: Harvard University Press.
Uranus Rehber. (2014). *Hierapolis (Pamukkale) – Laodikeia çevresi.* İstanbul.
Ustinova, Y. (2009). *Caves and the ancient Greek mind: Descending underground in the search for ultimate truth.* Oxford: Oxford University Press.
Walsh, R. (1820). *A journey from Constantinople to England.* London: Longman, Hurst, Rees, Orme & Brown.
Walsh, R. (1838). *Constantinople and the scenery of the seven churches of Asia Minor*. London: Fisher.
D'Andria, F. (2019). *Hierapolis alma Philippum: Havari'nin kutsal alanındaki yeni kazılar, araştırmalar ve restorasyonlar*. Geçmişten Günümüze Denizli, 58, 44–73.

EXPLORING THE ANTIDIABETIC AND NEUROPROTECTIVE PROPERTIES OF SHAHTARA (*FUMARIA INDICA*) IN UNCONTROLLED DIABETES

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Abstract

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia, often leading to severe complications such as neuropathy, cardiovascular diseases, and organ dysfunction. Conventional antidiabetic therapies may not adequately control blood glucose levels in all patients, highlighting the need for alternative approaches. Shahtara (*Fumaria indica*), a commonly available medicinal plant, has been traditionally used for managing diabetes and associated neurological complications. This study investigates the antidiabetic and neuroprotective effects of Shahtara in individuals with uncontrolled diabetes. A combination of in vivo and in vitro models was employed to evaluate its therapeutic potential. Biochemical parameters, including fasting blood glucose, glycated hemoglobin, and insulin sensitivity, were assessed to determine antidiabetic efficacy. Neuroprotective effects were evaluated through behavioral assays, nerve conduction studies, and oxidative stress markers, such as superoxide dismutase, catalase, and malondialdehyde levels. Phytochemical analysis revealed the presence of alkaloids, flavonoids, and polyphenols, which may contribute to the observed biological activities. Results demonstrated that Shahtara significantly reduced hyperglycemia, improved insulin sensitivity, and mitigated oxidative stress in neuronal tissues. Furthermore, improvements in behavioral and electrophysiological parameters suggest its potential in alleviating diabetic neuropathy. The findings highlight Shahtara as a promising natural therapeutic agent with dual antidiabetic and neuroprotective benefits. Its accessibility and traditional usage make it a valuable candidate for integrative management strategies in uncontrolled diabetes. Further clinical studies are warranted to confirm its efficacy, elucidate precise molecular mechanisms, and establish standardized dosing for safe human application.

Keywords: Shahtara, *Fumaria Indica*, Diabetes Mellitus, Neuropathy, Neuroprotection, Oxidative Stress

INTEGRATED SOLAR DESALINATION WITH THERMAL STORAGE AND ENERGY RECOVERY

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Abstract:

This work focuses on the development and optimization of an integrated solar desalination system that combines photothermal evaporation, thermal energy storage, and energy recovery to enhance freshwater production. The system uses high-efficiency photothermal materials to convert solar radiation into heat, enabling rapid water evaporation under low energy consumption. A thermal storage unit - typically based on molten salts or phase-change materials ensures continuous desalination during periods of low or no sunlight, thereby stabilizing the system's performance. Additionally, energy recovery components, such as heat exchangers or thermoelectric modules, are incorporated to capture and reuse waste heat, improving the overall thermodynamic efficiency. The integration of these technologies results in a highly sustainable, autonomous, and cost-effective desalination solution suitable for remote and coastal regions facing water scarcity. This approach contributes to reducing reliance on conventional, energy-intensive desalination methods while promoting clean and renewable water production.

Keywords:

Solar desalination, photothermal materials, thermal energy storage (TES), molten salts
Thermal efficiency, Hybrid solar system, Freshwater production

PRECISION FERTILIZATION AND SUSTAINABLE PRACTICES FOR ENVIRONMENTAL PROTECTION

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Abstract

In agriculture, soil and water pollution by nitrates is significantly exacerbated by the excessive use of nitrogen fertilizers, which can lead to major environmental impacts such as eutrophication, groundwater contamination, and health risks.

Several strategies have been developed to address these issues by reducing nitrogen inputs while improving nitrogen use efficiency and maintaining agricultural productivity.

These strategies include adjusting fertilizer application rates, using slow-release fertilizers, applying precision fertilization tailored to crop needs, introducing nitrogen-fixing crops such as legumes, practicing crop rotation, and improving agricultural techniques.

These approaches not only help limit nitrogen losses to the environment but also enhance the quality of agricultural products and reduce costs for farmers. They form part of a broader effort to ensure the sustainability of agricultural systems in the face of climate change, balancing productivity, environmental protection, and resilience.

Keywords

Nitrate pollution, Nitrogen fertilizers, Groundwater contamination, Eutrophication, Precision fertilization, Sustainable agricultura, Environmental protection, Climate change resilience

SUSTAINABLE SOIL MANAGEMENT PRACTICES FOR ENVIRONMENTAL PROTECTION

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Keywords

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MACHINE LEARNING IN ENTERTAINMENT

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Abstract

This era of "Co-Creativity" has effectively democratized high-end production, utilizing neural rendering and procedural generation to allow independent creators to execute complex visual and narrative feats once reserved for major studios. This shift is not merely about speed; it is about the move from automation to anticipation. Predictive engines no longer just recommend content; they forecast audience needs and "market shifts" before a human even drafts a brief, allowing creators to test fifteen audience segments in the time it once took to test three. However, this technical empowerment is mirrored by a shift toward hyper-personalization in distribution. Streaming ecosystems now leverage real-time behavioral data and "sentiment matching" to curate content that aligns with the viewer's immediate psychological state. This creates a fascinating tension between the efficiency of the algorithm and the "irrational" risks of human artistry. While AI can optimize for clicks and engagement, it lacks the life experience to generate true cultural resonance. Consequently, the industry’s sustainability now rests on its ability to safeguard intellectual property and ensure that while AI handles the labor-intensive synthesis of pixels and data, human creators remain the essential architects of emotional depth and "narrative soul."

Key words

Generative AI, Deep Learning (DL), Reinforcement Learning (RL), Computer Vision (CV), Natural Language Processing (NLP), Hyper-Personalization, Synthetic Media, Procedural Content Generation (PCG), Automated Metadata Tagging.

[1] Introduction

Machine Learning has shifted from a background technical utility to the foundational architecture of the entertainment industry. This transformation is driven by a move toward "Co-Creativity," where high-fidelity generative tools and predictive analytics are woven into the entire creative lifecycle. In production, ML has democratized the field by automating labor-intensive tasks like visual effects rendering and procedural world-building, allowing independent creators to achieve studio-level quality with fewer resources. Simultaneously, distribution has evolved into a system of hyper-personalization; streaming platforms now utilize deep-learning models to analyze behavioral metadata and real-time psychological profiles, ensuring that content delivery is uniquely tailored to the individual viewer's mood and context. However, this rapid integration has introduced significant ethical and structural friction. The industry is currently navigating the complexities of synthetic media, where the rise of deepfakes and AI-generated assets has forced a legal re-evaluation of intellectual property and creative ownership. There is also a growing concern regarding market saturation, as automated workflows risk flooding the space with low-effort content that lacks human nuance. Ultimately, the future of entertainment depends on a balanced hybrid model: while machine intelligence manages the "heavy lifting" of data processing and asset synthesis, human creators remain the vital architects of narrative strategy and emotional connection, ensuring that technology serves to amplify, rather than replace, the human experience.

[2] Architecture

The architectural framework of Machine Learning in the 2026 entertainment sector is built upon a sophisticated, multi-layered ecosystem that integrates raw compute power with agentic intelligence. At its base, the Infrastructure Layer utilizes a hybrid of edge computing and vector databases to manage the massive data throughput required for real-time asset generation and low-latency streaming. Above this sits the Intelligence Layer, which has moved away from monolithic models toward a "mixture-of-experts" approach, where specialized micro-models—fine-tuned for specific creative tasks like lighting, orchestration, or character dialogue—collaborate under the guidance of a central multimodal foundation.This technical foundation is managed by an Agentic Orchestration Layer, the most critical evolution in the 2026 stack Finally, the Delivery Layer acts as the interface for the consumer, employing dynamic rendering engines that can alter the content's metadata in real-time to match a viewer's psychological profile. This entire architecture is underpinned by blockchain-based provenance protocols,

ensuring that every piece of machine-generated content is watermarked for intellectual property protection and authenticity verification before it ever reaches the screen.

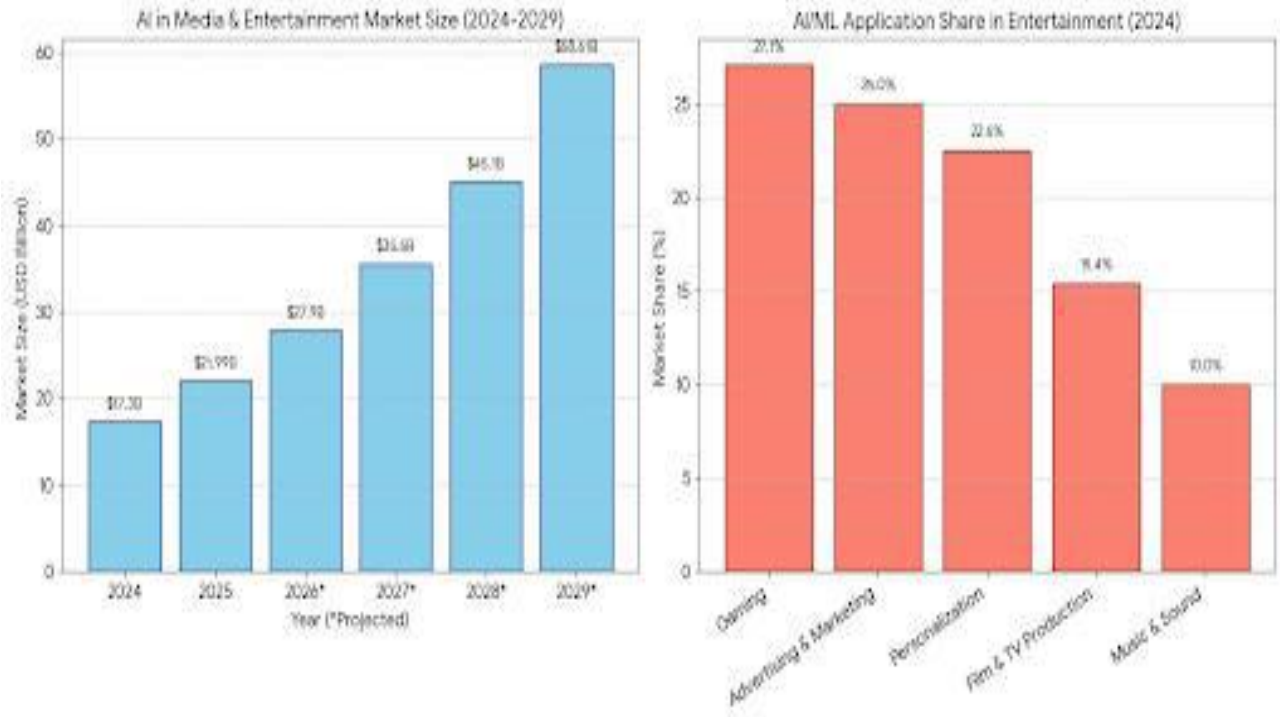
[3] Advantages

The integration of Machine Learning into the entertainment sector offers transformative advantages that redefine how content is created, distributed, and experienced. By automating labor-intensive technical processes such as rotoscoping, color grading, and audio syncing, ML significantly reduces production timelines and costs, allowing small teams to achieve the visual fidelity once exclusive to major studios. This democratization of high-end tools fosters a surge in creative experimentation, as artists are freed from repetitive "pixel-pushing" to focus on high-level narrative and emotional strategy. Furthermore, machine learning provides a strategic edge through hyper-personalization and predictive analytics. Streaming platforms and gaming ecosystems now use deep learning to analyze behavioral patterns in real-time, delivering bespoke experiences that match a viewer's immediate psychological profile or adapting gameplay difficulty to a player’s unique skill level. This precision not only maximizes audience engagement and retention but also enables studios to forecast market trends with greater accuracy, reducing the financial risk associated with large-scale productions. Ultimately, the greatest advantage of ML in 2026 is its role as a creative "exoskeleton," amplifying human imagination and ensuring that the entertainment landscape remains both commercially viable and deeply resonant.

[4] Table

Architectural Layer	Core ML Components	Primary Advantage	Real-World 2026 Application
Data & Infrastructure	Vector Databases, Edge-Cloud Hybrid, Multimodal Data Lakes	Extreme Speed: Reduces latency for real-time interaction and asset retrieval.	Cloud Gaming: Near-instant rendering of complex 3D environments on mobile devices.
Model & Intelligence	Mixture-of-Experts (MoE), LoRAs, Predictive Analytics	Domain Expertise: High-fidelity generation in niche styles (e.g., specific music genres or lighting).	Pre-Production: Instant generation of photorealistic storyboards from text scripts.
Agentic Orchestration	Task Planners, Inter-Agent Communication, Human-in-the-Loop	Workflow Efficiency: Automates the coordination of complex multi-step creative tasks.	Post-Production: AI "editors" that automatically sync audio, color grade, and de-noise footage.
Experience & Delivery	Dynamic Rendering, Sentiment Analysis, Provenance (C2PA)	Hyper-Personalization: Tailors content to individual psychological profiles in real-time.	Streaming Platforms: Movies where the ending or music changes based on the viewer's mood.

[5] Bar chart



[6] Conclusion

The architectural maturity achieved this year allows for a seamless transition from traditional production to an agentic model, where AI agents manage the technical complexities of rendering and distribution while humans retain control over narrative soul and ethical oversight. As hyper-personalization becomes the standard, the industry is balancing the immense benefits of efficiency and custom experiences with the urgent need for digital provenance and copyright reform. Ultimately, the 2026 landscape demonstrates that while machine intelligence can synthesize the data of human preference, it is the unique, "irrational" human spark that remains the essential driver of true cultural impact. " This evolution is defined by a shift from static content to dynamic, agent-driven ecosystems where the entire media lifecycle—from initial ideation to final delivery—is governed by a collaborative "Human-AI" intelligence. In this landscape, the democratization of high-end production has empowered a new generation of "solopreneur" creators who can leverage multimodal models to produce cinematic experiences that were once the exclusive domain of major studios.

[7] Reference

1. Altaher, N., & El Erafy, E. (2023). Applications of Artificial Intelligence in the Field of Media. International Journal of Artificial Intelligence and Emerging Technology. doi: 10.21608/ijaiet.2024.275179.1006 GSJ: Volume 13, Issue 2, February 2025 ISSN 2320-9186 132 GSJ© 2025 www.globalscientificjournal.com
2. Balusamy, N. (2024). E-Resources Content Recommendation System Using AI. Advances in Library and Information Science ALIS Book Series. doi: 10.4018/979-8-3693-5593-0.ch011

3. Buolamwini, J., & Gebru, T. (2018). Gender shades: Intersectional accuracy disparities in commercial gender classification. In Proceedings of the conference on fairness, accountability and transparency (pp. 77-91).
4. Chenwei, Z., Wenjing, L., Chunhe, N., Hongbo, W., & Junyong, W. (2024). Enhanced user interaction in operating systems through machine learning language models. doi: 10.1117/12.3033610
5. Dong, W. (2024). Digital Media Information Recommendation Model Based on Artificial Intelligence Technology. doi: 10.1109/icdcot61034.2024.10515981
6. Dongsheng, L., Jianxun, L., Le, Z., Kan, R., Tun, L., Tao, W., & Xing, X. (2023). Deep Learning-Based Recommendation Algorithms. doi: 10.1007/978-981-99-8964-5_4
7. Dr. Burange, R. A. (2024). Development of Movie Recommendation System Using Machine Learning. Indian Scientific Journal of Research In Engineering And Management. doi: 10.55041/ijsrem29879
8. Habil, S., El-Deeb, S., & El-Bassiouny, N. (2023). AI-based recommendation systems: the ultimate solution for market prediction and targeting. In The Palgrave handbook of interactive marketing (pp. 683-704). Cham: Springer International Publishing.
9. Li, J., Guangyan, L., & Huobin, T. (2018). Neural Collaborative Filtering: Hybrid Recommendation Algorithm with Content Information and Implicit Feedback. doi: 10.1007/978-3-030-03493-1_71
10. Magrani, E., & da Silva, P. G. F. (2023). The Ethical and Legal Challenges of Recommender Systems Driven by Artificial Intelligence. In Multidisciplinary Perspectives on Artificial Intelligence and the Law (pp. 141-168). Cham: Springer International Publishing.

RESULTS FOR RESULTS FOR P-DERIVATIONS IN LEFT NEAR-RINGS

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Abstract

Let N be a near-ring, and let P be a prime ideal of N. In this paper, we introduce the notion of P-derivation in near-rings. Furthermore, we investigate the structure of the quotient near-ring N/P and examine its algebraic properties in relation to generalized-P-derivations.

Key words: 3-prime near-ring; commutativity theorems; derivations; generalized-P-derivations; derivations.

THE KEY ISSUE FEATUTRES OF THE EVOLVING NEOPLASTIC MICROENVIRONMENT PARADIGM: AN INTEGRATED AND MULTIDIMENSIONAL STRATEGY FOR ONCOLOGIC INVESTIGATION AND MOLECULAR ONCOLOGY RESEARCH

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Abstract:

The Evolving Neoplastic Niche Framework (ENNF) represents a transformative conceptual advancement in oncologic science and molecular cancer studies, introducing a model distinguished by analytical breadth and structural integration. This construct signifies a major progression in deciphering the regulatory mechanisms that orchestrate the reciprocal and

continuously shifting interactions between malignant cells and their surrounding stromal milieu. By synthesizing principles derived from cellular oncology, molecular biochemistry, and integrative systems science, the ENNF establishes a unified interpretative lens that captures the layered complexity and adaptive plasticity intrinsic to neoplastic ecosystems. Such a comprehensive analytical stance not only clarifies the subtle regulatory determinants underlying tumor progression, invasion, and therapeutic resistance, but also stimulates the formulation of next-generation intervention strategies that extend beyond traditional cytotoxic or reductionist methodologies. The conceptual reach of the ENNF crosses conventional disciplinary demarcations, supporting the evolution of emerging therapeutic platforms and reinforcing the scientific foundation of stratified and individualized oncologic management. By mapping multidirectional signaling cascades, metabolic reprogramming networks, and macro-environmental influences, the framework serves as a strategic scaffold that broadens investigative horizons beyond historically compartmentalized cancer research paradigms. Furthermore, the ENNF redefines the operational architecture of precision oncology. Its integrative appraisal of the malignant niche enables the systematic discovery of previously unrecognized molecular indicators and actionable targets, thereby advancing a more discriminating and patient-specific therapeutic design. This broadened conceptualization strengthens insight into the interdependent relationships among immune components, extracellular matrix dynamics, vascular remodeling, metabolic flux, and genomic instability. Consequently, it inaugurates a refined phase of individualized treatment development in which therapeutic regimens are calibrated according to the distinct biological signature and adaptive behavior of each tumor entity. The ENNF surpasses conventional theoretical limits by providing a wide-ranging and sophisticated examination of the interconnected layers shaping oncologic biology and biochemical transformation. This integrative model not only deepens mechanistic understanding but also accelerates the transition toward innovative therapeutic paradigms, thereby reshaping the future direction of cancer investigation and precision-based clinical intervention.

Keywords: Tumor Microenvironment, Personalized Medicine, Therapeutic Strategies, Dynamic Interactions, Metabolic Adaptation, Extracellular Matrix Remodeling, Immune Modulation.

Introduction:

Cancer remains one of the most formidable biomedical challenges of the twenty-first century, representing a heterogeneous constellation of diseases driven by genomic instability,

epigenetic dysregulation, metabolic reprogramming, and adaptive cellular plasticity. Despite decades of progress in molecular oncology, targeted therapeutics, immunotherapy, and precision medicine, malignant tumors continue to demonstrate remarkable resilience, therapeutic resistance, and evolutionary adaptability. Central to these phenomena is the recognition that neoplasia cannot be fully understood as a purely cell-autonomous disorder. Instead, tumor initiation, progression, invasion, and metastatic dissemination are profoundly influenced by the surrounding cellular and acellular context in which malignant cells reside. This contextual domain, widely referred to as the tumor microenvironment (TME), has emerged as a critical determinant of oncologic behavior and therapeutic outcome.

Historically, early cancer models were dominated by the somatic mutation theory, which emphasized the accumulation of genetic alterations within epithelial cells as the principal engine of malignant transformation. While foundational, this reductionist paradigm underestimated the dynamic and reciprocal interactions between transformed cells and adjacent stromal components. Contemporary oncologic research increasingly supports an ecological and systems-oriented perspective, in which tumors are conceptualized as evolving, multicellular ecosystems. Within this framework, malignant cells co-exist with fibroblasts, endothelial cells, pericytes, immune infiltrates, adipocytes, and neural elements, all embedded within a structurally and biochemically complex extracellular matrix (ECM). These constituents engage in continuous bidirectional communication mediated by cytokines, chemokines, growth factors, extracellular vesicles, metabolic intermediates, and biomechanical signals.

The Evolving Neoplastic Niche Framework (ENNF) builds upon this ecological perspective, proposing a multidimensional model that integrates tumor cell intrinsic mechanisms with extrinsic regulatory networks operating at molecular, cellular, tissue, and systemic levels. Rather than depicting the microenvironment as a passive scaffold, the ENNF conceptualizes it as an active, adaptive, and co-evolving participant in oncogenesis. Tumor and stroma are thus understood as mutually influential entities engaged in a dynamic process of selection, adaptation, and co-dependence. This paradigm underscores the importance of temporal evolution, spatial heterogeneity, and feedback-driven regulation in shaping tumor phenotypes.

One of the defining features of the neoplastic niche is its structural and biochemical heterogeneity. Cancer-associated fibroblasts (CAFs), for instance, exhibit diverse phenotypic states ranging from inflammatory to myofibroblastic subtypes, each contributing distinct paracrine signals and matrix remodeling capabilities. Endothelial cells within tumor-associated

vasculature display abnormal architecture, permeability, and metabolic characteristics, influencing hypoxia gradients and drug delivery efficiency. Immune populations—including tumor-associated macrophages, regulatory T cells, myeloid-derived suppressor cells, and exhausted cytotoxic lymphocytes—create an immunomodulatory milieu that may either restrain or facilitate tumor progression. The ENNF emphasizes that these cellular constituents do not operate independently; instead, they participate in a coordinated network governed by shared signaling axes such as TGF-β, NF-κB, STAT3, HIF-1α, and PI3K/AKT/mTOR pathways.

Hypoxia represents a particularly influential microenvironmental factor. As proliferating tumor masses outpace their vascular supply, oxygen deprivation triggers stabilization of hypoxia-inducible factors (HIFs), which orchestrate transcriptional programs promoting angiogenesis, glycolytic metabolism, epithelial–mesenchymal transition (EMT), and immune evasion. This hypoxic adaptation not only enhances tumor survival under stress conditions but also fosters intratumoral heterogeneity and metastatic competence. Through the lens of the ENNF, hypoxia is interpreted not merely as a consequence of disorganized vasculature but as a regulatory node that shapes systemic tumor evolution.

Metabolic reprogramming constitutes another cornerstone of the dynamic tumor ecosystem. The classical Warburg effect—characterized by preferential aerobic glycolysis—has been expanded to include complex metabolic symbiosis between cancer cells and stromal components. Lactate shuttling, glutamine dependency, lipid metabolism alterations, and redox balancing mechanisms collectively generate a metabolic landscape that supports proliferation, invasion, and immune suppression. Fibroblasts and adipocytes may undergo metabolic coupling with malignant cells, supplying nutrients and buffering oxidative stress. The ENNF integrates these findings into a systems-level understanding in which metabolic flux is interwoven with signaling cascades and epigenetic modulation.

Extracellular matrix remodeling further exemplifies the active role of the tumor niche. Alterations in matrix stiffness, composition, and topography influence mechanotransduction pathways through integrins, focal adhesion kinase (FAK), and YAP/TAZ signaling. Increased matrix rigidity enhances invasive behavior and therapeutic resistance, while proteolytic enzymes such as matrix metalloproteinases facilitate local invasion and metastatic dissemination. Rather than treating ECM changes as secondary events, the ENNF positions biomechanical forces as primary regulators of tumor cell fate decisions.

The immune dimension of the neoplastic microenvironment has garnered unprecedented attention, particularly in the era of immune checkpoint blockade therapies targeting PD-1/PD-L1 and CTLA-4 pathways. However, clinical heterogeneity in response underscores the complexity of immune–tumor interactions. Immunoediting processes encompass elimination, equilibrium, and escape phases, reflecting dynamic evolutionary pressures exerted by host immunity. Tumors may develop immune-privileged niches through cytokine secretion, metabolic deprivation of effector lymphocytes, and recruitment of suppressive cell subsets. The ENNF contextualizes immunotherapy within a broader adaptive system, emphasizing that successful intervention requires modulation of both malignant and stromal compartments.

Spatial heterogeneity within tumors further complicates therapeutic design. Advanced imaging modalities and single-cell sequencing technologies reveal mosaic patterns of clonal diversity, stromal composition, and immune infiltration across different tumor regions. This spatial complexity is mirrored temporally, as treatment pressures induce selective sweeps, clonal expansion, and phenotypic plasticity. Drug resistance, therefore, emerges not solely from pre-existing mutations but from adaptive reconfiguration of the tumor ecosystem. The ENNF accommodates this evolutionary perspective, highlighting the necessity of longitudinal monitoring and adaptive treatment strategies.

At the systemic level, endocrine signals, neural inputs, microbiome composition, and host metabolic status exert additional influence over tumor behavior. Chronic inflammation, obesity-associated cytokine profiles, and stress-related neuroendocrine mediators can modify the tumor milieu and promote progression. The ENNF broadens the conceptual boundaries of tumor biology by incorporating these organism-wide determinants, advocating a holistic appreciation of cancer as a systemic disorder rather than an isolated lesion.

Technological advancements have been instrumental in shaping this integrative paradigm. High-throughput genomics, proteomics, metabolomics, spatial transcriptomics, and multiplex imaging provide multidimensional datasets capturing the interplay between tumor cells and their environment. Computational modeling and network analysis facilitate the interpretation of these complex interactions, enabling identification of emergent properties and regulatory hubs. Systems biology approaches thus align closely with the theoretical foundations of the ENNF, offering methodological tools to quantify and simulate dynamic tumor ecosystems.

Translational implications of this framework are substantial. Therapeutic strategies increasingly target stromal components, angiogenesis, immune checkpoints, metabolic vulnerabilities, and ECM remodeling pathways. Combination regimens designed to disrupt cooperative signaling networks demonstrate enhanced efficacy compared with monotherapies focused solely on tumor cell cytotoxicity. Personalized medicine initiatives integrate molecular profiling with microenvironmental characterization to stratify patients and optimize treatment selection. The ENNF provides a conceptual scaffold for these efforts, guiding rational therapeutic design based on ecosystem-level analysis.

Moreover, biomarker discovery benefits from this multidimensional orientation. Circulating tumor DNA, extracellular vesicles, stromal gene signatures, immune infiltration patterns, and metabolic imaging parameters collectively contribute to predictive and prognostic modeling. By interpreting these indicators within an interconnected framework, clinicians can achieve more precise risk assessment and therapeutic monitoring.

The introduction of the Evolving Neoplastic Niche Framework reflects a paradigm shift in oncologic science. It transcends reductionist models by integrating genetic, biochemical, cellular, mechanical, immunologic, and systemic dimensions into a cohesive theoretical architecture. This perspective acknowledges tumors as adaptive, co-evolving systems shaped by continuous interaction between malignant cells and their environment. As research advances, such integrative conceptualization will be indispensable for deciphering tumor complexity, overcoming therapeutic resistance, and advancing precision oncology. Through comprehensive exploration of dynamic tumor ecosystems, the field moves closer to transformative strategies capable of reshaping cancer diagnosis, treatment, and long-term disease management.

The Dynamic Tumor Microenvironment Theory (DTMT) constitutes a pivotal milestone in tumor research and biochemistry, ushering in a paradigm characterized by substantial depth and comprehensiveness. This theory represents a substantial leap in comprehending the intricacies governing the dynamic interplay between tumor cells and their microenvironment. Through the integration of insights from tumor biology, biochemistry, and systems biology, DTMT provides an all-encompassing perspective, revealing the intricate complexity inherent in the dynamic nature of tumors.

This holistic viewpoint not only elucidates the nuanced intricacies of tumor behavior but also catalyzes the development of innovative therapeutic strategies that surpass conventional approaches. The expansive scope of DTMT transcends disciplinary boundaries,

important for emerging treatment modalities and advancing personalized medicine. Navigating the intricate network of molecular interactions and systemic influences, DTMT functions as a guiding framework, offering insights beyond the traditional confines of tumor research.

DTMT extends to reshaping the landscape of personalized medicine in cancer treatment. The theory's comprehensive understanding of the tumor microenvironment facilitates the identification of novel biomarkers and therapeutic targets, fostering a nuanced and tailored approach to patient care. This expanded view not only enhances our comprehension of intricate interrelationships between diverse biological components but also heralds a new era in precision medicine, where treatment strategies are finely tuned to the unique characteristics of individual tumors.

The DTMT transcends conventional boundaries, offering an expansive and intricate exploration of the multifaceted dimensions of tumor research and biochemistry. This all-encompassing framework not only advances our understanding of tumors but also propels the field towards innovative therapeutic frontiers, ultimately redefining the trajectory of cancer research and personalized medicine.

Advances in traditional cancer treatments, such as standard cytotoxic chemotherapy [1, 36, 38, 39], radiation therapy [2, 34, 35], and surgery [3], have led to a decline in cancer mortality over the past decades; However, serious problems remain, often leading to tumor recurrence and death. These issues have led to research into mutation therapy for cancer. While standard chemotherapy uses cytotoxic agents that kill cancer cells and cause normal cells to divide rapidly, targeted therapy targets abnormal proteins encoded by mutated genes [4]. Because normal cells do not have the oncogenic mutations used for drug targeting, there is often a high degree of differential sensitivity of malignant and benign cells to targeted therapy. As a result, targeted therapy often results in rapid and dramatic tumor regression while limiting the potential for off-target toxicity associated with traditional chemotherapy. Peptides have emerged as promising tools in cancer therapy, offering targeted and specific approaches to treatment. Their ability to bind selectively to cancer cell receptors and disrupt crucial signaling pathways makes them valuable candidates. Some peptides, like Antimicrobial Peptides (AMPs) and Cell-Penetrating Peptides (CPPs), exhibit cytotoxic effects on cancer cells, showcasing their potential as anticancer agents. Furthermore, peptide-based drugs, including monoclonal antibodies and vaccines, target specific molecules related to cancer development. The unique properties of peptides, such as cell-penetrating abilities and inhibition of protein-protein interactions, enhance their efficacy while minimizing collateral damage to healthy tissues.

Despite promising advancements, challenges like stability and immunogenicity need addressing. Ongoing research seeks to optimize peptide structures and delivery methods for improved cancer therapeutic outcomes. In summary, peptides represent a transformative frontier in cancer treatment, holding the promise of more effective and personalized options for patients [40]. Thus, the overall strategy for anticancer drug discovery has shifted from cytotoxic agents to identifying actionable tumor-specific mutations and developing molecularly targeted agents. The rapid development of immunotherapy has also radically changed the landscape of cancer treatment [31, 32, 33] .

Goal:

The overarching goal of this research was to delve into the intricacies of the Dynamic Tumor Microenvironment Theory (DTMT) and its transformative impact on the landscape of tumor research and biochemistry. Our aim was to comprehensively investigate and analyze the multifaceted interactions between tumor cells and their microenvironment, as elucidated by DTMT, with the objective of advancing our understanding of tumor biology and biochemistry. This exploration sought to uncover the dynamic nature of tumors, emphasizing the critical role played by the tumor microenvironment in shaping tumor development, progression, and responses to therapeutic interventions.

RESEARCH AND FINDINGS

Rationale and Significance:

Traditional approaches to tumor research have historically centered around unraveling the genetic mutations inherent to cancer cells. However, the limited focus on the genetic aspect often neglects the profound influence exerted by the microenvironment in which tumor cells reside. Recognizing this gap, our research aimed to address the critical importance of the tumor microenvironment as a dynamic and integral player in the complex orchestra of tumorigenesis. The DTMT, serving as the theoretical framework guiding our investigation, integrates principles from tumor biology, biochemistry, and systems biology. By doing so, it offers a more holistic perspective that goes beyond the reductionist viewpoint, presenting an opportunity to unravel the nuanced and dynamic interactions occurring within the tumor microenvironment.

Specific Objectives:

Explore Dynamic Interactions: Investigate the dynamic and bidirectional interactions between tumor cells and their microenvironment, emphasizing the reciprocal influence of biochemical signals, extracellular matrix remodeling, and immune cell infiltration on tumor behavior.

Examine Metabolic Adaptation: Analyze the metabolic plasticity of tumor cells in response to the changing microenvironment. Investigate how distinct metabolic profiles influenced by nutrient availability, oxygen levels, and cellular interactions impact the growth and survival of tumor cells.

Understand Extracellular Matrix Remodeling: Uncover the role of extracellular matrix (ECM) dynamics in tumor progression. Investigate how changes in ECM composition and stiffness influence cellular signaling pathways, modulating cell migration, invasion, and responses to therapeutic interventions.

Evaluate Immune Modulation: Focus on the intricate involvement of the immune system in the tumor microenvironment as outlined by DTMT. Explore how various immune cells, including T cells, macrophages, and dendritic cells, contribute to both anti-tumor responses and immunosuppressive mechanisms.

Expected Outcomes:

The anticipated outcomes of this research are not only to contribute significantly to the existing body of knowledge on tumor biology and biochemistry but also to lay the groundwork for novel therapeutic strategies and personalized medicine. By elucidating the dynamic nature of the tumor microenvironment as posited by DTMT, we aim to provide insights that may inform the development of targeted interventions, ultimately advancing the field and fostering improved outcomes for individuals affected by cancer. Through this research, we aspire to bridge the gap between traditional genetic-focused approaches and a more holistic understanding of tumors, paving the way for a paradigm shift in cancer research and treatment.

Methodology:

Literature Review: Conducted an extensive literature review to identify and analyze key publications related to the DTMT, tumor biology, biochemistry, and systems biology. This involved searching databases such as PubMed, Scopus, and Web of Science for relevant articles, reviews, and meta-analyses.

Data Collection: Gathered information from primary research articles, reviews, and relevant textbooks to understand the foundational principles and key tenets of DTMT. Extracted data on dynamic interactions between tumor cells and the microenvironment, metabolic adaptation, extracellular matrix remodeling, and immune modulation as outlined in the theory.

Synthesis of Information: Integrated information obtained from the literature into a cohesive narrative to highlight the multifaceted approach of DTMT. Emphasized the theory's

implications on tumor development, progression, and treatment response, incorporating insights from tumor biology, biochemistry, and systems biology.

Visualization: Developed visual aids, including diagrams and figures, to illustrate the dynamic interactions proposed by DTMT. Used graphic design tools such as Adobe Illustrator to create clear and informative visuals that enhance the understanding of the theory's key concepts.

Programs and Software: Employed statistical analysis software such as R and Python for data processing and analysis, particularly in cases where quantitative information was involved. Utilized citation management software like EndNote to organize and manage references throughout the literature review and analysis process.

Critical Analysis: Conducted a critical analysis of the identified literature to evaluate the strength of evidence supporting DTMT. Addressed any controversies or gaps in understanding and critically appraised the methodologies used in primary studies.

Integration with Key Tenets: Systematically integrated findings from the literature into the key tenets of DTMT, specifically focusing on dynamic interactions, metabolic adaptation, extracellular matrix remodeling, and immune modulation. This integration aimed to provide a comprehensive overview of the theory's foundations and implications.

Collaboration and Peer Review: Engaged in collaborative discussions with colleagues and experts in the field to gather diverse perspectives and ensure the accuracy and validity of the synthesized information. Subjected the manuscript to peer review to incorporate constructive feedback and enhance the robustness of the methodology and interpretation.

In summary, the methodology employed a systematic and multidisciplinary approach, combining literature analysis, data synthesis, visualization, critical analysis, and collaboration to comprehensively explore and present the DTMT and its multifaceted implications for tumor research and biochemistry.

Tumor and microenvironment

Tumors develop in a complex and dynamic microenvironment (Fig.1 A), which influences their growth, invasion and metastasis. In this space, tumor cells and the surrounding microenvironment are in constant interaction [5]. The interaction of tumor cells with their microenvironment is dynamic and bidirectional and involves intercellular or extracellular contacts (involving the ECM) and mediators that mediate these contacts. Mediators are secreted soluble molecules/factors/vesicles responsible for the horizontal transfer of genetic information between communicating cellular/non-cellular cells [6].

The process of tumorigenesis and progression is influenced by two factors: genetic/epigenetic changes in tumor cells and rearrangement of tumor microenvironment (TME) components through reciprocal and dynamic interactions. The TME is formed by tumor cells, tumor stromal cells including stromal fibroblasts, endothelial cells and immune cells such as microglia, macrophages and lymphocytes, as well as non-cellular components of the extracellular matrix such as collagen, fibronectin, hyaluronic acid, laminin and others [7]. At the core of the TME, tumor cells control the functions of cellular and non-cellular components via complex signaling networks to exploit benign cells for their own purposes. The consequences of such intervention are manifested by the formation and maintenance of tumors, as well as poor response to treatment and multidrug resistance (MDR) [8]. Non-malignant TME cells are known to promote tumorigenesis at all stages of cancer development and metastasis. Cancer is a multicausal, multistep process characterized by heterogeneity of dominant outcomes.

Cancer involves several cellular functions that regulate the process and progression of the tumor. Previously, cancer was considered a disease associated with environmental and endogenous factors. Recently, molecular and genetic studies have been carried out to try to explain cancer and understand its underlying mechanisms [9]. It is now clear that cancer cells disrupt the rules and functions of normal cells. This is because cancer cells divide and multiply when not needed, do not die when needed, use the resources of other normal cells, and disrupt the harmony of the normal tissue environment. Moreover, cooperating “normal” cells can only reproduce so far, but cancer cells can resist cell death and evade the immune system [10]. Moreover, while normal cells generate and use biological signals and mediators necessary for their function and survival, tumor cells transform surrounding normal cells to use more resources for their growth and proliferation in an endlessly self-centered manner. Therefore, tumor cells can be viewed as newly altered normal cells that no longer interact normally with other immediate cells. During these processes, transformed cells adapt malignant mechanisms to take control of the newly transformed cells microenvironment [11].

Extracellular matrix remodeling in the tumor

The extracellular matrix (ECM) is a complex three-dimensional molecular structure that surrounds and supports tissue cells (Fig.1 B). This complex structure is composed of many macromolecules, including proteins such as collagen, proteoglycans (PGs) and matrix proteins, and glycosaminoglycans (GAGs) such as hyaluronic acid, among others. The ECM plays a

fundamental role in tissue development, maintaining homeostasis and regulating pathological processes. It performs these functions by providing structural support, controlling cellular activity, and facilitating cell-matrix interactions [12]. Various components of the ECM are involved in mutual interactions with each other and with cellular units through specific binding sites. This interaction is important for the proper structural organization and functional integrity of the ECM structure.

The importance of the physical properties of the ECM, in particular its stiffness, is increasingly supported by recent studies, especially in relation to the TME. In contrast to robust proteins in the ECM, immune cells in the TME exhibit dynamic behavior. The ECM, characterized by collagen cross-links and the presence of glycoprotein-mediated bio-activators, plays a critical role in transducing signals that control immune cell functions [13]. Although these aspects have been extensively studied, the interaction between the ECM and immune cells remains an area that has received relatively little attention. There is need to comprehensively investigate the relationship between ECM stiffness, its components, and their effects on immune cells.

The extracellular matrix (ECM) plays a crucial role in cancer progression, influencing tumor growth, invasion, and metastasis (Fig. 1 C). Its complex network of proteins and other components provides structural support to tissues and regulates cellular behavior. Cancer cells often undergo changes in the ECM, promoting an environment conducive to tumor development. Enzymes like matrix metalloproteinases (MMPs) are involved in ECM remodeling, facilitating cancer cell invasion. The interaction between cancer cells and the ECM influences cell migration, angiogenesis, and resistance to therapy. Specific proteins within the ECM, such as fibronectin and collagen, contribute to the creation of a supportive niche for cancer cells. Targeting the ECM in cancer therapy is gaining attention, with researchers exploring ways to disrupt the interaction between cancer cells and their microenvironment. Understanding the intricate relationship between the ECM and cancer holds potential for developing novel therapeutic strategies. Despite the challenges, advances in ECM-targeted therapies may pave the way for more effective treatments, addressing the complexities of cancer progression within the tumor microenvironment [41].

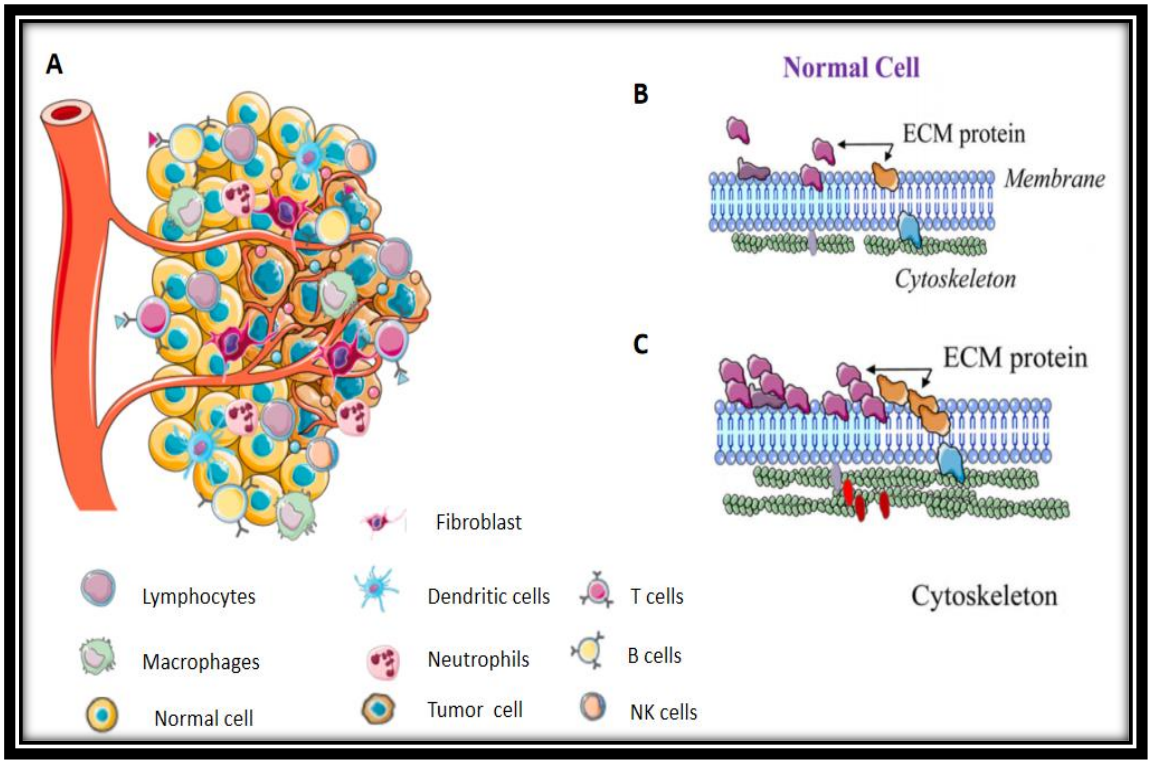

Figure 1

A. Immune cells associated with the tumor microenvironment. B. The cytoskeleton and matrix interact mutually. This interaction maintains normal cellular architecture and function through the expression and restructuring of ECM components. Activated cytoskeletal molecules mediate the activation of various nuclear promoters, which in turn induce the expression of molecules, including ECM components, that control cell shape and structure. C. In cancer cells, this regulation is disrupted, leading to increased expression of cytoskeletal and extracellular matrix components.

Metabolic Crosstalk among Tumor Compartments

There is significant metabolic heterogeneity in solid tumors, primarily due to vascular integrity and proximity to the vasculature, which creates oxygen and nutrient gradients. As a result, regional tumor cells have different metabolic profiles. For example, in non-small cell lung cancer (NSCLC), highly vascularized tumor subdomains use different nutrients, whereas less vascularized regions use glucose as the main carbon source [14]. It is important to note that lactate (previously considered only a metabolic product) is preferred over glucose for maintaining the tricarboxylic acid (TCA) cycle in NSCLC. Lactate and glucose are used in parallel because lactate can be sent directly into the TCA cycle through mitochondrial lactate dehydrogenase (LDH) activity. Metabolism of lactate by Lactate dehydrogenase A chain (LDHA) can also influence the redox state of the cytosol and direct glucose to the pentose phosphate pathway and hexosamine biosynthesis [15]. Alternatively, lactate as a signaling

molecule could potentially alter intracellular signaling pathways and/or gene expression, thereby affecting glucose uptake and catabolism. Tumor cells in tumor compartments work together and form a metabolic "symbiosis." The lactate shuttle is an example of how tumor cells in hypoxic areas consume glucose through anaerobic glycolysis and release lactate; lactate as fuel for the TCA cycle. The cells are located in adjacent oxygen-rich areas of the tumor. Acute hypoxia caused by antiangiogenic therapy causes pancreatic neuroendocrine cells and breast cancer cells to produce excess lactate, which is then used by tumor cells located near blood vessels [16]. A similar metabolic symbiosis has also been described in lung and colon cancer, suggesting that this may be a common pathway of destruction. Lactate transport likely results from differential expression of the respective monocarboxylate transporters (MCTs): hypoxic tumor cells express high levels of MCT4, which act as major lactate exporters, whereas oxygenated tumor cells express MCT1 as lactate importers [17]. It is currently unknown to what extent tumor-derived hypoxic lactate contributes to overall oxidative metabolism, since well-oxygenated tumor cells can readily metabolize circulating glucose and other nutrients, including lactate. Moreover, the precise functions and mechanisms of action of lactate in this context are not yet fully understood.

Immune Modulation

The balanced activation and inhibition of the immune response of the immune system provides protection against infectious antigens and autoantigens. Dysregulated cross-talk between stromal, immune, and tumor cells leads to immune evasion and tumor progression. Basophils, dendritic cells (DCs), eosinophils, macrophages, monocytes, neutrophils and natural killer (NK) cells constitute the innate immune system, while the adaptive system is made up of lymphocytes [18]. In the thymus, mature T cells develop into CD8+ cytotoxic lymphocytes (CTL) and CD4+ T helper (Th1) cells, which are activated by binary signals from the CD3+ T cell receptor (TCR). This determines the release of gamma interferon (IFN-γ) and factors involved in cytotoxic functions (perforins and granzymes), which favor the development of effector cells and the destruction of tumor cells. CTL recognize tumor cells through interaction of the TCR with key histocompatibility complex (MHC) class I molecules [19]. Antigen-specific CD4+ T cells can be divided into several T cell subsets, including Th1, Th2, Th9, Th17, Th22 and regulators. T cells. In the early stages of tumor development, NK and T cells recognize and destroy highly immunogenic tumor cells [20]. However, conditions such as stress, infection or chronic inflammation help tumor cells escape these mechanisms and promote tumor progression.

Personalized treatment strategies

Personalized medicine (PM) or precision medicine in oncology is a new approach to the treatment and prevention of tumors, taking into account inter- and intratumorally genetic variability, the tumor (immunological) environment, as well as lifestyle and patient morbidity. Each individual tumor. A person diagnosed with cancer, PMs have the potential to adapt treatment to tumor oncogenic factors and modulate the tumor immune environment. Additionally, PM strives to optimize tumor response, taking into account treatment-related toxicities for each patient [21]. In this way, optimization of the tumor response is combined with the preservation of organic functions and therefore quality of life. In addition, this ultimately guarantees better patient care, which is obviously the desired objective.

In this context, the objective of this special issue of Cancers is to exchange and present the latest results of research in precision medicine and recent advances in personalized medicine against cancer and its associated symptoms.

There is developed therapies against mono-oncogenic tumors over the past several decades. They highlight the need for a multimers approach integrating DNA and RNA alterations to better understand tumor biology, intratumorally heterogeneity and the development of immune defense mechanisms [22]. This enables the identification of tumor-specific biomarkers and the development of innovative treatment strategies that optimize response rates and avoid treatment resistance. They also address the emerging field of liquid biopsy, a non-invasive method of detecting and diagnosing tumors, as well as the early development of treatment resistance.

Colorectal cancer is a well-known and widely used model in which tumor-specific treatments have already been implemented. In colorectal cancer, it is known that the progressive accumulation of genetic and epigenetic events leads to the development of carcinoma. Prognostic and prognostic biomarkers such as KRAS (Kirsten Rat Sarcoma Virus) and microsatellite instability (MSI) have been identified to help guide specific treatment decisions within current standards of care [23]. There is developed novel biomarkers and innovative liquid biopsy platforms that could pave the way for new combination therapeutic options targeting not only tumor cells but also the tumor microenvironment [21]. Additionally, driver mutations are being identified in non-small cell lung cancer (NSCLC), for which effective treatment strategies have been developed. The known oncogenic drivers of NSCLC and various targeted treatment strategies that have been shown to improve the overall survival of these patients are described. Given that only a small proportion of the programs currently expressed

in NSCLC involve oncogenic drivers, the authors also conclude that further research is needed to identify novel molecular targets [24]. To optimize patient and tumor specific treatment for breast cancer patients, they present an in-silico analysis showing that four well-known numerical risk scores (OncoMasTR, EndoPredict, OncotypeDX, and tumor-infiltrating leukocytes) predict significantly the overall pathology. Remission with neoadjuvant chemotherapy in patients with estrogen receptor (ER) - and human epidermal growth factor receptor (HER)-2-positive breast cancer [25].

Although molecular oncology has significantly optimized the prognosis of many tumor subtypes, specific therapeutic options for long-term disease control in tumors whose tumorigenesis is still largely unknown are still lacking. Pancreatic ductal carcinomas and glioblastomas are tumors whose tumorigenesis process has not yet been determined and therefore always has a delay in its development. As a result, limited progress has been made in increasing the overall survival of these tumors by five years. Precision medicine initiatives for patients with pancreatic ductal cancer, enabling preclinical studies and detailed molecular profiling of patients' tumor tissue and blood [26]. These research initiatives may lead to a better understanding of pancreatic ductal carcinoma and the development of new biomarkers and innovative treatment strategies. In glioblastoma, several large-scale single-cell sequencing studies have revealed strong intratumorally heterogeneity, with a single tumor consisting of multiple tumor clones with significant genetic and epigenetic differences [27]. Thus, targeted therapeutic strategies that inhibit the activation of specific oncogenes have not yet been successful. In these molecularly heterogeneous glioblastomas, targeting the tumor microenvironment appears to be an interesting strategy. Immune cells are an important component of the tumor microenvironment. Like many other tumors, glioblastomas can evade an effective immune response. However, immune checkpoint inhibitors, which are known to create a favorable immune environment by activating infiltrating T cells, are not effective in glioblastoma. Information is available on the unique composition of the glioblastoma-specific immune milieu [28, 30]. This helps explain why clinical trials of known immunomodulators have not yet shown an increase in overall survival. There is important to develop new therapeutic strategies combining different immunomodulators. Because the blood-brain barrier can limit the intratumorally availability of systemically administered compounds, there is found a way to bypass the blood-brain barrier. Intratumorally convection-enhanced delivery (CED) of the RNA therapeutic OT101 inhibits the immunosuppressive effects of transforming growth factor beta 2, subsequently resulting in clinically relevant single-agent activity [29]. At the same

time, several DEC procedures and device-related complications are being identified that require risk mitigation strategies to determine how to proceed in this area of practice.

DTMT not only unravels the complexities of the tumor microenvironment but also beckons a revolutionary shift in therapeutic paradigms. By recognizing the dynamic interactions between tumor cells and their microenvironment, DTMT opens avenues for tailoring treatment strategies to the distinct characteristics of individual tumors. This personalized approach holds immense potential to enhance treatment efficacy, minimize side effects, and usher in a new era of precision medicine in cancer therapeutics [42-44].

1. Targeting Dynamic Interactions:

- *Objective:* Develop interventions that disrupt the reciprocal influence of biochemical signals, extracellular matrix (ECM) remodeling, and immune cell infiltration on tumor behavior.
- *Strategy:* Investigate targeted therapies, such as kinase inhibitors or immune checkpoint inhibitors, tailored to the specific signaling pathways implicated in dynamic interactions.

2. Modulating Metabolic Adaptation:

- *Objective:* Customize interventions to manipulate the unique metabolic profiles of tumor cells influenced by nutrient availability, oxygen levels, and interactions with neighboring cells.
- *Strategy:* Explore personalized metabolic therapies, including precision nutrition plans, and the use of metabolic modulators based on individual tumor metabolic characteristics.

3. Intervening in Extracellular Matrix Remodeling:

- *Objective:* Address changes in ECM composition and stiffness that impact cellular signaling pathways, modulating cell migration, invasion, and responses to therapeutic interventions.
- *Strategy:* Investigate nanotechnology-based drug delivery systems for precision targeting of ECM components or enzymes involved in remodeling, offering a tailored approach to the tumor microenvironment.

4. Enhancing Immune Modulation:

- *Objective:* Leverage the intricate involvement of the immune system, fostering anti-tumor responses and overcoming immunosuppressive mechanisms.
- *Strategy:* Develop personalized immunotherapies, possibly utilizing patient-specific tumor antigens for vaccine development or employing adoptive cell therapies based on the individual's immune landscape.

5. Combination Therapies:

- *Objective:* Recognize the necessity of a comprehensive approach, integrating both intrinsic tumor properties and the dynamic aspects of the microenvironment for effective treatment.
- *Strategy:* Design combination therapies that strategically merge traditional treatments, like chemotherapy or targeted therapy, with agents targeting specific aspects of the tumor microenvironment, creating a synergistic and personalized treatment regimen.

Implementation Challenges: While personalized treatment strategies guided by DTMT hold promise, their implementation faces challenges such as the need for advanced diagnostic technologies, robust biomarker identification, and the development of individualized treatment protocols. Collaborative efforts between clinicians, researchers, and technology innovators are crucial to overcoming these challenges and translating personalized approaches from theory to clinical practice.

Personalized treatment strategies, informed by the principles of DTMT, represent the pinnacle of cancer therapeutics. As our understanding of the dynamic tumor microenvironment deepens, the translation of these insights into tailored interventions heralds a new era in which each patient's cancer journey is unique and optimally addressed. The ongoing pursuit of personalized approaches guided by DTMT promises not only to revolutionize cancer treatment but also to provide renewed hope for patients facing the complexities of this formidable disease.

The DTMT emerges as a cornerstone in unraveling the intricate web of tumor biology. Its holistic approach, taking into account the dynamic interplay between tumor cells and their microenvironment, has not only deepened our understanding of cancer but also paved the way for groundbreaking research and therapeutic interventions in the realms of cancer biology and biochemistry. The multifaceted nature of cancer, characterized by its heterogeneity and adaptability, necessitates a paradigm shift in our approach to comprehend its complexity fully.

The conventional reductionist perspective, which often isolated tumor cells from their surroundings, has been transcended by DTMT. This theory underscores the importance of viewing tumors as dynamic entities existing in a constantly evolving microenvironment. The tumor microenvironment (TME) is no longer considered a passive backdrop but an active participant influencing cancer progression. The reciprocal communication between tumor cells and the TME orchestrates a symphony of molecular events that shape the course of the disease.

One of the pivotal aspects highlighted by DTMT is the plasticity of tumor cells. Tumor cells exhibit remarkable adaptability in response to the changing dynamics of their microenvironment. This adaptability encompasses not only genetic alterations but also

epigenetic modifications and alterations in the expression of various signaling pathways. Understanding this plasticity is crucial for devising targeted therapeutic strategies that can outsmart the tumor's ability to evolve and evade treatment [46-48].

The DTMT sheds light on the role of the immune system in the tumor microenvironment. The intricate interplay between tumor cells and immune cells within the TME has significant implications for immunotherapy. Harnessing the power of the immune system to recognize and eliminate cancer cells has become a cornerstone in cancer treatment, and DTMT provides a nuanced understanding of the immunological landscape within tumors [49-51].

The therapeutic implications of DTMT extend beyond traditional treatments. Targeting specific components of the TME, such as stromal cells, angiogenesis, and extracellular matrix, opens new avenues for innovative therapeutic interventions. The development of drugs that modulate the tumor microenvironment or disrupt the supportive niches for cancer cells holds promise in enhancing the efficacy of existing treatments and overcoming resistance mechanisms.

The DTMT stands as a transformative paradigm in cancer research, offering a comprehensive and dynamic lens through which we can decipher the intricacies of tumor biology. Its implications resonate across various facets of cancer science, from understanding tumor heterogeneity to devising novel therapeutic strategies. As we delve deeper into the era of precision medicine, DTMT serves as a guiding compass, steering us toward a more profound comprehension of the dynamic interplay between tumors and their microenvironment, ultimately fostering advancements in cancer biology and biochemistry. The continued exploration of the DTMT framework is poised to unravel new dimensions in the quest to conquer cancer and enhance the lives of individuals affected by this formidable disease.

The Evolving Neoplastic Niche Framework (ENNF) provides a comprehensive lens through which to interpret the dynamic and multifactorial nature of tumor biology. Unlike traditional reductionist models that focus solely on tumor cell-autonomous mechanisms, the ENNF situates malignant cells within a complex, adaptive, and co-evolving microenvironment that includes stromal, immune, vascular, and extracellular matrix (ECM) components. The framework emphasizes that tumor progression, invasion, metastasis, and therapeutic resistance are emergent properties of a continuously interacting system rather than the sum of isolated cellular abnormalities. This paradigm shift reflects a growing consensus in oncology that

effective interventions require holistic consideration of the tumor ecosystem, integrating molecular, cellular, and systemic factors into a unified conceptual and translational approach.

Tumor–Stroma Interactions

One of the foundational insights provided by the ENNF is the recognition of stromal elements as active participants in oncogenesis rather than passive scaffolds. Cancer-associated fibroblasts (CAFs), for example, display remarkable phenotypic plasticity and functional heterogeneity. CAFs secrete growth factors, cytokines, and ECM-modifying enzymes that modulate tumor proliferation, invasion, and therapeutic response. Inflammatory CAF subsets generate paracrine signaling loops involving IL-6, IL-8, and TGF-β, which promote epithelial–mesenchymal transition (EMT) and enhance metastatic potential. Myofibroblastic CAFs contribute to desmoplastic remodeling, increasing matrix stiffness and facilitating integrin-mediated mechanotransduction that drives invasion and chemoresistance. Understanding these diverse stromal phenotypes and their spatial distribution within tumors is crucial for therapeutic targeting, as interventions that ignore stromal heterogeneity often fail to achieve sustained clinical benefit.

Furthermore, the bidirectional nature of tumor–stroma communication creates feedback loops that amplify oncogenic signaling. Tumor-derived exosomes and secreted metabolites influence CAF activation, while CAFs reciprocally secrete factors that reinforce tumor aggressiveness. This co-evolutionary relationship exemplifies the adaptive, ecosystem-like characteristics emphasized by the ENNF. Interventions that selectively disrupt these interactions—such as inhibitors of TGF-β signaling, CAF-derived chemokines, or ECM remodeling enzymes—have demonstrated preclinical efficacy and represent promising translational strategies.

Immune Modulation within the Tumor Microenvironment

Immune cells within the tumor microenvironment (TME) function both as regulators and effectors of tumor evolution, a duality captured by the ENNF. Tumor-infiltrating lymphocytes (TILs), cytotoxic T cells, and natural killer (NK) cells exert anti-tumor effects, while immunosuppressive populations, including regulatory T cells (Tregs), myeloid-derived suppressor cells (MDSCs), and tumor-associated macrophages (TAMs), facilitate immune evasion. The ENNF conceptualizes these interactions as dynamic, context-dependent processes influenced by metabolic gradients, hypoxia, and stromal signaling. For example, lactate accumulation in hypoxic tumor regions suppresses effector T-cell function, while promoting differentiation of M2-like macrophages that support tumor progression.

Immune checkpoint pathways, particularly PD-1/PD-L1 and CTLA-4, represent critical regulatory nodes within this adaptive landscape. Therapeutic blockade of these pathways has yielded unprecedented clinical responses, yet heterogeneity in efficacy reflects the complexity of the immune microenvironment. The ENNF emphasizes that effective immunotherapy must consider not only tumor-intrinsic antigenicity but also the systemic and microenvironmental context, including stromal signaling, metabolic constraints, and vascular accessibility. Multi-modal approaches that combine checkpoint inhibition with stromal targeting, metabolic modulation, or vascular normalization may overcome these limitations, aligning with the integrative vision of the ENNF.

Hypoxia and Metabolic Adaptation

Hypoxia is a pervasive feature of rapidly proliferating tumors and serves as a master regulator of adaptive responses within the TME. Stabilization of hypoxia-inducible factors (HIF-1α and HIF-2α) initiates transcriptional programs that promote angiogenesis, glycolytic metabolism, EMT, and immune evasion. These adaptations not only support survival under oxygen-deprived conditions but also enhance intratumoral heterogeneity, contributing to the emergence of therapy-resistant clones.

Metabolic reprogramming extends beyond the classical Warburg effect to include glutamine addiction, lipid metabolism shifts, and redox balancing mechanisms. The ENNF emphasizes metabolic symbiosis between tumor cells and stromal components. For instance, CAFs may undergo aerobic glycolysis to produce lactate, which tumor cells then utilize for oxidative phosphorylation, establishing a metabolic coupling that reinforces tumor growth. Similarly, adipocytes in the tumor niche supply fatty acids to support proliferation and survival, particularly in metastatic sites such as the bone marrow or omentum. These findings underscore the necessity of systems-level approaches in developing metabolic interventions, as targeting a single pathway may be insufficient to disrupt the integrated metabolic network.

Extracellular Matrix and Mechanotransduction

The ECM is both a structural scaffold and a dynamic regulator of tumor biology. Alterations in matrix composition, crosslinking, and stiffness influence cell behavior through mechanotransduction pathways mediated by integrins, focal adhesion kinase (FAK), and YAP/TAZ signaling. Stiffened matrices enhance invasive phenotypes, promote EMT, and contribute to chemoresistance, while ECM degradation by matrix metalloproteinases (MMPs) facilitates local invasion and metastatic dissemination.

The ENNF positions ECM remodeling as a central regulatory node rather than a secondary consequence of tumor growth. Therapeutic strategies that normalize ECM architecture or disrupt maladaptive mechanotransduction have demonstrated efficacy in preclinical models, highlighting the translational relevance of considering biomechanical cues alongside molecular and cellular factors. Furthermore, the interplay between ECM stiffness, hypoxia, and immune cell infiltration exemplifies the interconnectedness of TME components emphasized in the ENNF.

Spatial and Temporal Heterogeneity

Tumors exhibit profound spatial heterogeneity, with distinct regions characterized by variable cellular composition, vascular density, metabolic activity, and immune infiltration. Single-cell sequencing, multiplex imaging, and spatial transcriptomics have revealed the mosaic nature of tumors, demonstrating that distinct niches may harbor differential responses to therapy. Temporal evolution further compounds this complexity, as selective pressures imposed by therapy drive clonal expansion, phenotypic plasticity, and adaptive resistance.

The ENNF framework accommodates these dynamics by emphasizing longitudinal and spatially resolved analysis. Therapeutic strategies informed by the ENNF may include adaptive regimens that anticipate clonal evolution, sequential targeting of different microenvironmental niches, and real-time monitoring of systemic and local tumor adaptations. By integrating spatial and temporal heterogeneity into therapeutic planning, clinicians can move beyond static, one-size-fits-all interventions toward more nuanced, ecosystem-oriented approaches.

Systemic Influences on Tumor Evolution

Beyond local microenvironmental interactions, systemic factors—including endocrine signaling, neural inputs, microbiome composition, and metabolic status—profoundly shape tumor behavior. Chronic inflammation, obesity-associated cytokine profiles, stress-mediated neuroendocrine signaling, and microbial metabolites all contribute to shaping the TME and influencing progression and therapeutic response. The ENNF extends conceptual boundaries to incorporate these organism-wide determinants, framing cancer as a systemic disorder.

For example, catecholamines released during chronic stress can activate β-adrenergic signaling in tumor cells and stromal components, promoting angiogenesis and immunosuppression. Similarly, gut microbiota influence immune cell priming, systemic metabolite levels, and the efficacy of checkpoint inhibitors. Recognizing these systemic inputs reinforces the integrative, multi-level perspective central to the ENNF and highlights opportunities for combinatorial interventions targeting both local and systemic regulatory axes.

Translational Implications

The ENNF provides a robust conceptual scaffold for translating mechanistic insights into clinical interventions. Therapeutic strategies informed by this framework extend beyond cytotoxic agents to include targeted modulation of stromal signaling, immune landscape reshaping, metabolic reprogramming, vascular normalization, and ECM remodeling. Multi-modal combination therapies, designed to simultaneously disrupt cooperative networks within the TME, have demonstrated superior efficacy in preclinical and early clinical studies.

Biomarker discovery is also enhanced by this integrative perspective. Circulating tumor DNA, extracellular vesicles, stromal gene expression patterns, immune cell infiltration profiles, and metabolic imaging parameters can be interpreted within the ENNF to improve predictive and prognostic modeling. Stratifying patients based on these multi-dimensional signatures enables precision medicine approaches that are adaptive, context-specific, and resilient to evolutionary pressures within tumors.

Future Directions

Several avenues of research emerge from the ENNF. First, advanced imaging and single-cell profiling technologies should be leveraged to map the spatial and temporal dynamics of tumor niches at high resolution. Second, computational modeling and systems biology approaches must integrate multi-omic, spatial, and functional datasets to identify emergent properties and critical regulatory nodes. Third, therapeutic development should focus on ecosystem-level interventions, combining cell-intrinsic targeting with modulation of stromal, immune, metabolic, and biomechanical networks. Finally, longitudinal studies incorporating real-time monitoring of tumor adaptation will be essential to anticipate resistance and optimize adaptive therapeutic strategies.

The ENNF also underscores the importance of interdisciplinary collaboration. Effective translation of this framework requires integration of molecular oncology, immunology, bioengineering, systems biology, computational modeling, and clinical oncology. Such convergence will facilitate a mechanistic understanding of tumor ecosystems while simultaneously enabling development of innovative, multi-modal, and personalized therapeutic approaches.

Conclusion:

- The Evolving Neoplastic Niche Framework establishes a comprehensive and integrative conceptual architecture for understanding malignancy as a dynamic, adaptive, and systemically

interconnected biological process. By transcending reductionist tumor-centric doctrines, this model positions cancer within a multidimensional ecosystem in which malignant cells, stromal constituents, immune populations, extracellular matrix components, metabolic circuits, biomechanical forces, and systemic regulators function as interdependent determinants of disease behavior. Such a perspective recognizes that oncogenesis, progression, metastasis, and therapeutic resistance are emergent properties arising from continuous reciprocal signaling rather than isolated genetic aberrations alone.

- Through synthesis of molecular oncology, biochemical regulation, systems biology, and translational therapeutics, the framework clarifies how spatial heterogeneity, temporal evolution, and microenvironmental plasticity govern tumor adaptability. It underscores that hypoxia, metabolic reprogramming, immune modulation, matrix remodeling, and angiogenic dynamics operate not as peripheral phenomena but as central regulatory axes shaping malignant phenotypes. By mapping these interconnected pathways, the model enhances mechanistic resolution while simultaneously providing strategic guidance for intervention design.
- Importantly, this integrative construct strengthens the scientific basis of precision oncology. The identification of context-dependent biomarkers, actionable stromal targets, and ecosystem-level vulnerabilities supports the development of combinatorial and adaptive therapeutic strategies tailored to the unique biological signature of each tumor. Rather than focusing exclusively on cytotoxic eradication, future treatment paradigms informed by this model emphasize ecological reprogramming, immune restoration, metabolic disruption, and microenvironmental normalization.
- Ultimately, the Evolving Neoplastic Niche Framework redefines the trajectory of contemporary cancer research. It advances a systems-oriented, translationally aligned vision in which mechanistic insight and clinical application converge. By embracing the complexity of tumor ecosystems, the field is better equipped to confront therapeutic resistance, refine individualized treatment algorithms, and move toward more durable and transformative oncologic outcomes.

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References:

1. Bailly C, Thuru X, Quesnel B. Combined cytotoxic chemotherapy and immunotherapy of cancer: modern times. NAR Cancer. 2020 Feb 17;2(1): zcaa002. doi: 10.1093/narcan/zcaa002. PMID: 34316682; PMCID: PMC8209987.
2. Kurrikoff K, Aphkhazava D, Langel Ü. The future of peptides in cancer treatment. Curr Opin Pharmacol. 2019 Aug;47:27-32. doi: 10.1016/j.coph.2019.01.008. Epub 2019 Mar 8. PMID: 30856511.

3. Walker C, Mojares E, Del Río Hernández A. Role of Extracellular Matrix in Development and Cancer Progression. Int J Mol Sci. 2018 Oct 4;19(10):3028. doi: 10.3390/ijms19103028. PMID: 30287763; PMCID: PMC6213383.
4. Hanahan D, Weinberg RA. Hallmarks of cancer: the next generation. *Cell*. 2011;144(5):646–674.
5. Quail DF, Joyce JA. Microenvironmental regulation of tumor progression and metastasis. *Nat Med*. 2013;19(11):1423–1437.
6. Junttila MR, de Sauvage FJ. Influence of tumour micro-environment heterogeneity on therapeutic response. *Nature*. 2013;501(7467):346–354.
7. Bissell MJ, Hines WC. Why don't we get more cancer? A proposed role of the microenvironment in restraining cancer progression. *Nat Med*. 2011;17(3):320–329.
8. Joyce JA, Pollard JW. Microenvironmental regulation of metastasis. *Nat Rev Cancer*. 2009;9(4):239–252.
9. Polyak K, Haviv I, Campbell IG. Co-evolution of tumor cells and their microenvironment. *Trends Genet*. 2009;25(1):30–38.
10. Kumar V, Gabrilovich DI. Hypoxia-inducible factors in the tumor microenvironment: regulation of cancer progression and immune response. *Cancer Immunol Immunother*. 2014;63(1):1–9.
11. Pickup MW, Mouw JK, Weaver VM. The extracellular matrix modulates the hallmarks of cancer. *EMBO Rep*. 2014;15(12):1243–1253.
12. Wu T, Dai Y. Tumor microenvironment and therapeutic response. *Cancer Lett*. 2017;387:61–68.
13. Fong MY, Kakar SS. The role of exosomes in the regulation of the tumor microenvironment. *Oncotarget*. 2015;6(32):33626–33643.
14. Sagae S, Toita T, Matsuura M, Saito M, Matsuda T, Sato N, Shimizu A, Endo T, Fujii M, Gaffney DK, Small W Jr. Improvement in radiation techniques for locally advanced cervical cancer during the last two decades. Int J Gynecol Cancer. 2023 Aug 7;33(8):1295-1303. doi: 10.1136/ijgc-2022-004230. PMID: 37041022; PMCID: PMC10423558.
15. Michael S. Sabel MD, Kathleen M. Diehl MD and Alfred E. Chang MD Principles of Surgical Therapy in Oncology. Oncology pp 58–72.
16. Kuijk E, Kranenburg O, Cuppen E, Van Hoeck A. Common anti-cancer therapies induce somatic mutations in stem cells of healthy tissue. Nat Commun. 2022 Oct 7;13(1):5915. doi: 10.1038/s41467-022-33663-5. PMID: 36207433; PMCID: PMC9546852.
17. Zafari N, Khosravi F, Rezaee Z, Esfandyari S, Bahiraei M, Bahramy A, Ferns GA, Avan A. The role of the tumor microenvironment in colorectal cancer and the potential therapeutic approaches. J Clin Lab Anal. 2022 Aug;36(8): e24585. doi: 10.1002/jcla.24585. Epub 2022 Jul 8. PMID: 35808903; PMCID: PMC9396196.
18. Dzobo K, Dandara C. The Extracellular Matrix: Its Composition, Function, Remodeling, and Role in Tumorigenesis. Biomimetics (Basel). 2023 Apr 5;8(2):146. doi: 10.3390/biomimetics8020146. PMID: 37092398; PMCID: PMC10123695.
19. Baghban R, Roshangar L, Jahanban-Esfahlan R, Seidi K, Ebrahimi-Kalan A, Jaymand M, Kolahian S, Javaheri T, Zare P. Tumor microenvironment complexity and therapeutic implications at a glance. Cell Commun Signal. 2020 Apr 7;18(1):59. doi: 10.1186/s12964-020-0530-4. PMID: 32264958; PMCID: PMC7140346.
20. Emran TB, Shahriar A, Mahmud AR, Rahman T, Abir MH, Siddiquee MF, Ahmed H, Rahman N, Nainu F, Wahyudin E, Mitra S, Dhama K, Habiballah MM, Haque S, Islam A, Hassan MM. Multidrug Resistance in Cancer: Understanding Molecular Mechanisms, Immunoprevention and Therapeutic Approaches. Front Oncol. 2022 Jun 23; 12:891652. doi: 10.3389/fonc.2022.891652. PMID: 35814435; PMCID: PMC9262248.
21. Shlyakhtina Y, Moran KL, Portal MM. Genetic and Non-Genetic Mechanisms Underlying Cancer Evolution. Cancers (Basel). 2021 Mar 18;13(6):1380. doi: 10.3390/cancers13061380. PMID: 33803675; PMCID: PMC8002988.
22. Kim SK, Cho SW. The Evasion Mechanisms of Cancer Immunity and Drug Intervention in the Tumor Microenvironment. Front Pharmacol. 2022 May 24; 13:868695. doi: 10.3389/fphar.2022.868695. PMID: 35685630; PMCID: PMC9171538.
23. Pernot S, Evrard S, Khatib AM. The Give-and-Take Interaction Between the Tumor Microenvironment and Immune Cells Regulating Tumor Progression and Repression. Front

Immunol. 2022 Apr 13; 13:850856. doi: 10.3389/fimmu.2022.850856. PMID: 35493456; PMCID: PMC9043524.
24. Yue B. Biology of the extracellular matrix: an overview. J Glaucoma. 2014 Oct-Nov;23(8 Suppl 1): S20-3. doi: 10.1097/IJG.0000000000000108. PMID: 25275899; PMCID: PMC4185430.
25. Cox TR, Erler JT. Remodeling and homeostasis of the extracellular matrix: implications for fibrotic diseases and cancer. Dis Model Mech. 2011 Mar;4(2):165-78. doi: 10.1242/dmm.004077. Epub 2011 Feb 14. PMID: 21324931; PMCID: PMC3046088.
26. Li F, Simon MC. Cancer Cells Don't Live Alone: Metabolic Communication within Tumor Microenvironments. Dev Cell. 2020 Jul 20;54(2):183-195. doi: 10.1016/j.devcel.2020.06.018. Epub 2020 Jul 7. PMID: 32640203; PMCID: PMC7375918.
27. Faubert B, Li KY, Cai L, Hensley CT, Kim J, Zacharias LG, Yang C, Do QN, Doucette S, Burguete D, Li H, Huet G, Yuan Q, Wigal T, Butt Y, Ni M, Torrealba J, Oliver D, Lenkinski RE, Malloy CR, Wachsmann JW, Young JD, Kernstine K, DeBerardinis RJ. Lactate Metabolism in Human Lung Tumors. Cell. 2017 Oct 5;171(2):358-371.e9. doi: 10.1016/j.cell.2017.09.019. PMID: 28985563; PMCID: PMC5684706.
28. Zhuang Y, Liu K, He Q, Gu X, Jiang C, Wu J. Hypoxia signaling in cancer: Implications for therapeutic interventions. MedComm (2020). 2023 Jan 23;4(1): e203. doi: 10.1002/mco2.203. PMID: 36703877; PMCID: PMC9870816.
29. Payen VL, Mina E, Van Hée VF, Porporato PE, Sonveaux P. Monocarboxylate transporters in cancer. Mol Metab. 2020 Mar; 33:48-66. doi: 10.1016/j.molmet.2019.07.006. Epub 2019 Jul 27. PMID: 31395464; PMCID: PMC7056923.
30. Castaño M, González-Cantó E, Aghababyan C, Tomás-Pérez S, Oto J, Herranz R, Medina P, Götte M, Mc Cormack BA, Marí-Alexandre J, Gilabert-Estellés J. New Roles for Old Friends: Involvement of the Innate Immune System in Tumor Progression. Int J Mol Sci. 2023 Apr 20;24(8):7604. doi: 10.3390/ijms24087604. PMID: 37108767; PMCID: PMC10144334.
31. Hoeks C, Duran G, Hellings N, Broux B. When Helpers Go Above and Beyond: Development and Characterization of Cytotoxic $CD4^+$ T Cells. Front Immunol. 2022 Jul 12; 13:951900. doi: 10.3389/fimmu.2022.951900. PMID: 35903098; PMCID: PMC9320319.
32. Zhu X, Zhu J. CD4 T Helper Cell Subsets and Related Human Immunological Disorders. Int J Mol Sci. 2020 Oct 28;21(21):8011. doi: 10.3390/ijms21218011. PMID: 33126494; PMCID: PMC7663252.
33. Hoeben A, Joosten EAJ, van den Beuken-van Everdingen MHJ. Personalized Medicine: Recent Progress in Cancer Therapy. Cancers (Basel). 2021 Jan 11;13(2):242. doi: 10.3390/cancers13020242. PMID: 33440729; PMCID: PMC7826530.
34. Zhu X, Fan C, Xiong Z, Chen M, Li Z, Tao T, Liu X. Development and application of oncolytic viruses as the nemesis of tumor cells. Front Microbiol. 2023 Jun 12; 14:1188526. doi: 10.3389/fmicb.2023.1188526. PMID: 37440883; PMCID: PMC10335770.
35. Bupathi M, Wu C. Biomarkers for immune therapy in colorectal cancer: mismatch-repair deficiency and others. J Gastrointest Oncol. 2016 Oct;7(5):713-720. doi: 10.21037/jgo.2016.07.03. PMID: 27747085; PMCID: PMC5056251.
36. Chevallier M, Borgeaud M, Addeo A, Friedlaender A. Oncogenic driver mutations in non-small cell lung cancer: Past, present and future. World J Clin Oncol. 2021 Apr 24;12(4):217-237. doi: 10.5306/wjco. v12.i4.217. PMID: 33959476; PMCID: PMC8085514.
37. Mazo C, Barron S, Mooney C, Gallagher WM. Multi-Gene Prognostic Signatures and Prediction of Pathological Complete Response to Neoadjuvant Chemotherapy in ER-positive, HER2-negative Breast Cancer Patients. Cancers (Basel). 2020 May 1;12(5):1133. doi: 10.3390/cancers12051133. PMID: 32369904; PMCID: PMC7281334.
38. Zheng-Lin B, O'Reilly EM. Pancreatic ductal adenocarcinoma in the era of precision medicine. Semin Oncol. 2021 Feb;48(1):19-33. doi: 10.1053/j.seminoncol.2021.01.005. Epub 2021 Feb 11. PMID: 33637355; PMCID: PMC8355264.
39. Patel AP, Tirosh I, Trombetta JJ, Shalek AK, Gillespie SM, Wakimoto H, Cahill DP, Nahed BV, Curry WT, Martuza RL, Louis DN, Rozenblatt-Rosen O, Suvà ML, Regev A, Bernstein BE. Single-cell RNA-seq highlights intratumoral heterogeneity in primary glioblastoma. Science. 2014

Jun 20;344(6190):1396-401. doi: 10.1126/science.1254257. Epub 2014 Jun 12. PMID: 24925914; PMCID: PMC4123637.

40. Persico P, Lorenzi E, Dipasquale A, Pessina F, Navarria P, Politi LS, Santoro A, Simonelli M. Checkpoint Inhibitors as High-Grade Gliomas Treatment: State of the Art and Future Perspectives. J Clin Med. 2021 Mar 26;10(7):1367. doi: 10.3390/jcm10071367. PMID: 33810532; PMCID: PMC8036455.
41. Uckun FM, Qazi S, Hwang L, Trieu VN. Recurrent or Refractory High-Grade Gliomas Treated by Convection-Enhanced Delivery of a TGFβ*2*-Targeting RNA Therapeutic: A Post-hoc Analysis with Long-Term Follow-Up. Cancers (Basel). 2019 Nov 28;11(12):1892. doi: 10.3390/cancers11121892. PMID: 31795071; PMCID: PMC6966490.
42. Akinleye A., Rasool Z. Immune checkpoint inhibitors of PD-L1 as cancer therapeutics. J. Hematol. Oncol. 2019; 12:92.
43. Jiao P., Geng Q., Jin P., Su G., Teng H., Dong J., Yan B. Small molecules as PD-1/PD-L1 pathway modulators for cancer immunotherapy. Curr. Pharm. Des. 2018; 24:4911–4920.
44. Liu X., Guo C.Y., Tou F.F., Wen X.M., Kuang Y.K., Zhu Q., Hu H. Association of PD-L1 expression status with the efficacy of PD-1/PD-L1 inhibitors and overall survival in solid tumours: a systematic review and meta-analysis. Int. J. Cancer. 2019; doi:10.1002/ijc.32744.
45. Roviello G., Corona S.P., Nesi G., Mini E. Results from a meta-analysis of immune checkpoint inhibitors in first-line renal cancer patients: does PD-L1 matter. Ther. Adv. Med. Oncol. 2019; 11: doi:10.1177/1758835919861905.
46. Green J, Kirwan J, Tierney J, et al. Concomitant chemotherapy and radiation therapy for cancer of the uterine cervix. Cochrane Database Syst Rev 2005;3:CD002225. 10.1002/14651858.CD002225.
47. Chemoradiotherapy for Cervical Cancer Meta-Analysis Collaboration. Reducing uncertainties about the effects of chemoradiotherapy for cervical cancer: a systematic review and meta-analysis of individual patient data from 18 randomized trials. J Clin Oncol 2008; 26:5802–12. 10.1200/JCO.2008.16.4368
48. Toita T, Kitagawa R, Hamano T, et al. Feasibility and acute toxicity of concurrent chemoradiotherapy (CCRT) with high-dose rate intracavitary brachytherapy (HDR-ICBT) and 40-mg/m2 weekly cisplatin for Japanese patients with cervical cancer: results of a multi-institutional phase 2 study (JGOG1066). Int J Gynecol Cancer 2012; 22:1420–6. 10.1097/IGC.0b013e3182647265
49. Hsu HC, Li X, Curtin JP, et al. Surveillance epidemiology and end results analysis demonstrates improvement in overall survival for cervical cancer patients treated in the era of concurrent chemoradiotherapy. Front Oncol 2015; 5:81. 10.3389/fonc.2015.00081
50. Hsu HC, Li X, Curtin JP, et al. Surveillance epidemiology and end results analysis demonstrates improvement in overall survivalfor cervical cancer patients treated in the era of concurrent chemoradiotherapy. Front Oncol 2015; 5:81.
51. Shrivastava S, Mahantshetty U, Engineer R, et al. Cisplatinchemoradiotherapy vs radiotherapy in FIGO stage IIIB squamous cell carcinoma of the uterine cervix: a randomized clinical trial. JAMA Oncol 2018; 4:506–13.

AI-ENHANCED SUPPLY CHAIN OPTIMIZATION IN THE DIGITAL ERA

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Abstract

This study investigates the role of AI in optimizing supply chains under digital transformation initiatives. AI techniques, including reinforcement learning, predictive analytics, and digital twins, are evaluated for their ability to reduce inefficiencies, forecast demand, and automate logistics operations. Using data from multinational supply chains and simulation models, the research demonstrates that AI integration improves inventory management, minimizes delays, and enhances decision-making agility. Challenges such as interoperability, data standardization, and workforce reskilling are addressed. The study proposes a model for AI-driven digital supply chains, highlighting scalable, sustainable, and resilient practices for modern enterprises.

Keywords: AI techniques, inefficiencies, forecast,

SELECTIVE ISOLATION AND ENUMERATION OF SAHARAN ACTINOMYCETES FROM TAMANRASSET SOILS

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Abstract:

Extreme environments, such as the Saharan soils of Tamanrasset (Algeria), represent a promising reservoir for rare actinomycetes with unique biosynthetic capabilities. This study focuses on the selective isolation and purification of actinobacteria strains adapted to arid conditions. Soil samples were collected and subjected to physical and chemical pretreatments, including heat treatment and the addition of calcium carbonate (CaCO_3), to reduce fungal contamination and favor the growth of spore-forming actinomycetes.

The isolation process was conducted on Chitin-Vitamin B agar medium, supplemented with selective agents such as Gentamicin and Kanamycin to inhibit competing eubacteria. Quantitative analysis (enumeration) revealed a diverse microbial population specifically adapted to the harsh Saharan climate. Representative colonies were subsequently purified on International Streptomyces Project medium 2 (ISP2). This systematic approach allowed for the establishment of a robust collection of Saharan isolates, providing a fundamental resource for further screening of secondary metabolites with potential applications in phytopathogen biocontrol.

Keywords: Saharan soil, Tamanrasset, Selective isolation, Chitin medium, Actinomycetes.

POTENT ANTIFUNGAL AND ANTIBACTERIAL ACTIVITY OF SAHARAN ACTINOMYCETES AGAINST MAJOR PHYTOPATHOGENS

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Abstract:

The search for natural alternatives to chemical pesticides is crucial for sustainable agriculture. This study evaluates the antagonistic potential of 40 actinomycete strains isolated from Tamanrasset (Algeria) against a panel of 4 phytopathogenic bacteria and 12 fungi. Preliminary screening using the "strie croisée" method on ISP2 medium revealed exceptional bioactivity. Notably, several isolates exhibited significant inhibition zones reaching up to 40 mm against highly resistant fungal genera, including Alternaria and Fusarium. These results demonstrate the superior ability of Saharan isolates to produce potent antifungal metabolites. The broad-spectrum activity observed against both bacterial and fungal pathogens suggests that these strains possess diverse biosynthetic pathways, making them ideal candidates for the development of new bio-fungicides to protect strategic crops.

Keywords: Antagonistic activity, Alternaria, Fusarium, Bio-control, Phytopathogens.

PHYSIOLOGICAL CHARACTERIZATION AND GROWTH KINETICS OF BIOACTIVE SAHARAN ACTINOBACTERIA

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Abstract:

This research details the physiological and chemical characterization of 40 actinomycete strains originating from Saharan soil. The isolates underwent rigorous testing to determine their biochemical profiles and growth requirements. Kinetic studies were conducted in liquid media (YGB and ISP2) to monitor the evolution of biomass, pH variations, and the timing of secondary metabolite production. It was observed that the pH stability and biomass accumulation significantly influenced the yield of bioactive molecules. The correlation between the idiophase and the peak of inhibitory activity was established, providing essential data on the optimal harvest time for the crude extracts. These physiological insights provide a better understanding of how extreme-environment strains adapt their metabolism to produce defensive molecules under laboratory conditions.

Keywords: Growth kinetics, Biomass, pH profile, Physiological characterization, Secondary metabolites.

OPTIMIZATION OF CULTURE CONDITIONS USING RSM AND SOLVENT EXTRACTION OF BIOACTIVE METABOLITES

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Abstract:

To maximize the production of bioactive compounds, an optimization study was performed using the Response Surface Methodology (RSM) (MSR in French). The study focused on optimizing the components of the YGB medium, while keeping other environmental factors constant. This statistical approach allowed for the identification of the ideal concentrations of nutrients that significantly enhance the antimicrobial yield. Following the production phase, metabolites were recovered through liquid-liquid extraction. Comparative analysis of different organic solvents revealed that Dichloromethane (DCM) and Hexane provided the highest extraction efficiency for the active principles. The resulting crude extracts maintained high inhibitory levels, confirming that the optimized conditions and the chosen extraction protocol are effective for recovering stable and potent bioactive scaffolds from Saharan actinomycetes.

Keywords: RSM (MSR), YGB medium optimization, Dichloromethane, Hexane extraction, Bioactive yield.

DETOXIFICATION OF FEED USING LACTIC ACID BACTERIA

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ABSTRACT

Contamination of feed with mycotoxins (toxicogenic mold metabolites) poses a serious problem for livestock farming. Consumption of such feed results in mycotoxicosis, which leads to decreased productivity, increased resistance to infectious diseases, and mortality in farm animals and poultry. One of the promising methods of feed detoxification is the use of probiotic bacteria that degrade mycotoxins. Biodegradation (biodetoxification) of mycotoxins is the process of breaking down toxic mycotoxin molecules with the help of living organisms (bacteria, yeast, fungi) or their enzymes to non—toxic or less toxic compounds. Lactic acid bacteria (LAB) are specific strains of lactobacilli that have the ability to neutralize mycotoxins. Some probiotics are able to modify the structure of aflotoxin AFB1, ochratoxin A, converting it into less toxic compounds. For example: Bacillus subtilis and B. licheniformis produce enzymes (e.g., laccases) that break down aflotoxin and ochratoxin into safe metabolites. The Lactobacillus plantarum strain and L. reuteri hydrolyze the toxin, reducing its activity. To reduce the decrease in bioavailability and body protection of LAB, probiotics minimize the negative effects of mycotoxin on the body by reducing absorption into the intestine. In addition, LAB protect the liver of animals. Lactobacillus rhamnosus and L. brevis strains reduce oxidative stress and liver damage caused by mycotoxin. Probiotics have an immunosuppressive effect on AFB1 aflotoxin, enhancing the immune system response. To date, Bacell-M probiotic complexes based on Bacillus subtilis are used in animal husbandry for detoxification of feed and LAB can be used as functional products to reduce the risk of aflatoxicosis in humans. Thus, lactic acid bacteria and probiotics are promising, safe tools for neutralizing mycotoxins, especially in combination with physico-chemical methods. Lactic acid bacteria (lactobacillus) have a whole arsenal of methods for survival under the influence of mycotoxins. The most valuable and promising strains are those capable of not only binding, but also biotransforming toxins into non-toxic forms, which is the most reliable and promising mechanism of detoxification. Their use helps to reduce economic losses and increase the safety of the food chain.

INVESTIGATING THE CATALYTIC AND ANTIMICROBIAL PROPERTIES OF TERNARY CESIUM/POLYETHYLENE GLYCOL-SRO SUPPORTED BY MOLECULAR DOCKING AND DFT ANALYSIS

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Abstract:

This study explores the use of ternary system nanocomposites to degrade methyl orange (MO) dye in water as well as assesses their antibacterial properties. For this purpose, the co-precipitation process was adopted to synthesize strontium oxide (SrO) doped with a fixed amount (3 wt%) of polyethylene glycol (PEG) as a capping agent, and various weight ratios (2 and 4 wt%) of cesium (Cs) were added to the binary system (PEG-SrO). Advanced characterization techniques were employed to analyze the various properties of the resulting materials. XRD unveiled the cubic crystal structure of SrO, while TEM revealed randomly oriented nanorods in the pristine sample. The optimum sample (2% Cs/PEG-SrO) demonstrated efficient catalytic activity (CA) in degrading MO dye. The 4% Cs/PEG-SrO sample showed significant bactericidal efficacy against *Escherichia coli* (*E. coli*), exhibiting inhibition zones ranging from 2.05 to 6.15 mm at higher concentrations. Furthermore, the computational findings align with the experimental data, offering strong evidence for the microbial effectiveness of Cs/PEG-SrO in hindering DNA gyrase in *E. coli*.

OPTİMİZATİON OF GREEN HYDROGEN PRODUCTİON BY SOLAR-DRİVEN PHOTOCATALYSİS

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ABSTRACT

Green hydrogen production via solar-driven photocatalysis has emerged as a promising and sustainable approach to address global energy and environmental challenges. This process enables the direct conversion of solar energy into chemical energy by splitting water into hydrogen and oxygen using semiconductor-based photocatalysts. However, the practical efficiency of photocatalytic hydrogen generation remains limited by several factors, including poor visible-light absorption, rapid charge carrier recombination, low surface reaction kinetics, and photocatalyst instability.

This study focuses on the optimization of green hydrogen production through advanced photocatalytic strategies under solar irradiation. Various approaches are investigated, including band gap engineering, heterojunction formation, elemental doping, surface modification, and cocatalyst loading, aiming to enhance light harvesting, charge separation efficiency, and catalytic activity. Particular attention is given to metal oxides, sulfides, and emerging two-dimensional materials due to their suitable electronic structures and chemical stability. The influence of operational parameters such as light intensity, wavelength, pH, sacrificial agents, and reactor configuration on hydrogen evolution rates is also systematically analyzed.

The results highlight that rational photocatalyst design combined with optimized reaction conditions significantly improves hydrogen production efficiency under simulated and natural sunlight. Moreover, the integration of cost-effective and earth-abundant materials contributes to the economic feasibility of large-scale implementation. This work provides a comprehensive insight into recent advancements and optimization pathways for solar photocatalytic hydrogen production, offering valuable perspectives for the development of efficient, stable, and scalable green hydrogen technologies. Ultimately, these findings support the transition toward renewable energy systems and a carbon-neutral hydrogen economy.

Keywords: Green hydrogen; Photocatalysis; Solar energy; Water splitting; Photocatalyst

A PROBLEM OF IMPLEMENTING REPRESENTATION

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ABSTR ACT:

Here is a problem given to a fourth-grade class before division had been taught.

A pastry chef made 274 chocolates. He prepares packages. In each

package, he must put 16 chocolates. How many packages can he fill?

Approaches of three students, A, B, and C.

A sets up the operation 274 × 16.

B sets up the operation 274 – 16.

C calculates 16 + 16 + 16 = 48; 48 + 48 + 48 + 48 = 192; 192 + 48 = 240; 240 + 34 = 274 and, finally, he answers 34 packages.

Students A and B do not have a complete representation of the problem; they develop a solution method based on clues contained in the problem statement.

- The first student identifies a verbal clue and associates it with an operation, the operation needed to solve the problem: the word "each" is associated with multiplication.

- The second student understands, unlike the first, that there will be fewer packages than chocolates and makes an association between reduction and subtraction.

- The third student, however, has developed a representation of the problem that conforms to the statement. This representation is operational since the student simulates the production of the packages. But their method is too costly, leading to a phenomenon of mental overload. At the end of the operationalization process, the student no longer clearly knows what they are looking for. For this student, we can say that the difficulty lies in the implementation of the problem representation.

REFERENCES:

[1] **H. Besse :** Remarques sur le statut de la didactique des langues étrangères dans le champ des sciences humaines et sociales. Bulletin de l'ACLA, 7, 7–27. (1985)
[2] **M.Artigue – R.Douady** : La didactique des mathématiques en France. Revue Française de Pédagogie N° 76 (1986) P.69-88.
[3] **G.Brousseau** : Fondements et méthodes de la didactique des mathématiques. Recherche en Didactique des Mathématiques, Vol 7 n°2 (1986) P33-115.

[4] **E.N.Ivantsyna :** Achieving skill in solving geometry problems – in : soviet studies in the psychology of learning mathematics – vol/4 : problem solving in geometry – University of Chicago, 1970.

INFORMATION TECHNOLOGY MANAGEMENT IN ENVIRONMENTAL STUDIES PROGRAMS: ENHANCING SUSTAINABILITY THROUGH DIGITAL INTEGRATION

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Abstract

Information technology (IT) management plays an increasingly important role in supporting environmental studies programs by improving data management, research efficiency, and sustainable decision-making. Environmental studies involve the collection, analysis, and interpretation of large volumes of environmental data, including climate patterns, biodiversity records, and pollution monitoring results. Effective IT management enables educational institutions and research centers to organize digital resources, integrate environmental databases, and utilize analytical tools that support environmental monitoring and policy development. Technologies such as geographic information systems (GIS), cloud computing, environmental data platforms, and decision-support systems help researchers and students analyze environmental trends and evaluate sustainable solutions. However, managing these technologies requires structured planning, proper data governance, cybersecurity measures, and efficient resource allocation to ensure reliability and accessibility. This paper discusses the role of IT management in strengthening environmental studies programs by integrating digital infrastructure, data management practices, and collaborative research platforms. It also highlights how effective IT governance can support environmental education, interdisciplinary research, and evidence-based environmental policy. By aligning IT management strategies with environmental sustainability goals, institutions can enhance research capability, improve learning outcomes, and support informed environmental decision-making.

Keywords: Information Technology Management, Environmental Studies, GIS, Environmental Data Management, Sustainable Development

A CONCEPTUAL FRAMEWORK FOR INTEGRATING ARTIFICIAL INTELLIGENCE INTO STRATEGIC MANAGEMENT PROCESSES

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Abstract:

The growing adoption of Artificial Intelligence is transforming organizational decision-making and strategic planning across industries. As business environments become increasingly complex and data-driven, organizations are seeking innovative approaches to enhance the effectiveness of their Strategic Management processes. This study proposes a conceptual framework for integrating AI into strategic management activities in order to improve strategic decision-making, operational efficiency, and organizational performance.

The paper examines how AI technologies—such as machine learning, predictive analytics, and intelligent decision-support systems—can support various stages of the strategic management process, including environmental scanning, strategy formulation, strategy implementation, and strategic evaluation. By synthesizing existing theoretical and empirical literature, the study identifies the key mechanisms through which AI can assist organizations in analyzing large datasets, identifying market trends, forecasting uncertainties, and optimizing resource allocation.

The proposed conceptual framework highlights the role of AI in enhancing strategic agility, innovation capability, and competitive advantage. It also discusses potential challenges related to AI integration, including technological infrastructure, data quality, ethical considerations, and organizational readiness. The framework provides guidance for managers and policymakers on how AI-driven tools can be effectively embedded into strategic management systems.

Overall, the study contributes to the emerging literature on AI-enabled management by offering a structured perspective on how organizations can leverage AI technologies to strengthen strategic processes and achieve sustainable growth in the digital era.

Keywords: Artificial Intelligence, Strategic Management, AI Integration, Strategic Decision-Making, Predictive Analytics, Organizational Performance

AN ADAPTIVE EWMA CONTROL CHART BASED ON CONWAY-MAXWELL-POISSON DISTRIBUTION FOR DISPERSED COUNT DATA WITH APPLICATIONS IN INDUSTRIAL PROCESSES

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Abstract

Count data in real-world applications often exhibit over- or under-dispersion, which limits the effectiveness of standard Poisson-based control charts. The Conway-Maxwell-Poisson (COM-Poisson) distribution offers a flexible alternative, but existing EWMA-type control charts based on COM-Poisson are less sensitive to unknown process shifts due to fixed smoothing parameters. This study proposes a COM-Poisson-based Adaptive EWMA (COMP-AEWMA) control chart that employs a continuous adaptive function to dynamically adjust the smoothing parameter, enhancing sensitivity to estimated shifts. The performance of the COMP-AEWMA chart is evaluated via Monte Carlo simulations under zero- and steady-state conditions across different dispersion levels, using metrics such as the mean, standard deviation, and percentiles of run length distributions. Results show that the COMP-AEWMA chart significantly improves the detection of small-to-moderate shifts while maintaining stability for larger shifts compared to conventional COM-Poisson EWMA charts. The method is further illustrated using real-world datasets from various industrial settings, demonstrating its practical applicability. The proposed COMP-AEWMA control chart provides a reliable and effective tool for monitoring dispersed count data, with potential applications in manufacturing, healthcare, and other process monitoring contexts.

Keywords: Adaptive Exponentially Weighted Moving Average Control Chart; Continuous Function; COM-Poisson Distribution; Dispersed Count Data; Monte Carlo Simulation.

MATRICARIA CHAMOMILLA L.: A REVIEW OF ETHNOMEDICINAL USE, PHYTOCHEMISTRY, AND PHARMACOLOGICAL POTENTIAL FOR VALORIZATION IN THE CENTRAL PLATEAU OF MOROCCO

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Abstract.

Matricaria chamomilla L., commonly known as chamomile, German chamomile, or Hungarian chamomile, is a well-known annual herb from the Asteraceae family, often called the "star among medicinal species." Widely distributed in Morocco, particularly in regions between Tangier, Ouezzane, Souk Larbaa, Moulay Bousselham, Azilah, Kenitra, Sidi Slimane, Khemisset, and Rabat, this plant holds significant potential for valorization in the Central Plateau region. This study aims to synthesize and capitalize on the available scientific knowledge regarding the ethnomedicinal uses, phytochemistry, and pharmacological properties of *M. chamomilla*, with a focus on its potential applications in the context of the Central Plateau of Morocco. Data were systematically gathered from published studies using scientific search engines including Web of Science, PubMed, ScienceDirect, Scopus, and Google Scholar. The synthesis reveals that *M. chamomilla* contains over 120 phytochemical constituents. Essential oils are predominantly composed of terpenoids, including α-bisabolol and its oxides A and B, bisabolone oxide A, chamazulene, and β-farnesene, while extracts are rich in phenolic compounds (phenolic acids, flavonoids, and coumarins). The therapeutic valorization of *M. chamomilla* lies in this richness of bioactive compounds, which confer demonstrated pharmacological activities: antioxidant, antibacterial (including against MRSA and multidrug-resistant *Pseudomonas aeruginosa*), antifungal (particularly against *Candida* and *Aspergillus* species), antiparasitic, insecticidal, anti-diabetic, anti-inflammatory, anticancer, analgesic, and neuroprotective effects. In Moroccan traditional medicine, the plant (locally known as "Babonj/Babounj") is prepared as infusion or decoction for treating diabetes, nervous disorders, diarrhea, angina, canker sore, abscess, infections, and painful menstruation. The socio-economic valorization of *M. chamomilla* on the Central Plateau, an important agricultural region, could involve optimizing cultivation practices, sustainable harvesting of flower heads, and appropriate drying techniques to standardize raw material quality. This would enable applications in the pharmaceutical, cosmetic, and agri-food industries, including natural food preservatives in dairy products and biscuits, and as a surfactant agent. This data capitalization establishes a knowledge base for sustainable post-harvest management and processing of this species, contributing to food security, local

economic development through high-value-added products, and the preservation of traditional medicinal knowledge.

Keywords: *Matricaria chamomilla*, Chamomile, Data Capitalization, Phytochemistry, Therapeutic Valorization, Essential Oil, Central Plateau of Morocco, Ethnomedicine

OCIMUM BASILICUM L.: A REVIEW OF ETHNOMEDICINAL USE, PHYTOCHEMISTRY, AND PHARMACOLOGICAL POTENTIAL FOR VALORIZATION IN THE CENTRAL PLATEAU OF MOROCCO

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Abstract.

Ocimum basilicum L., commonly known as sweet basil, is a herbaceous perennial plant belonging to the Lamiaceae family, universally cultivated and originated from the Asian continent. Widely used in cuisines worldwide, including Moroccan traditional medicine, this plant holds significant potential for valorization in the Central Plateau region. This study aims to synthesize and capitalize on the available scientific knowledge regarding the ethnomedicinal uses, phytochemistry, and pharmacological properties of *O. basilicum*, with a focus on its potential applications in the context of the Central Plateau of Morocco. Data were systematically gathered from published studies exploring the phytochemistry, pharmacology, and traditional uses of this species. The synthesis reveals that *Ocimum basilicum* is a significant source of bioactive compounds. Phytochemical analysis by GC-MS and HPLC techniques demonstrates the presence of approximately 20 major compounds, including monoterpenes (linalool, 1,8-cineole, limonene, camphor), phenylpropanoids (eugenol, methyl eugenol, estragole), sesquiterpenes (β-elemene, β-caryophyllene, farnesene, α-bisabolol), and phenolic compounds (chicoric acid, rosmarinic acid, anthocyanins). Linalool (52.42%), methyl eugenol (18.74%), and 1,8-cineole (5.61%) constitute the major compounds. The therapeutic valorization of *Ocimum basilicum* lies in this richness of bioactive compounds, which confer demonstrated pharmacological activities: antioxidant, antimicrobial (against bacteria including *E. coli* and *S. aureus*, and fungi including *Aspergillus flavus*), anti-inflammatory, anti-hyperlipidemic, anticonvulsant, antiplatelet, anti-thrombotic, immunomodulatory, insecticidal (larvicidal activity against *Culex tritaeniorhynchus*, *Aedes albopictus*, and *Anopheles subpictus* with LC_{50} values of 18.56-23.44 ppm), and cytotoxic effects against various cancer cell lines (HeLa, MCF-7, HEp-2, Ln-CaP) with IC_{50} values ranging from 30.33 to 270.3 µg/mL. In traditional medicine, *O. basilicum* has been used to treat headaches, coughs, diarrhea, kidney malfunctions, diabetes, cardiovascular disorders, pimples, insect stings, snake bites, and skin infections. The plant also demonstrates promising applications in effluent treatment, serving as a natural coagulant for textile wastewater and as a biosorbent for copper and chromium uptake due to its mucilaginous seeds. The socio-economic valorization of *Ocimum basilicum* on the Central Plateau, an important agricultural region, could involve

optimizing cultivation practices, sustainable harvesting of leaves and seeds, and appropriate extraction techniques to standardize raw material quality. This would enable applications in the pharmaceutical, cosmetic, and agri-food industries, including natural food preservatives, fragrances, flavors, and wastewater treatment agents. This data capitalization establishes a knowledge base for sustainable post-harvest management and processing of this species, contributing to food security, local economic development through high-value-added products, and the preservation of traditional medicinal knowledge.

Keywords: *Ocimum basilicum*, Sweet Basil, Data Capitalization, Phytochemistry, Therapeutic Valorization, Essential Oil, Linalool, Central Plateau of Morocco, Ethnomedicine

ARTS-BASED METHODS AND VISUAL EDUCATION FOR SUPPORTING ADULTS WITH AUTISM: THEORETICAL FOUNDATIONS AND EXPERIENCES

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ABSTRACT:

This study presents the theoretical background of visual education and various arts-based methods, alongside practical experiences and results observed in work with adults living with autism spectrum disorder.

The first section explores the concepts of education through art and education for art, touching upon the distinctions between visual arts pedagogy and arts psychotherapy.

The study then describes the characteristics of the drawing activities of individuals with autism, where repetitive, recurring motifs appear as a kind of stabilising, self-regulating structure.

For people with autism, visual support is a fundamental, essential, and decisive element of everyday life. Visible structure creates the predictability that is a prerequisite for emotional stability.

Finally, the study summarises the experiences of applying a visual arts–based pedagogical therapy developed by Éva Sándor in a residential care home group.

Preliminary research results show that providing structured frameworks, a “protective space”, the freedom of choice, and the possibility of creation without interpretation helps to establish inner peace, reduce internal tension, and support social connection.

Within the examined group, visual development facilitated through these sessions serves as an important tool in daily activities. It provides a foundation for self-expression, enhances self-awareness, and supports both verbal and non-verbal modes of expression, thereby enabling more nuanced emotional expression.

DEFECT-INDUCED ELECTRONIC STRUCTURE MODULATION IN CR-DOPED CUS NANOSTRUCTURES: EXPERIMENTAL AND COMSOL MULTIPHYSICS INVESTIGATION FOR ENERGY STORAGE APPLICATIONS WITH PERSPECTIVES TOWARD QUANTUM DEFECT ENGINEERING

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Abstract:

The increasing global demand for electrical energy and the rapid transition toward electric vehicles and renewable energy technologies require the development of efficient and environmentally sustainable energy storage systems. In this work, chromium-doped copper sulfide (Cr–CuS) nanostructures with varying dopant concentrations (5%, 10%, and 15%) were synthesized via a hydrothermal route to investigate the role of defect engineering in modulating their electronic and electrochemical properties. Structural, morphological, optical, and electrochemical characteristics were systematically examined using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), ultraviolet–visible spectroscopy (UV–Vis), cyclic voltammetry (CV), galvanostatic charge–discharge (GCD), and electrochemical impedance spectroscopy (EIS). XRD analysis confirmed the successful incorporation of Cr ions within the CuS lattice while maintaining structural stability, particularly for the 10% doped sample. Optical studies revealed a reduced bandgap of approximately 2.1 eV for this composition, suggesting enhanced electrical conductivity and improved charge transport properties. SEM micrographs further indicated the presence of porous surface features and open voids, which facilitate efficient electrolyte ion adsorption and diffusion during electrochemical processes. FTIR spectra verified the formation of the doped CuS structure through characteristic vibrational modes. Defect states introduced by chromium substitution were further analyzed through Urbach energy estimation from UV–Vis absorption spectra, indicating increased structural disorder and defect-induced electronic states within the band structure. Electrochemical measurements demonstrated superior performance for the 10% Cr-doped CuS electrode, achieving a maximum energy density of 29.2 Wh kg^{-1} with a corresponding power density of 284.10 W kg^{-1}. Charge storage mechanisms were evaluated using Dunn's power-law analysis to distinguish between surface-controlled capacitive behavior and diffusion-controlled battery-type contributions. Furthermore, numerical simulations performed using COMSOL Multiphysics were employed to model charge transport and ion diffusion processes, supporting the experimentally observed diffusion-dominant behavior in the optimized sample. The results highlight the importance of controlled defect engineering in

tuning the electronic structure and electrochemical response of CuS-based nanomaterials. These findings provide valuable insights for the design of advanced nanostructured materials for high-performance energy storage systems and may offer future perspectives for engineered quantum defect states relevant to emerging technologies in Quantum Computing.

Keywords: Chromium doping; Defect engineering ; Bandgap analysis; Dunn's method, Energy density and power density ; Quantum defect states; COMSOL Multiphysics simulation

"BELL PEPPERS AS FUNCTIONAL FOODS: ROLE OF CAROTENOIDS AND CAPSAICINOIDS IN ANTIOXIDANT AND METABOLIC HEALTH"

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Abstract

Bell peppers (*Capsicum annuum* L.) are among the most widely consumed vegetables worldwide and are valued not only for their sensory attributes but also for their substantial contribution to human nutrition and health. The green, yellow, and red varieties of bell peppers represent different stages of fruit development and ripening, which strongly influence their phytochemical composition, particularly the content and profile of carotenoids and capsaicinoid-related compounds. These bioactive constituents play a crucial role in mediating antioxidant, anti-inflammatory, metabolic, and disease-preventive effects.

Carotenoids are the principal pigments in bell peppers and include capsanthin, capsorubin, β-carotene, β-cryptoxanthin, lutein, and zeaxanthin. Their concentration increases progressively during ripening, with red bell peppers exhibiting the highest total carotenoid content, followed by yellow and green peppers. These compounds possess strong antioxidant properties, effectively scavenging reactive oxygen species and reducing oxidative stress, which is a central mechanism in the pathogenesis of chronic diseases such as cardiovascular disorders, type 2 diabetes, cancer, and neurodegenerative conditions. β-Carotene and β-cryptoxanthin function as provitamin A carotenoids, contributing to immune competence, epithelial integrity, and visual health, while lutein and zeaxanthin selectively accumulate in the macula of the eye, offering protection against age-related macular degeneration and visual impairment.

Although bell peppers are classified as non-pungent due to the absence or suppression of capsaicin biosynthesis, several studies have reported the presence of trace levels of capsaicinoids or non-pungent capsinoid analogues depending on genotype, cultivation conditions, and maturity stage. These compounds exert biological activity primarily through interaction with the transient receptor potential vanilloid 1 (TRPV1) receptor, influencing thermogenesis, lipid oxidation, glucose metabolism, and inflammatory signaling pathways. Experimental and clinical evidence suggests that capsaicinoids and capsinoids may support metabolic regulation, contribute to reduced adiposity, improve lipid profiles, and exert cardioprotective and anti-inflammatory effects, even at low dietary concentrations.

In addition to carotenoids and capsaicinoids, bell peppers are rich sources of vitamin C, phenolic acids, and flavonoids, which act synergistically to enhance overall antioxidant

capacity and bioavailability. The combined action of these phytochemicals strengthens cellular defense mechanisms, modulates immune responses, and mitigates chronic low-grade inflammation. Importantly, comparative analyses among green, yellow, and red bell peppers highlight the nutritional advantage of consuming peppers at different ripening stages, thereby maximizing the intake of diverse bioactive compounds.

In conclusion, the rich and variable composition of carotenoids and capsaicinoid-related compounds in bell peppers supports their classification as functional foods with significant health-promoting potential. Regular consumption of a variety of bell pepper colors may represent an effective dietary strategy for enhancing antioxidant defense, supporting metabolic and immune health, and reducing the risk of chronic disease. Further clinical and molecular studies are warranted to elucidate dose–response relationships and to optimize the utilization of bell peppers in functional nutrition and public health interventions.

Keywords: Bell peppers, *Capsicum annuum*, Carotenoids, Capsaicinoids; Antioxidant activity, Functional foods, Chronic disease prevention, Health benefits

AN INTEGRATED METHODOLOGICAL FRAMEWORK FOR ENSURING MARITIME NAVIGATION SAFETY AND PROTECTING THE MARINE ECOSYSTEM OF THE REPUBLIC OF KAZAKHSTAN

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Abstract:

With the rapid advancement of science and technology, strategies for preventing ship collisions have evolved from traditional mathematical approaches to modern integrated systems that incorporate elements of artificial intelligence, advanced algorithms, and real-time navigational data. These systems operate in accordance with the requirements of the International Regulations for Preventing Collisions at Sea (COLREGs-72) and consider complex operational conditions of maritime navigation. At the same time, contemporary navigation safety concepts increasingly emphasize environmental protection and the preservation of marine ecosystems. Ship collisions and emergency maneuvers pose significant risks not only to human life and property but also to the marine environment, potentially leading to oil spills, hazardous cargo releases, and ecological degradation. Therefore, the development of intelligent decision-support systems for collision avoidance contributes not only to navigational safety but also to minimizing environmental risks and supporting sustainable maritime transport. The integration of digital navigation technologies, automated monitoring systems, and environmentally oriented risk-assessment models represents an important step toward ensuring safe, efficient, and environmentally responsible maritime operations.

Keywords: methods mathematical models, on artificial intelligence.

ENVIRONMENTALLY-ORIENTED METHODS FOR PROTECTING TELECOMMUNICATION EQUIPMENT OF 4G SYSTEMS IN THE KURYK SEAPORT OF THE REPUBLIC OF KAZAKHSTAN, ENSURING OPERATIONAL RELIABILITY AND MINIMIZING ECOLOGICAL IMPACT

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Abstract:

The rapid development of digital communication systems has made the protection of telecommunication equipment in critical maritime infrastructure a priority. This study focuses on methods for safeguarding 4G systems at the Kuryk Seaport of the Republic of Kazakhstan, emphasizing both operational reliability and environmental sustainability. Port telecommunication equipment is exposed to harsh maritime conditions, electromagnetic interference, and potential human-induced hazards, all of which can impact system performance. In addition, improper maintenance, accidental damage, or system failures may indirectly affect the surrounding marine and coastal environment, including water quality and local ecosystems. By integrating advanced protective technologies, real-time monitoring systems, and environmentally conscious design principles, the proposed methods aim to enhance system resilience while minimizing ecological risks. This approach not only ensures uninterrupted port communications but also aligns with sustainable maritime operations, contributing to the long-term preservation of the Caspian Sea ecosystem.

Keywords: 4G systems, telecommunication protection, Kuryk Seaport, environmental safety

PREDICTING CLIMATE-DRIVEN SHIFTS IN SWEET CHERRY (*PRUNUS AVIUM* L.) SUITABLE HABITATS IN THE FES-MEKNES REGION OF MOROCCO USING MAXENT

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Abstract

Sweet cherry (Prunus avium L.) is an economically important fruit crop in the Fes-Meknes region of Morocco, where its productivity strongly depends on winter chilling accumulation. Ongoing climate warming, particularly milder winter temperatures, threatens the sustainability of sweet cherry cultivation in mountainous agroecosystems. This study aims to assess the current and future suitability of sweet cherry habitats in the Fes-Meknes region using species distribution modeling and geographic information systems. Habitat suitability was modeled using the MaxEnt algorithm based on verified occurrence data and a set of independent bioclimatic predictors selected through Pearson correlation and variance inflation factor (VIF) analyses. Climatic variables and elevation were integrated to characterize the ecological niche of the species. The model demonstrated high predictive accuracy (AUC = 0.959). The most influential predictors included the minimum temperature of the coldest month (BIO6), maximum temperature of the warmest month (BIO5), precipitation variables (BIO14 and BIO19), and altitude. Suitable habitats were mainly concentrated in mountainous areas such as Ifrane, Azrou, Aïn Leuh, and Sefrou. Future projections for 2041–2060 under SSP2-4.5 and SSP5-8.5 scenarios indicate a contraction of suitable habitats, particularly below 1200 m, while higher elevations may act as climatic refugia. These findings provide valuable insights for climate adaptation strategies, agroecological zoning, and sustainable orchard management.

Keywords : Prunus avium; MaxEnt ; Climate Change ; Habitat Suitability; Fes-Meknes Region.

GEL-POLYMER ELECTROLYTES MADE FROM POLYACRYLONITRILE, DESIGNED FOR SODIUM-ION BATTERIES

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Abstract: In recent years, research and development on sodium-ion batteries has gained significant momentum. Unlike lithium-based batteries, sodium-based batteries are expected to be more cost-effective, since sodium is widely available in the earth's crust and even in seawater.

In this study, we prepared and examined polyacrylonitrile (PAN)-based gel-polymer electrolytes using NaClO4 as the salt, dissolved in a mixture of ethylene carbonate (EC) and propylene carbonate (PC). By carefully adjusting the weight ratios of polymer, salt, and solvents, we achieved an optimal ionic conductivity of 4.9 Ms cm-1 at room temperature for the composition 11PAN-12NaCl O4-40EC-37PC (wt. %), which is very promising for practical applications. This conductivity level is on par with other sodium-ion conducting gel-polymer electrolytes reported recently.

The ionic conductivity versus inverse temperature followed Arrhenius behaviour, with only minor differences in activation energy across samples, suggesting that a single conduction mechanism governed by the EC/PC co-solvent system controls ion transport.

Thermogravimetric analysis (TGA) confirmed that these electrolytes are thermally stable, showing no significant weight loss up to 100 0 C, making them suitable for operation at elevated temperatures.

GLOBAL RESEARCH TRENDS ON MOROCCAN MEDİCİNAL PLANTS: A BİBLİOMETRİC AND SCİENCE MAPPİNG ANALYSİS (2000–2025)

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Abstract

Morocco is recognized as one of the richest regions in the Mediterranean basin in terms of biodiversity of medicinal and aromatic plants. These plants have long been used in traditional medicine and represent an important source of bioactive compounds with potential pharmaceutical and nutraceutical applications. In recent years, scientific interest in Moroccan medicinal plants has grown considerably due to their pharmacological potential and their relevance in natural product research. In this context, bibliometric analysis provides an effective quantitative approach to evaluate scientific productivity, collaboration patterns, and thematic evolution within a research field.

This study aimed to analyze global scientific production related to Moroccan medicinal plants and to identify major research trends, leading authors, institutions, and emerging scientific themes. Bibliographic data corresponding to publications indexed between 2000 and 2025 were collected and analyzed using bibliometric tools. Key indicators such as annual scientific production, authorship patterns, institutional productivity, and international collaboration were examined. In addition, keyword co-occurrence analysis and science mapping techniques were performed using bibliometric visualization software to identify major thematic clusters and research directions.

A total of 1,219 documents published in 466 scientific sources were identified. The results show a significant increase in scientific production over time, particularly during the last decade, with the highest number of publications recorded in 2024. The research field is largely dominated by original research articles and characterized by strong collaborative networks among researchers. Moroccan universities play a central role in this scientific production, with institutions such as Sidi Mohamed Ben Abdellah University, Ibn Tofail University, and

Mohammed V University among the most productive contributors. Thematic analysis of keywords revealed that the main research areas focus on ethnobotany, phytochemical characterization, antioxidant and antimicrobial activities, and essential oils. The collaboration network also indicates increasing international partnerships, particularly with European and Asian research institutions.

Overall, the results highlight the rapid expansion and growing internationalization of research on Moroccan medicinal plants. These findings underline the importance of further investigations aimed at pharmacological validation, clinical studies, and sustainable valorization of Morocco's rich medicinal plant biodiversity.

Keywords: Moroccan medicinal plants; bibliometric analysis; ethnobotany; phytochemistry; research trends; natural products.

ENERGY-EFFİCİENT CAPACİTİVE DEİONİZATİON DESALİNATİON USİNG A PULSED RESONANCE CONTROL STRATEGY

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Abstract

Conventional capacitive deionisation (CDI), operating at constant voltage (CV) or constant current (CC), often requires a compromise between salt extraction rate and energy efficiency. Recent work has shown that a sinusoidal signal at a specific resonance frequency can balance these parameters. This article proposes a new control strategy using a hybrid signal (a combination of optimised sinusoidal and impulse modes). By exploiting Fourier decomposition and the impulse response of the system, we demonstrate that this hybrid signal minimises losses associated with higher Fourier modes while maximising the average reduction in concentration (thus surpassing the pure sinusoidal signal.

The application of the hybrid signal should enable: an increase in by perfectly aligning the phase of the concentration with that of the drive voltage, simulating a permanent state of resonance, and a reduction in consumption by eliminating high-frequency harmonics that resalinize the treated water before extraction (poor flow efficiency), which translates into greater stability in the management of faradic losses compared to pure current force.

The optimisation of the hybrid signal acts on the dynamics of the macroscopic system by coupling the time constant and the hydraulic residence time inside the cell so that they exit the flow at the moment

Keywords: CDI, Résonance,Désalinisation , Hybrid Signal Control

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