Book of Abstracts

THE EXPLORATORY WORKSHOP

"INNOVATIVE CROSS-SECTORAL TECHNOLOGIES"

VIIth edition, 22-23 May 2025

Organized by INCDCP – ICECHIM,
with the recognition of the European Chemical Society (EuChemS)

Partner: Romanian Chemical Society

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Book of Abstracts comprising scientific contributions presented at the

Exploratory Workshop *NeXT-Chem: Innovative Cross-Sectoral Technologies*

22-23 May 2025

National Institute for Research & Development
in Chemisty and Petrochemistry - ICECHIM Bucharest

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Event held under the auspices of the International Year of Quantum Science and Technology

NeXT-Chem VII embraces the transformative potential of quantum science and technology as a frontier in cross-sectoral innovation. This edition of the workshop explores how quantum approaches intersect with advanced chemistry, nanomaterials, and molecular engineering—fields at the core of the event's scientific agenda. By featuring discussions on quantum-enabled sensing, simulation, and materials design, the workshop celebrates the growing role of quantum technologies in shaping sustainable solutions and next-generation processes. Through this interdisciplinary dialogue, NeXT-Chem VII positions itself as a platform that fosters awareness, collaboration, and innovation at the interface between chemistry and the quantum revolution.

The organizers

Partner:

Societatea de Chimie din ROMANIA

The Romanian Chemical Society (SChR), a long-standing partner of scientific events organized by the National Institute for Research & Development in Chemistry and Petrochemistry – ICECHIM Bucharest, and a proud member of EuChemS, brings together professionals with a background in higher education working in research, education, industry, and other sectors relevant to chemistry and society.

Its goals include promoting chemistry in all its aspects and organizing scientific events such as communication sessions, symposia, seminars, workshops, conferences, and congresses, both nationally and internationally.

SChR has been organizing annual scientific events for both early-career and established chemists, and publishing materials of interest to the chemistry community since 1992. Noteworthy is the initiative to compile the "Chemical Bibliography in Romania", which records all original works published nationally, complete with accurate references. Additionally, significant scientific results have been published in the "Bulletin of Pure and Applied Chemistry", in international languages.

The Romanian Chemical Society is strongly committed to supporting not only established researchers but also young scientists at the beginning of their careers. It does so by offering awards for outstanding contributions during the scientific events it co-organizes and supports.

For more information, please visit www.schr.ro or contact the Romanian Chemical Society at:

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Foreword

The VIIth edition of the **Exploratory Workshop *NeXT-Chem: Innovative Cross-Sectoral Technologies***, held on 22–23 May 2025 at the headquarters of the National Institute for Research and Development in Chemistry and Petrochemistry – ICECHIM Bucharest, marked another important step in the institute's continuous efforts to foster excellence in research and innovation. Organized as part of the events celebrating ICECHIM's 75th anniversary, this edition carried special significance, reflecting both the Institute's legacy and its forward-looking vision.

Dedicated especially to master's and PhD students, as well as early-career researchers, NeXT-Chem VII offered a platform for young scientists to present their work, exchange ideas, and engage in cross-sectoral dialogue. By adopting a hybrid format, the workshop welcomed participants from across Romania and abroad, ensuring broader accessibility and encouraging international collaboration.

This year, 27 young researchers from cities including Bucharest, Pitești, Bacău, and Timișoara – as well as from Kazakhstan, India, and Germany – contributed presentations aligned with national priorities outlined in the National Plan for Research, Development and Innovation and the National Strategy for Research, Innovation and Smart Specialization (2022–2027).

The workshop featured 35 submitted papers, enhanced by invited lectures delivered by established experts in chemical engineering, physical sciences, and agricultural research, offering participants valuable insights into current challenges and emerging directions in applied science.

We are confident that the knowledge shared and the connections made during this event will contribute to shaping the future of research, while inspiring the next generation of innovators.

Invited lectures

AGROECOLOGY LIVING LABS: INNOVATIVE TOOLS FOR CLIMATE-NEUTRAL AND RESILIENT AGRICULTURE

VERTICAL FARMING AS A DRIVER OF SOCIAL INNOVATION WITHIN THE GREEN BIOECONOMY: EDUCATIONAL PATHWAYS AND APPLIED EXPERIENCES

MULTIFUNCTIONAL MATERIALS WITH BIOMEDICAL AND ENVIRONMENTAL APPLICATIONS

SHORT JOURNEY INTO THE HYDROGEN WORLD

CHEMISTRY FROM THE PAST

STORYTELLING AND PERSONAL BRADINING IN SCIENCE. TIPS & TRICKS

EUCHEMS & SChR

CHEMISTRY FROM THE PAST

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Keywords: chemistry; ancient technologies; pigments; medicine; traditional materials; fermentation; extraction

Before the word "science" was ever spoken, human curiosity and observation led to the discovery of countless chemical processes—often unknowingly. From prehistoric fire-making and pigment creation to fermentation, and medieval alchemy, our ancestors applied what we now understand as chemistry to shape tools, preserve food, craft medicines, and manipulate materials. This paper explores the evolution of chemistry through the lens of history, highlighting how early civilizations experimented with natural substances, developed techniques like distillation and extraction, and used both practical and mystical approaches to interact with the material world. By retracing these ancient innovations— using traditional medicine, or even the use of poisons in royal courts, , and the creation of dyes—we uncover the hidden laboratory of humanity's past. Through visual storytelling, historical case studies, this session brings to light the foundational role of chemistry in cultural and technological development long before it became a formal science.

STORYTELLING AND PERSONAL BRANDING IN SCIENCE. TIPS & TRICKS

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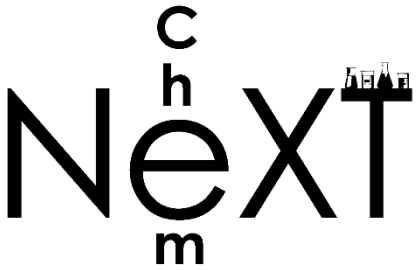
Keywords: digital storytelling; personal branding; online platforms; identity; audience

There is no ideal formula for success regarding scientist's public image. However, the public image defines his identity, both offline and online. In order to highlight their results as effectively as possible in the scientific community, researchers must identify the factors that hinder the creation of a narrative with which to build their presentations and posts on online platforms. Once difficulties have been overcome, scientists can move on to simple ideas that are appreciated by the public and helpful in the given context. Following steps, such as developing the idea, planning the whole offline/online story, outlining it, building a storyboard and using proper editing tools, leads to an excellent personal brand. The review is very important as well, as a final step. Also, it is highly recommended to follow rules in presentations, about the number of used elements, colors, fonts, writing style.

Section 1 - Multifunctional materials, nanocomposites, innovative technologies and cultural heritage preservation



DEVELOPMENT OF ADVANCED CATALYSTS FOR WASTEWATER TREATMENT

FRIENDLY ENVIRONMENTAL APPLICATIONS OF POLYMER-BASED COMPOSITES FOR WATER TREATMENTS

NEW POLYSACCHARIDE-BASED FORMULATIONS WITH APPLICATIONS IN BIOMEDICINE

DESIGN STRATEGIES IN DEVELOPING NOVEL MATERIALS FOR ENERGY INDUSTRY

EFFECTS OF MAGNETIZED WATER ON PLANT GROWTH AND WATER QUALITY: AN EXPERIMENTAL STUDY

ELECTROCHEMICAL SYNTHESIS OF GRAPHENE FROM ACTIVATED CARBON FOR OIL SPILL MANAGEMENT

RECYCLING OF PLASTIC WASTES. USE OF PLASTIC BRICKS

HAP-MAGNETITE: A NEW OPPORTUNITY FOR IMPROVING WATER QUALITY

THERAPEUTIC APPLICATION OF KHEWRA HIMALAYAN SALT IN TREATING CHRONIC RESPIRATORY ILLNESSES: A PROPOSAL FOR THE COUNTRIES OF CENTRAL ASIA

THEORETICAL STUDY OF THE EFFECTIVENESS OF TERT-AMYL METHYL ETHER AND ETHYNYLCYCLOPENTANOL IN INCREASING THE OCTANE NUMBER OF GASOLINE

ENANTIOANALYSIS OF OCHRATOXINE A IN FOOD SAMPLES

ENANTIOANALYSIS OF DEOXYNIVALENOL IN URINE SAMPLES

2D DISPOSABLE STOCHASTIC SENSOR FOR THE ENANTIOANALYSIS OF LYSINE IN LUNG CANCER

DEVELOPING NEW MATERIALS WITH ENHANCED PROPERTIES FOR Li – ION BATTERIES

ION-MODIFIED MESOPOROUS NANOMATERIALS FOR ENHANCED BONE TISSUE REGENERATION

A DISPOSABLE SCREEN-PRINTED ELECTRODE FOR GLUTAMINE ENANTIOANALYSIS IN BIOLOGICAL SAMPLES

ULTRAFAST AND ULTRASENSITIVE SIMULTANEOUS MOLECULAR RECOGNITION AND QUANTIFICATION OF CA12-5, CA72-4, HER1, AND AFP IN BIOLOGICAL SAMPLES

ELECTROCHEMICAL SENSING OF QUERCETIN FROM MEDICINAL PLANTS USING A STOCHASTIC SENSOR

GREEN ELECTROCHEMICAL SENSOR FOR DETERMINATION OF BETAMETHASONE IN SEMI-SOLID PHARMACEUTICAL FORMULATIONS

MULTIFUNCTIONAL HYDROGELS FOR WOUND HEALING: A COMPARATIVE STUDY OF DOPAMINE AND SERICIN AS CELL-ADHESIVE COMPONENTS

EFFICIENT ADSORPTION OF ACID RED 66 DYE ON A TWO COMPONENTS HYDROGEL

EXPLORING THE STRUCTURE AND PROPERTIES OF CUENHANCED HEA COATINGS DEPOSITED BY DC MAGNETRON SPUTTERING

FABRICATION OF RE-ZrO_2 BASED MULTILAYER COATINGS VIA EB-PVD FOR HIGH-TEMPERATURE APPLICATIONS

ASSESSMENT OF GRANITE WEATHERING UNDER ACCELERATED SALT CRYSTALIZATION CYCLES

SILVER-ENHANCED LAYERED DOUBLE HYDROXIDES: A POTENTIAL CATALYST FOR METHYLENE BLUE DEGRADATION

ENANTIOSELECTIVE DETERMINATION OF CYSTEINE IN WHOLE BLOOD SAMPLES USING A NOVEL 2D ELECTROCHEMICAL SENSOR

A NOVEL STOCHASTIC PLATFORM FOR THE SIMULTANEOUS DETERMINATION OF FUSIDIC ACID AND BETAMETHASONE IN REAL SAMPLES

MORPHOLOGICAL EFFECTS ON IONIC CONDUCTIVITY IN SOLID POLYMER NANOCOMPOSITE ELECTROLYTES

IMPACT OF VARIOUS BIOGLASS COMPOSITIONS ON THE DEVELOPMENT OF TRICALCIUM PHOSPHATE-BASED SCAFFOLDS

DEVELOPMENT OF ADVANCED CATALYSTS FOR WASTEWATER TREATMENT

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Keywords: emerging pollutants; photocatalysis; Ag-modified zeolites; Fe-doped TiO2; caffeine degradation

Introduction: The presence of emerging pollutants in water bodies is a relatively new environmental concern. Emerging pollutants involve various chemical substances such as pharmaceuticals, disinfection byproducts, gasoline additives, and man-made nanomaterials. One of the major problems is the increased inefficiency of conventional treatments in Municipal Wastewater Treatment Facilities (MWTF).

Materials and methods: In the present work, catalytic and photocatalytic processes were applied to caffeine aqueous solutions. Ag-modified zeolites and Fe-doped TiO_2 catalysts were synthesized. Ag-modified zeolites were studied using XRD, TEM, and SEM analysis. The catalytic and photocatalytic efficiency of all the catalysts was examined using pH measurements, Total Carbon (TC) analysis, and High-Performance Liquid Chromatography (HPLC). Each experiment lasted for 150 minutes, and samples were taken every 30 minutes for analysis. For Ag-modified zeolites, ultraviolet light with 254 nm was used, while for Fe-doped TiO_2 catalysts, a 365 nm UV lamp was used. The concentration of caffeine was 30 ppm, and the volume of the photocatalytic reactor was 500 ml.

Results: The first part of the work examined the catalytic and photocatalytic efficiency of Ag-modified zeolites. The application of ultraviolet light without catalysts resulted in only 5% caffeine removal, indicating high resistance to UV light. Overall caffeine removal using Ag-modified zeolites was low (15–20%). In the adsorption process, the highest removal was achieved using Ag_2O_NZU catalyst, while in the photocatalytic process, Ag_2O_NZU showed the best performance. These results illustrate the complexity of the caffeine structure and the formation of intermediate compounds. The second part of the work focused on the photocatalytic activity of Fe-doped TiO_2 catalysts with different iron concentrations (0.5%, 1%, 2%, 4%). Their efficiency was compared with a commercial TiO_2 (Degussa P-25) catalyst. All catalysts achieved successful mineralization of caffeine. However, TC removal was lower than that observed with TiO_2. The results confirmed the presence of intermediates and incomplete degradation of the caffeine molecule to carbon dioxide.

Conclusion: This study highlights the challenges in removing emerging pollutants such as caffeine from aqueous solutions using photocatalytic and catalytic methods. While some catalysts showed improved performance, the overall removal efficiency was limited, and intermediate compounds remained. Further optimization of catalyst composition and treatment conditions is necessary for improved degradation efficiency.

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FRIENDLY ENVIRONMENTAL APPLICATIONS OF POLYMER-BASED COMPOSITES FOR WATER TREATMENTS

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Keywords: water purification; polymer composites; dye decomposition

Introduction: A massive directive at the level of global politics is represented by the actual concerns regarding ecological treatments for water purification. Recent advances in green chemistry show an increased tendency for innovative methods of using polymeric composites in chemical removal (heavy metals, drugs, antibiotics, dyes, solvents, etc.). Biopolymers represent a healthy and friendly alternative for wastewater treatments, because of the low costs and efficiency in developing various materials: nanocomposites, fibrils, microspheres, films, gels or hybrid materials. Shaping chitosan (CS) in the present study leads to interesting and original perspectives on water technology, especially for dye removal (methyl red, naphthol green B, indigo carmine) mediated by enzyme immobilization onto polymeric supports [1,2].

Materials and methods: Obtaining material supports consists in using high-concentrated stock solutions of CS (LMW and HMW, 3% w/v) with 3% of polyacrylic acid (PAA) as crosslinker, combining and mixing it under magnetic stirring, adjusted with a few drops of HCl to create homogenous environments, left overnight, precipitated in a coagulation bath, gently washed, purified and kept for further investigation such as kinetics, morphology analysis, viscoelastic behavior and molecular docking.

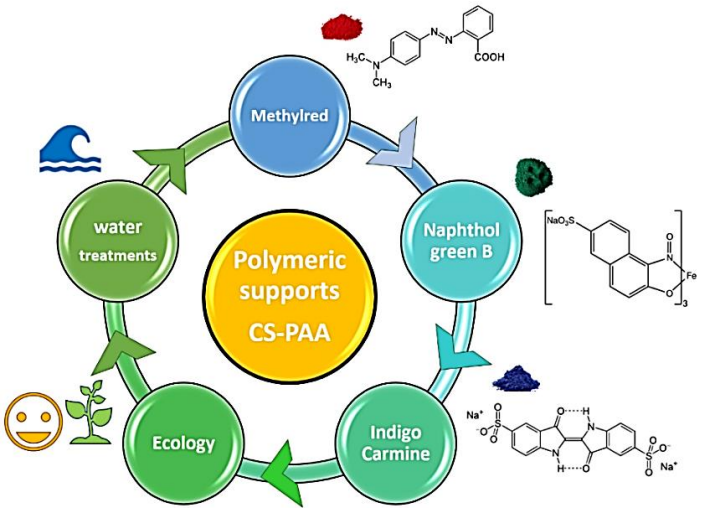

Figure 1. Applications of CS-PAA microspheres

Results: PAA modulated the supports and immobilized enzyme properties, which improved the kinetic profile of *Laccase* in dye degradation with a major impact on harmful chemicals extinction.

Conclusions: Based on different mass ratios, CS-PAA microspheres were obtained, characterized and further investigated as friendly supports for *Laccase* immobilization with applications in water treatments.

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NEW POLYSACCHARIDE-BASED FORMULATIONS WITH APPLICATIONS IN BIOMEDICINE

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Keywords: nanocellulose; polysaccharide; thermogravimetric analysis; scanning electron microscopy

Introduction: Cellulose, a material with a long history, once deemed unlikely to offer further breakthroughs for science or industry, underwent a revival in the mid-90s in its nanoscale form, commonly referred to as "nanocellulose" (NC), when proven effective as reinforcing agent for polymer matrices[1]. Since then, the attractive characteristics of NC including its biodegradability, biocompatibility, bio-based origin, inexpensiveness, high surface area, high mechanical strength, and richness in reactive hydroxyl (-OH) groups that openend many possibilities for chemical and physical modifications, have propelled NC as a building block for applications in a wide range of fields. However, a major limitation of NC is the lack of intrinsic antibacterial activity[2], which restricts its use in fields such as biomedicine or food packaging. Therefore, NC is frequently combined with other polymers possessing antibacterial properties (*e.g.* chitosan, gelatin, etc.[3]), impregnated with natural or synthetic antibacterial agents, decorated with metal or metal oxide nanoparticles, or chemically modified at the surface to endow it with antibacterial activity[2]. In this work, we aimed to develop new formulations based on NC and fucoidan (F), a sulfated polysaccharide extracted mainly from brown algae, with documented antibacterial, antiviral, antioxidant, anti-inflammatory, anti-tumor, anti-coagulant, anti-thrombotic, and immunoregulatory properties[4]. The obtained compositions have potential applications as antibacterial materials in orthodontic engineering.

Materials and methods: NC was obtained from microcrystalline cellulose by mechanical fibrillation in a microfluidizer and then modified by silanization with an amino functional alkoxysilane. Compositions based on silanized NC and F were obtained by the simple mixing of the two components in different ratios in the absence or in the presence of a natural crosslinking agent. The resulting materials were analyzed by Fourier-transform infrared spectroscopy (FTIR), dynamic light scattering, thermogravimetric analysis (TGA), rheometry, scanning electron microscopy (SEM), and atomic force microscopy.

Results: The FTIR analysis confirmed the presence of characteristic absorption bands corresponding to both polysaccharides, while the thermogravimetric analysis and rheological measurements showed the effect of the ratio between the two polysaccharides on the thermal stability and rheological behavior of the products. The SEM images showed the distribution of the two component polysaccharides in the final materials, in the presence or absence of the crosslinking agent.

Conclusions: The novel formulations developed in this study are entirely bio-based, easy to obtain, inexpensive and may constitute promising antibacterial materials for orthodontic engineering.

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DESIGN STRATEGIES IN DEVELOPING NOVEL MATERIALS FOR ENERGY INDUSTRY

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Keywords: energy; improved performance; complex concentrated alloys; modeling; technology

Introduction: With the continuous advancement of technology, the global community concurrently faces the pressing challenge of climate change, thereby necessitating the identification and development of sustainable energy alternatives. Among these, hydrogen emerges as a promising energy carrier due to its high versatility and zero carbon emissions. However, the efficient and safe storage of hydrogen remains a significant barrier to its widespread implementation. For efficient hydrogen storage systems are required materials that exhibit specific physicochemical properties. The selection of an appropriate storage technology is influenced by application-specific parameters, including volumetric capacity, system weight and economic feasibility. Complex concentrated alloys (CCAs) represent a novel class of materials characterized by multiple principal elements in varied atomic proportions and have recently attracted considerable attention for hydrogen storage applications. Owing to their high configurational entropy, CCAs tend to form stable, single-phase solid solutions, which may exhibit favorable hydrogen absorption and desorption characteristics. The composition and stoichiometric ratios of constituent elements play a pivotal role in determining the structural, thermodynamic and kinetic properties associated with hydrogen storage capacity and reversibility.

Materials and methods: This study focuses on the development and preliminary evaluation of a new complex concentrated alloy (CCA) with potential for hydrogen storage. The alloy design process was guided by thermodynamic criteria and computational modeling. Specifically, the CALPHAD (CALculation of PHAse Diagrams) method was employed to predict phase stability and identify suitable compositional ranges.

Results: The modeling results indicated that specific elemental combinations and compositional ranges favor the formation of single-phase solid solutions with high mixing entropy. These configurations are expected to provide improved hydrogen sorption properties. Preliminary calculations support the feasibility of tuning CCA compositions to achieve desirable thermodynamic stability and hydrogen storage capacity.

Conclusions: This preliminary investigation underscores the promise of complex concentrated alloys as viable candidates for hydrogen storage. The use of thermodynamic modeling offers a powerful framework for the rational design and optimization of CCA compositions. Future work will involve experimental synthesis and characterization to validate the predicted properties and to further assess hydrogen storage performance in real-world conditions.

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EFFECTS OF MAGNETIZED WATER ON PLANT GROWTH AND WATER QUALITY: AN EXPERIMENTAL STUDY

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Keywords: magnetized water; plant growth; water quality; root development; agricultural innovation

Introduction: Plants play a critical role in oxygen production and ecological balance, yet their growth can be hindered by impurities in tap water. Magnetized water is proposed as a means to improve plant development by enhancing water properties that may boost fluidity and nutrient absorption. This study aims to evaluate the effects of magnetized water on plant growth, particularly its impact on the growth rate and robustness of plants. The research compares the growth outcomes of plants irrigated with magnetized versus regular water. To collect and analyze information on magnetic fields, investigate the properties of water influenced by magnetic fields, monitor the impact of magnetized water on plant growth, and draw conclusions based on experimental results.

Materials and methods: The methodology encompasses experimental observations, data analysis, and a comprehensive review of relevant literature. Plants were observed under conditions using both magnetized and non-magnetized water[1], with specific attention to growth rates, root development, and overall health. Additionally, the properties of magnetic fields, such as their influence on charged particles, were examined for their potential biological applications.

Results: Preliminary observations suggest that onions grown with magnetized water exhibit a faster growth rate and improved root establishment compared to those watered with non-magnetized water[2]. Magnetized water showed reduced sediment formation and was effective in enhancing nutrient uptake without chemical additives. Additional benefits noted include improved water quality and potential positive effects on human health, as magnetized water is reported to aid in detoxification and alleviate various health issues.

Conclusion: The study supports the hypothesis that magnetized water positively influences plant growth and suggests practical applications for household and educational settings to boost plant development. The findings recommend using magnetized water for irrigation to enhance plant growth and for various health and domestic applications[3], including water treatment for appliances and personal care. Further research could explore the long-term effects and scalability of magnetized water use in agriculture[4].

***Acknowledgements**: Nazarbayev Intellectual School of Chemistry and Biology in Atyrau, Kazakhstan.*

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ELECTROCHEMICAL SYNTHESIS OF GRAPHENE FROM ACTIVATED CARBON FOR OIL SPILL MANAGEMENT

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Keywords: electrochemical exfoliation; environmental remediation; green technology; sorbent material; active carbon

Introduction: Graphene is a highly valued nanomaterial due to its exceptional mechanical, thermal, and electrical properties. However, conventional synthesis methods often involve high temperatures, hazardous chemicals, and expensive equipment, making them inaccessible for small-scale and eco-friendly applications[1]. This study aims to develop a simple, low-cost, and sustainable method for synthesizing graphene from activated carbon via electrochemical exfoliation in a sulfate-based electrolyte. The resulting graphene is intended for use in cleaning oil-contaminated water bodies[2], with a focus on the Caspian Sea.

Materials and methods: The electrochemical exfoliation process was carried out using a solution of Na_2SO_4 and H_2SO_4 under standard laboratory conditions. Activated carbon was used as the primary electrode material. The reaction produced a black precipitate, which was collected and analyzed under a microscope to identify graphene-like flakes[3] and assess structural differences from the original carbon material.

Results: Microscopic analysis revealed thin, flake-like structures indicative of graphene formation. The synthesized material exhibited distinct textural and optical characteristics compared to untreated carbon. This method eliminated the need for thermal treatment or chemical reduction, offering a safer and more scalable approach for graphene production[4].

Conclusion: The study demonstrates the feasibility of producing graphene-like materials from activated carbon through electrochemical exfoliation in sulfate solution. This method holds promise for environmental remediation technologies, particularly in oil spill management. Future research will focus on optimizing synthesis parameters[5] and evaluating the graphene's sorbent efficiency in real-world applications.

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RECYCLING OF PLASTIC WASTES. USE OF PLASTIC BRICKS

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Keywords: additive and condensation polymers; plastic waste; recycling; environment; biodegradation

Introduction: Research objective: Investigation of the physical and chemical properties of additive and condensation polymer to create an economical building material - plastic brick. The new material is based on small crushed stone, sand and plastic containers with a volume of 0.5 - 5 liters. Plastic waste currently poses a threat to the environment. One of the best solutions to the problem of excessive plastic waste is the recycling of plastic materials and the subsequent use of the resulting product. The project is both economically and environmentally beneficial. Plastic bricks were created using plastic bottles with volumes ranging from 0.5 L to 5 L, fine gravel, and sand. The plastic brick is a multifunctional composite material that can be used as a base for an unlimited number of structures, tools, and platforms. Plastic bricks are made using PET polymer (typically from drinking bottles) and sand, at a temperature above 250°C but below 360°C. For easier melting, plastic is cut using a hydraulic device operated manually. The environmental durability of the plastic brick was confirmed through experiments simulating exposure to acidic and alkaline environments, temperature fluctuations, and weak acid solutions (imitating acid rain). The results demonstrated the brick's strong resistance under such conditions.

Materials and methods:
1) Preparation of raw materials from plastic bottles (volumes of 0.5–5 liters), fine gravel, and sand; firing in a kiln (using charcoal); mixing containers; metal stirrer; molds for the product made from medical-grade gypsum.
2) Production of the plastic brick: preparation of weight proportions of the plastic brick components, shaping the plastic brick, determining the setting time of the mixture parts.
3) Testing the plastic brick for physical characteristics: strength; impact of ambient temperature changes; exposure to a weak acidic solution (to simulate acid rain); exposure to a weak alkaline solution (to simulate the effect of alkaline compounds); water absorption.
Creation of several versions of plastic bricks with different composition ratios, identification of the most effective plastic brick formulation, production of the plastic brick through component heating, economic calculations.

Results: The production of the first plastic brick (Plastic Brick №1) took 24 hours, with subsequent attempts, the production time decreased to 10 hours, and eventually to just 2 hours. In the production laboratory of the National Chamber of Entrepreneurs of the Republic of Kazakhstan "Atameken" in Atyrau, in partnership with "NOVA LLP," tests were conducted to assess the plastic brick's resistance to high loads and pressure. The results showed the brick could withstand a load of up to 110 kN (equivalent to 11,216.88 kg) and pressure of 10.45 MPa (equivalent to 103.13 atm). The tests were conducted at a temperature of 24.4°C and air humidity of 74%. Plastic products made from PET (polyethylene terephthalate) are more accessible and better suited for creating the new material—plastic brick—because PET only changes its properties at temperatures above 75°C or below –40°C. This means that once it is melted and formed into a plastic brick, it will not be affected by environmental thermal factors and will not degrade.

Conclusions: As a result, a new chemical material—plastic brick—was created using accessible raw materials, along with several experimental variations of plastic bricks. During the analysis of each sample, the mass ratio of the components was adjusted. This project offers a practical solution to the problem of excessive plastic waste by recycling it into a useful material for human needs. We are contributing to the practical implementation of the United Nations Sustainable Development Goals, aimed at improving well-being and protecting our planet from plastic pollution.

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HAP-MAGNETITE: A NEW OPPORTUNITY FOR IMPROVING WATER QUALITY

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Keywords: hydroxyapatite; nanotechnology; egg shell; water purification; heavy metals

Introduction: Access to clean water is essential for human health and environmental sustainability. However, water pollution by heavy metals and other contaminants remains a pressing global issue, especially in developing countries, due to a lack of affordable and efficient filtration systems. This study focuses on developing a cost-effective, environmentally friendly filter material based on hydroxyapatite (HAp) synthesized from eggshells and enhanced with nanostructured magnetite. The objective was to evaluate the filtration efficiency of the HAp-magnetite composite in removing heavy metals and other ions from water samples.

Materials and methods: Eggshells were processed to synthesize hydroxyapatite, then combined with magnetite nanoparticles to form a nanostructured filter material. Organoleptic analysis and chemical tests were conducted to determine the effectiveness of filtration. The ion concentrations before and after filtration were analyzed using titration methods and laboratory equipment at "KrisMas+" complex.

Results: The synthesized filter significantly reduced concentrations of chloride, nitrate, and sulfate ions in water. It demonstrated effective adsorption of heavy metals like lead and zinc. The pH of filtered water remained within safe limits. The use of nanostructures increased the surface area, improving adsorption. Compared to boiled tap water, filtered samples met or exceeded sanitary norms defined by SanPiN 2.1.4.559-96. One filter pouch treated at least 250 ml of contaminated water effectively.

Table 1: Ion concentration comparison before and after filtration

Ion Type	Max Permissible (mg/L)	Boiled Tap Water	Filtered Sample
Sulfates	500	268.9	192
Chlorides	350	213	142
Nitrates	45	15	15
Iron	0.3	<0.1	0.1
pH	6–9	7.88	9.56

Conclusions: HAp-magnetite synthesized from eggshells is a viable, eco-friendly filter material for water purification. It effectively removes heavy metals and balances ionic content while remaining economically advantageous. The incorporation of nanotechnology significantly improves adsorption efficiency. This approach provides a sustainable alternative to traditional water purification technologies and is suitable for both household and industrial applications.

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THERAPEUTIC APPLICATION OF KHEWRA HIMALAYAN SALT IN TREATING CHRONIC RESPIRATORY ILLNESSES: A PROPOSAL FOR THE COUNTRIES OF CENTRAL ASIA

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Keyword: feasibility of Himalayan pink salt-based halotherapy for managing asthma and TB in Kazakhstan

Introduction: Chronic respiratory diseases—including asthma, tuberculosis (TB), and bronchitis—represent significant public health challenges in Kazakhstan, where environmental factors such as air pollution, harsh climatic conditions, and industrial exposure contribute to their prevalence (World Health Organization, 2023). While conventional pharmacological treatments can alleviate symptoms, they often fall short in addressing persistent airway inflammation and facilitating effective mucociliary clearance. In recent years, halotherapy—a complementary therapy involving the inhalation of aerosolized salt particles within a controlled microclimate—has emerged as a potential adjunct in respiratory care (Chervinskaya & Zilber, 1995). Notably, the Khewra Salt Mine in Pakistan, one of the largest and oldest natural salt deposits globally, has been utilized for therapeutic purposes, offering salt chambers constructed with Himalayan pink salt, which contains over 80 trace minerals believed to contribute to its purported health benefits (Government of Pakistan, 2022). This study aims to assess the therapeutic effects of halotherapy based on the Khewra Salt Mine model and to evaluate the feasibility of introducing similar Himalayan salt-based therapy rooms in Kazakhstan as a complementary treatment for respiratory conditions.

Materials and methods: This study incorporated a field investigation at the Khewra Salt Therapy Center in Pakistan, where individuals diagnosed with asthma, tuberculosis (TB), and chronic bronchitis participate in therapeutic sessions within natural salt chambers. Clinical observations and semi-structured patient interviews (n = 80) were conducted to evaluate the outcomes of regular halotherapy exposure, consisting of 45-minute sessions administered over a period of 4 to 8 weeks. Pulmonary function was assessed using spirometric parameters, specifically forced expiratory volume in one second (FEV_1) and peak expiratory flow rate (PEFR), complemented by symptom monitoring and standardized patient-reported outcome measures, including quality-of-life indices (Ibrahim et al., 2020). In parallel, the mineral composition and microclimatic air quality within the salt chambers were analyzed to elucidate potential therapeutic mechanisms. A feasibility assessment was also conducted to examine the economic viability, construction logistics, and adaptability of implementing analogous Himalayan salt-based therapy rooms within the climatic and infrastructural context of Kazakhstan's healthcare system (Kazakhstan Ministry of Health, 2021).

Results: Patients at the Khewra Salt Therapy Center reported significant respiratory improvements: FEV_1 increased by 10–18% after six weeks, with a 60% reduction in coughing, wheezing, and breathlessness. Additionally, 80% of patients experienced better sleep and reduced reliance on bronchodilators. Air quality analysis of the salt chambers revealed a NaCl particle density of 4–6 mg/m³, within therapeutic ranges, and optimal humidity levels (40–60%) (Chervinskaya, 2007). Cost analysis indicated that constructing salt rooms in Kazakhstan using imported Himalayan salt is feasible, with setup costs estimated at $10,000–$15,000 per room, making them suitable for wellness centers, sanatoriums, or clinics (Cost may vary country to country).

Conclusions: The halotherapy model used in the Khewra Salt Mine offers a scientifically supported, non-invasive treatment that can significantly improve respiratory function in patients with chronic lung conditions. Introducing Himalayan salt-based therapy rooms in Kazakhstan could enhance the country's respiratory care offerings, particularly in regions affected by pollution or dry climates. The model is

scalable, safe, and complements existing treatments, with promising health and economic outcomes (Allegra et al., 2022).

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THEORETICAL STUDY OF THE EFFECTIVENESS OF TERT-AMYL METHYL ETHER AND ETHYNYLCYCLOPENTANOL IN INCREASING THE OCTANE NUMBER OF GASOLINE

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Keywords: petrol; octan number; environmental protection; tert-amyl methyl ether (TAME); ethynylcyclopentanol (ECP)

Introduction: Modern high-compression engines require fuels with good knock resistance to avoid incomplete combustion, engine wear, and increased exhaust emissions, which reduce efficiency and shorten engine lifespan. Antiknock agents are used at refineries to ensure the necessary knock resistance of fuels, and they can also be employed by consumers to adjust the octane number of gasoline, especially in cases where increased deposit formation in the engine may cause knocking [1]. Given the tightening environmental standards, the petroleum refining industry is focused on producing fuels with improved performance and ecological characteristics, aiming to reduce emissions of CO, NO_x, and unburned hydrocarbons.

Materials and methods: This literature review of the master's thesis examines the impact of tert-amyl methyl ether (TAME) and ethynylcyclopentanol (ECP) as gasoline additives. The aim of the study is a theoretical assessment of their effectiveness in increasing the octane number of fuel. Their influence on combustion processes, knock resistance, and the physicochemical properties of gasoline is analyzed. Special attention is given to the interaction of TAME and ECP with fuel components, taking into account their molecular structures and characteristics. The results of this study may contribute to the development of more efficient and environmentally friendly fuel compositions.
Currently, MTBE is the most widely used oxygenate, with global production and consumption of approximately 26.5 million tons [5]. The recommended concentration of oxygenates in gasoline is 3–15% by volume, while the total oxygen content in the fuel should not exceed 2.7%. Such a level of additives does not require additional adjustments or changes to the design of operating engines.

Results: Let's consider a comparison of different types of oxygenates, their properties, advantages, and disadvantages, as well as which is better: aliphatic or cyclic?

Table 1. Comparative quantum-chemical parameters of TAME and Ethynylcyclopentanol (approximate data):

Parameters	**TAME (Tert-Amyl Methyl Ether)**	**ECP (Ethynylcyclopentanol)**
HOMO (eV)	6.21	6.47
Energy gap width (eV)	8.66	7.31
ΔG of evaporation (kJ/mol)	~40–50	~65–70
Dipole Moment (D)	1.8–2.2	2.5–3.1
Global hardness (η)	~4.3	~3.65
Electrophilicity (ω)	~2.4	~3.1
C–O bond energy	~360 kJ/mol	~410 kJ/mol
Thermodynamic stability	Average	High
Antiknock effectiveness	Good	Very good

Conclusions:
Octane-boosting efficiency:
- TAME: When 15% TAME is added to straight-run gasoline, the increase in the octane number by the research method (RM) is about 6.2 units.
- ECM: Adding 15% ECM increases the octane number by 8.3 units according to RM, indicating higher efficiency in increasing the octane number.

Environmental and toxicological aspects:
- TAME: Has moderate toxicity and can contribute to ozone formation upon evaporation, raising environmental concerns.

- ECM: Has low toxicity and high environmental friendliness, making it attractive from an ecological safety perspective.

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ENANTIOANALYSIS OF OCHRATOXINE A IN FOOD SAMPLES

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Keywords: ochratoxine A; enantioanalysis; sensor

Introduction: Ochratoxine A is a very stable molecule that is not destroyed at temperatures below 250°C, and the heat alone will not be enough to prevent the risk. Found in contaminated grain such as wheat, rye, oat, coffee, grapes, eggs, milk, wine, ochratoxine A is responsible for kidneys' damage.

Materials and methods: A stochastic sensor designed using an oleamide impregnated on a carbon nanolayer deposited on silk was used for the determination of ochratoxine A in milk and wine samples.

Results: A linear concentration range between 1 and 100pg/mL was obtained, while the limit of determination was of 1pg/mL, and the sensitivity was of $4.29 \times 10^{9} s^{-1} g^{-1} mL$. Recoveries higher than 98.40% were recorded when ochratoxine A was determined in milk and wine, while the % RSD values were lower than 0.12.

Conclusions: The proposed stochastic sensor is able to determine reliable ochratoxine A in wine and milk, contributing to the food security check-up on site. This will also contribute to the state of health of the population.

ENANTIOANALYSIS OF DEOXYNIVALENOL IN URINE SAMPLES

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Keywords: ochratoxine A; enantioanalysis; sensor

Introduction: Deoxynivalenol is one of the most abundant Fusarium mycotoxins in European poultry feed, in both the level and the frequency of contamination. It is well known for producing hepatotoxicity, intestinal toxicity, nephrotoxicity, and reproduction toxicity. The wide distribution of it in food worldwide, produces a lot of adverse effects on animals, plants, and humans.

Materials and methods: A stochastic sensor based on octakis(6-deoxy-6-(2-aminoethyl)thio) gamma-cyclodextrin hydrochloride immobilized on a diamond nanolayer deposited on silk, was used for the determination of deoxynivalenol in urine samples.

Results: A linear concentration range between 10 and $1x10^4$ pg/mL was obtained, while the limit of determination was of 10 pg/mL, and the sensitivity was of $8.09x10^6$ $s^{-1}g^{-1}mL$. Recoveries higher than 99.80% were recorded when ochratoxine A was determined in milk and wine, while the % RSD values were lower than 0.20.

Conclusions: The proposed stochastic sensor is able to determine reliable deoxynivalenol in urine in very small concentrations, facilitating early detoxification in order to avoid the blockage of the kidneys, contributing to the state of health of the population.

2D DISPOSABLE STOCHASTIC SENSOR FOR THE ENANTIOANALYSIS OF LYSINE IN LUNG CANCER

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Keywords: lysine; 2D stochastic sensor; electrochemical sensor; lung cancer; whole blood

Introduction: Amino acid metabolism is essential for biological functioning, affecting protein synthesis, energy production, and signaling pathways. Changes in amino acid metabolism have been associated with numerous disorders, including cancer. Lysine, an essential amino acid, is significant for its role in post-translational changes and its influence on tumor growth. Precise monitoring of lysine concentrations in biological samples is crucial for establishing its function in lung cancer and for formulating possible treatment approaches. Conventional methods of analysis frequently require lengthy sample preparation and may be unsuitable for fast or point-of-care testing. Stochastic sensors have emerged as a viable alternative, providing quick and sensitive detection of analytes directly within complex matrices such as whole blood samples. For the assay of L- and D-lysine in whole blood samples from patients diagnosed with lung cancer, a 2D disposable stochastic sensor, modified with α-cyclodextrin (α-CD), was used.

Materials and methods: For the development of the 2D disposable stochastic sensor, graphene and copper were deposited onto the surface of copy paper. The sensor was immersed in a modifier solution containing alpha-cyclodextrin (10^{-3} mol L^{-1}) and allowed to dry for 24 hours before use. Lysine solutions were prepared using phosphate buffer solution (PBS) at a pH of 7.40 and deionized water. The successive dilution method was employed to prepare L- and D-lysine solutions with concentrations between 10^{-2} and 10^{-18} mol L^{-1}. The disposable stochastic sensor was employed to characterize and validate enantioanalytical studies conducted using whole blood samples.

Results: The samples were analyzed with the proposed 2D disposable stochastic sensor employing the stochastic method. The respective presence of L- and D-lysine in the samples was identified using their distinct signatures and t_{off} values. The sensor's enantioselectivity showed its capability to distinguish between the two enantiomers of lysine. The proposed sensor is an ideal option due to its high sensitivity, low limits of quantification, and wide working concentration ranges.

Conclusions: A 2D stochastic sensor was used for the precise qualitative and quantitative enantioanalysis of lysine in whole blood samples. This enables the further application of screening tests for whole blood from patients diagnosed with lung cancer and healthy volunteers, demonstrating that the enantioanalysis of lysine serves as a screening test that can aid in the early diagnosis of lung cancer.

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DEVELOPING NEW MATERIALS WITH ENHANCED PROPERTIES FOR LI – ION BATTERIES

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Keywords: Li-ion batteries; new materials; environmental footprint; simulation; climate changes

Introduction: Transportation industry represents one of the most controversial variables of nowadays society, owing to the large amount of generated pollutant emissions, with negative long - term effects, both on environment and human health. In the meanwhile, road vehicles infrastructure is considered an indicator of economic progress, therefore reducing their usage is not a feasible solution in the near future. To prevent fossil fuels depletion and irreversible consequences that lead to acceleration of climate changes, identifying alternative solutions became a necessity. In this context, the electric cars concept is increasingly rooted in public perception, which will bring numerous ecological benefits. Even in this case, continuous improvements are needed, to be able to adapt to society requirements, technology and climate, to bring a significant contribution in reducing the environmental footprint.

Materials and methods: Complex materials are intended to be obtained through different methods, including combustion synthesis and controlled atmosphere oxidizing of complex concentrated alloys. To identify the most appropriate compositions, advanced modelling techniques were used, including kinetic and thermodynamics parameters calculation. To stimulate the economical dimension and recyclability, the obtained compositions were optimized and different obtaining techniques were analyzed.

Results: The main purpose of this work is focused on developing new materials, with improved characteristics and reduced environmental impact, for lithium - ion batteries.

Conclusions: The selected compositions and obtaining techniques are both complying with environmental strategies, by reducing critical raw materials content and optimizing the experimental parameters, to be able to reduce materials and energetical consumptions.

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ION-MODIFIED MESOPOROUS NANOMATERIALS FOR ENHANCED BONE TISSUE REGENERATION

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Keywords: bioactive glass; mesoporous silica; ion doping; ion loading

Introduction: Bone tissue engineering continues to evolve through the integration of smart, bioactive nanomaterials designed to support regeneration and replicate the complexity of the natural bone environment. Among these, mesoporous bioactive glass nanoparticles (MBGNs) and mesoporous silica structures such as MCM-41 stand out due to their high surface area and well-defined pore networks, which make them excellent platforms for delivering therapeutic ions [1]. Many studies have demonstrated that incorporating specific metal ions can significantly enhance biological outcomes: copper and magnesium, for example, promote osteogenesis; magnesium and lithium support angiogenesis; while copper, zinc, and silver contribute to the antimicrobial activity [2]. In this study, we explore the regenerative potential of ion-doped MCM-41 and MBGN systems tailored for bone repair applications.

Materials and methods: The two mesoporous materials were synthesized through the sol-gel method, utilizing cetyltrimethylammonium bromide (CTAB) as a template and tetraethyl orthosilicate (TEOS) as the silica precursor. The reaction mixture was stirred at room temperature for 4 hours, followed by washing, drying and calcination. Metal incorporation was conducted using two distinct approaches: loading and doping. Loading was done by introducing the metal precursor into the pores under vacuum, using a basic solution to precipitate and anchor the ions [3]. Doping involved adding the precursor late in synthesis, embedding the metals into the silica framework [4]. The materials were characterized using standard physicochemical techniques and their bioactivity was evaluated.

Results: SEM analysis revealed predominantly uniform particle morphology, with slight size variations influenced by the specific doping and loading approaches. FTIR and XRD analyses confirmed the presence of characteristic signatures associated with the silica-based frameworks. Following immersion in simulated body fluid (SBF), the MBGNs samples exhibited the formation of apatite-like mineral layers, indicative of bioactivity.

Conclusions: Bone-related disorders, along with trauma, orthopedic surgeries and tumor resections, often result in bone defects that require advanced therapeutic strategies. Porous scaffolds, functionalized with bioactive molecules or enhanced through ion incorporation, offer promising solutions for regeneration. Doping and loading MCM-41 and MBGN with metals oxides significantly enhance their bioactivity and cytocompatibility. Furthermore, these multifunctional nanomaterials can be embedded in hydrogels and 3D printed into customized constructs, broadening their potential in bone tissue engineering by promoting mineralization and supporting cell proliferation.

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The financial support of the PN-III-P1-1.1-TE-2021-1242 is highly acknowledged. This research was funded by the Ministry of Research, Innovation, and Digitization through Program 1—Development of the national research and development system, Subprogram 1.2 -Institutional Performance- Projects to finance excellence in RDI, Grant no. 15PFE/2021.

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A DISPOSABLE SCREEN-PRINTED ELECTRODE FOR GLUTAMINE ENANTIOANALYSIS IN BIOLOGICAL SAMPLES

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Keywords: glutamine; enantioanalysis; cancer; stochastic sensor

Introduction: The metabolism of glutamine in cancer has been the subject of several in vivo and in vitro studies, and these studies have shown that a significant number of malignancies consume glutamine at an alarming rate. In addition, there is an increasing quantity of information suggesting that the microenvironment of the tumor, epigenetic modifications, the genesis of the tumor, the status of oncogenes and tumor suppressors, and the tumor itself are all factors that influence the regulation of glutamine metabolism.
Enantioanalysis of chiral chemicals, such as amino acids, is essential to the accurate detection of diseases, particularly in the specialized field of cancer diagnosis. In order to investigate the enantiomers of the chiral amino acid glutamine, biological samples were analysed with the use of a disposable stochastic sensor.

Materials and methods: In order to produce a disposable stochastic sensor, the active side of the functioning sensor (gold-based disposable screen-printed sensor) was coated with a drop of maltodextrin solution (10^{-3} mol L^{-1}), and then it was allowed to dry for 24 hours prior to use. To make the glutamine solutions, phosphate buffer solution (PBS) with a pH of 7.50 was used in the preparation process. For the purpose of preparing L- and D-glutamine solutions with concentrations ranging from 10^{-3} to 10^{-21} mol L^{-1}, the consecutive dilution technique was used. The disposable stochastic sensor has been used to describe and verify enantioanalysis investigations that were conducted utilizing samples of tissue, urine, saliva, and whole blood.

Results: The samples were screened using the stochastic method with a disposable stochastic sensor. The identification of L-glutamine and D-glutamine in the samples was determined by their respective signatures and t_{off} values. The enantioselectivity of the sensor demonstrated that it was able to differentiate between the two enantiomers with which glutamine is associated. With its high sensitivity, low limits of quantification, and broad operating concentration ranges, the sensor that has been proposed is an excellent choice.

Conclusions: A new method for the simultaneous assessment of D, L-amino acids in biological materials are needed in order to investigate the possible functions of D-amino acids. The enantioselective analysis of glutamine in whole blood, gastric tumor tissue, urine, and saliva samples was accomplished with the use of a disposable stochastic sensor. The sensor's large working concentration range and great sensitivity allowed for the examination of samples from proven stomach cancer patients.

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ULTRAFAST AND ULTRASENSITIVE SIMULTANEOUS MOLECULAR RECOGNITION AND QUANTIFICATION OF CA12-5, CA72-4, HER1, AND AFP IN BIOLOGICAL SAMPLES

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Keywords: gastric cancer; CA12-5; CA72-4; HER1; AFP

Introduction: The identification of tumor markers is essential for the successful early diagnosis and treatment of cancer, since they indicate the existence or recurrence of the disease. The development and execution of high-sensitivity, quick, and cost-effective detection systems need the identification of tumor markers, which is very important in this process. The remarkable attributes of electrochemical sensors [1, 2] account for their significant interest.
The concurrent molecular identification and quantification of a minimum of four biomarkers in biological samples may facilitate the early and fast diagnosis of illnesses such as cancer. Stochastic sensors are electrodes that can conduct these tests reliably in situ.

Materials and methods: Three unique three-dimensional stochastic sensors were used to conduct screening tests on whole blood, stomach tumoral tissue, urine, and saliva samples for the molecular detection and quantification of CA12-5, CA72-4, HER1, and AFP. The sensors used carbon (graphite, graphene, and nanographene) and were treated with a 10^{-3} mol L^{-1} solution of N-(2-mercapto-1H-benzo[d]imidazole-5-yl) oleamide.

Results: The graphene-based sensor exhibited optimal performance, with sensitivities for the detection of CA12-5, CA72-4, HER1, and AFP recorded at 10^{8} s^{-1} U^{-1} mL, 10^{6} s^{-1} U^{-1} mL, 10^{12} $s^{-1}g^{-1}$mL, and 10^{10} s^{-1} g^{-1} mL, across extensive working concentration ranges of 8.37 x 10^{-14} - 8.37 U mL^{-1} for CA12-5, 4.00 x 10^{-11} - 4.00 x 10^{-3} U mL^{-1} for CA72-4, 3.90 x 10^{-16} - 3.90 x 10^{-6} g mL^{-1} for HER1, and 3.00 x 10^{-20} - 3.00 x 10^{-6} g mL^{-1} for AFP. The broad linear concentration ranges include the biomarker levels seen in stomach cancer patients throughout all stages, from early to advanced. The recovery values exceeded 98.00%, and the relative standard deviation was below 1.00%.

Conclusions: For the molecular identification and measurement of CA12-5, CA72-4, HER-1, and AFP in whole blood, tumor tissue, urine, and saliva from patients with stomach cancer, the suggested stochastic sensors have shown excellent reliability. The sensors demonstrated broad concentration ranges, low limits of quantification, and great sensitivity. It is essential to investigate a number of biomarkers, particularly those linked to diseases or cancers, in order to start therapeutic treatment and diagnose diseases early.

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ELECTROCHEMICAL SENSING OF QUERCETIN FROM MEDICINAL PLANTS USING A STOCHASTIC SENSOR

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Keywords: DPV; quercetin; medicinal herbs; flavonoids

Introduction: Because of its broad range of bioactivity, including antibacterial, anti-inflammatory, anti-allergic, and antioxidant capabilities, quercetin (3,5,7,3',4'-pentahydroxyflavone) is considered to be one of the most significant natural phenolic compounds found in plants (fruits, vegetables, and medicinal herbs). In both the field of medicine (where it is a key component of pharmaceutical dosage forms) and the field of phytotherapy (where it is one of the active components in medicinal plants), quercetin is a substance of interest that is used extensively. On the other hand, the concentration of quercetin might be regarded a metric for the purpose of controlling the quality of therapeutic plants. Therefore, the development of methodologies that are sensitive and selective for the measurement of quercetin is something that is of interest. It is better to utilize electrochemical techniques since the majority of flavonoids are electrochemically active at low oxidation potentials. Electrochemical methods provide several benefits, including increased sensitivity and fewer interferences from compounds that are not electroactive.

Materials and methods: Standard solutions (of concentrations between 1.0×10^{-18} and 1.0 × 10–3 g L^{-1}) of quercetin were prepared in a floral solvent, using serial dilution method. Quercetin, calix[6]arene, and paraffin oil were obtained from Sigma Aldrich. Differential pulse voltammetry was used as the analysis procedure. To obtain the working electrode, graphene decorated with S and B was mixed with paraffin oil to obtain a homogeneous paste, which was modified with calix[6]arene.

Results: The DPV method has been used for the measurement of quercetin in extracts of medicinal plants and a herbal cream. Mallow flower (Malva sylvestris), snowdrop flowers (Galanthus), and birch sap (Betula) have been selected due to quercetin being one of their principal flavonoids. The quercetin levels in extracts of medicinal plants and a herbal cream were quantified using the DPV technique, yielding excellent results. The samples underwent analysis by the suggested method, and the peak current was quantified. The calibration equation was used to determine the corresponding concentrations of quercetin in the sample solutions. The presence of quercetin in the samples was confirmed by analysing its unique signatures and toff values. A wide operational concentration range, low limits of quantification, and great sensitivity are all characteristics of the described sensor.

Conclusions: Because quercetin has electrochemical activity, electroanalytical techniques have been effectively employed to determine quercetin. An electrochemical sensing electrode was established with high sensitivity for quercetin detection. The DPV technique has the potential to be suggested as a viable alternative to several existing analytical approaches. Because of the sensor's high sensitivity and wide working concentration range, it was able to perform an analysis on samples composed of extracts of medicinal herbs as well as a herbal cream.

GREEN ELECTROCHEMICAL SENSOR FOR DETERMINATION OF BETAMETHASONE IN SEMI-SOLID PHARMACEUTICAL FORMULATIONS

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Keywords: green electrochemical sensor; ZnO; graphene; betamethasone

Introduction: Corticosteroids like betamethasone are widely used to treat inflammatory and autoimmune diseases, impacting glucose and protein metabolism. While effective in dermatology due to its strong anti-inflammatory properties, excessive use can lead to adverse effects. This study presents a novel voltametric method for detecting betamethasone using a sulfur-doped graphene electrode modified with zinc oxide, offering high sensitivity, good reproducibility, and minimal environmental impact, as an efficient alternative to classical methods like high-performance liquid chromatography (HPLC) or ultraviolet-visible spectroscopy (UV/Vis spectrophotometry).

Materials and methods: Betamethasone, zinc oxide (ZnO), graphene (Gr) , and sulphur-doped graphene (Gr-S) were purchased from Sigma Aldrich. Stock solutions were prepared in dimethyl sulfoxide (DMSO), and Daivobet gel was obtained locally. Electrochemical measurements were conducted using an EmStat Pico potentiostat with a ZnO/Gr-S working electrode, Ag/AgCl reference electrode, and platinum auxiliary electrode. Differential pulse voltammetry (DPV) was used to measure betamethasone concentrations via current intensity calibration.

Results: Betamethasone was successfully quantified over a concentration range of 0.01 to 10.0 μmol L^{-1}, with a sensitivity of 1.16 μA mol L^{-1} and a detection limit of 0.003 μmol L^{-1}. The method showed good selectivity in the presence of interfering substances, as well as excellent repeatability, reproducibility, and stability. The ZnO/Gr-S electrode was effectively used to determine betamethasone in a gel formulation, with recovery rates ranging from 97.66% to 102.03% and relative standard deviation (RSD) values below 5%. Evaluation using the Green Analytical Procedure Index (GAPI), Analytical Greenness (AGREE), and Blu Application Grade Index (BAGI) tools indicated minimal environmental impact and strong applicability.

Conclusions: The proposed analytical method offers a valuable alternative to standard pharmacopoeial methods. Its main advantage lies in the simplified sample preparation, which involves dissolving a specified amount of betamethasone gel in an optimized buffer solution and distilled water. This is followed by direct measurement of the generated current intensity, which is then used to calculate the betamethasone concentration.

MULTIFUNCTIONAL HYDROGELS FOR WOUND HEALING: A COMPARATIVE STUDY OF DOPAMINE AND SERICIN AS CELL-ADHESIVE COMPONENTS

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Keywords: dopamine-grafted gelatin; wound healing; sericin; hydrogel; cell-adhesion

Introduction: Chronic diabetic wounds provide a considerable healthcare challenge, requiring the adoption of innovative treatment approaches. Hydrogels represent a novel therapeutic approach for diabetic wound healing and skin tissue regeneration due to their intrinsic hydrophilic and porous structure, which facilitates moisture retention, fluid absorption, gas exchange, and water evaporation management. Moreover, the resemblance to the extracellular matrix allows hydrogels to accurately mimic its structure and functions, hence promoting cell motility, adhesion, and proliferation [1, 2]. To address the shortcomings of current treatments, we aimed to develop multifunctional biomimetic hydrogels with extensive therapeutic capabilities that provide antibacterial, adhesive, and anti-inflammatory effects while facilitating skin regeneration. Inspired by marine mussels' capacity to establish robust interactions with various substrates through the secretion of dopamine-containing proteins, we grafted dopamine onto the gelatin backbone to enhance the hydrogels' tissue adhesion and to facilitate cell adhesion and proliferation [3]. We also evaluated the incorporation of sericin (Ser), a natural adhesive protein from silkworms, which has been shown to greatly enhance cell adhesion and proliferation [4].

Materials and methods: The current study is focused on investigating the potential of gelatin-based hydrogels, which can be enzymatically cured in situ using transglutaminase at physiological temperature, for skin regeneration of chronic diabetic wounds. Gelatin was functionalized with dopamine by EDC/NHS coupling chemistry, yielding Gel-Dopa, and FTIR, UV-Vis spectroscopy, and NMR were utilized to verify the chemical modification. One of the two adhesion components, Gel-Dopa or Ser, was integrated in a matrix composed of gelatin and chitosan, resulting in the formation of enzymatically crosslinked hydrogels. The resulting materials were structurally analyzed using FTIR, with their rehydration, stability, morphology, and mechanical characteristics assessed before in vitro biological investigations.

Results: Water intake tests shown that both Gel-Dopa and Ser-containing hydrogels have comparable and enhanced fluid absorption capacity, which is crucial for wound repair. All suggested formulations have an appropriate internal porous architecture that promotes cellular infiltration and nutrient absorption, as demonstrated by in vitro cytocompatibility experiments indicating exceptional biocompatibility, hence affirming the hydrogels' promise in facilitating skin regeneration.

Conclusions: The effective grafting of dopamine onto gelatin is demonstrated herein, and the resulting multifunctional hydrogels containing either Gel-Dopa or Ser exhibit appropriate physicochemical and mechanical properties to be used in tissue engineering. Moreover, the in vitro cellular investigations indicated that cell proliferation significantly improves with the incorporation of the adhesive component (Gel-Dopa/Ser), suggesting that the proposed formulations hold considerable potential for diabetic wound healing and skin regeneration.

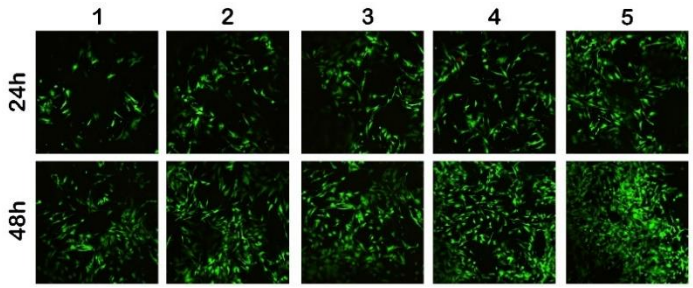

Figure 1. The Live/Dead assay of fibroblast cells seeded on the wound dressings proposed; the cells were cultured for 24 hours day or 48 hours days and then stained. The live and dead cells exhibited green and red fluorescence, respectively

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EFFICIENT ADSORPTION OF ACID RED 66 DYE ON A TWO COMPONENTS HYDROGEL

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Keywords: cherry stones; chitosan; hydrogel; Acid red 66; Response Surface Methodology

Introduction: Dyes are obtained in large quantities and are commonly used in the production of textiles, cosmetics, food, plastics, drugs etc. [1,2]. Part of them end up in water, either through the products in which they are found or as part of the discharged effluents thus becoming a source of contamination. Consequently, there is an amplified demand for the development of appropriate methodologies for the removal of these contaminants from water matrices. Adsorption is an attractive alternative since it stands out through operation simplicity, avoidance of supplementary chemicals, and nonexistence of undesirable products [3]. In this context, the current research was focused on the preparation of a low-cost adsorbent composed of cherry stones and chitosan and on the analysis its ability to remove Acid red 66 dye from aqueous solutions.

Materials and methods: Cherry stones in powder were carefully mixed with a chitosan solution. The suspension was dripped in a methanol–sodium hydroxide combination and left to rest. The hydrogel beads were heated at reflux in a methanol–glutaraldehyde mixture in order to ensure a good stability in acidic media. Point of zero charge ($p\mathrm{H}_{PZC}$) determination, scanning electron microscopy (SEM), and Fourier transform infrared spectroscopy (FTIR), and were employed for the characterization of the synthesized material. Then, a Response Surface Methodology (RSM) analysis was conducted on several parameters affecting the adsorption process.

Results: The obtained hydrogel had a $p\mathrm{H}_{PZC}$ of 7.8. According to the SEM analysis, it possessed a smooth external surface, and an internal structure with fine visible pores. FTIR spectra recorded before and after the Acid red 66 dye adsorption confirmed the retention of the contaminant from the aqueous environment. RSM was applied to optimize some of the main working parameters. Experiments conducted at *p*H 2, with an adsorbent dose of 100 g/L, and at a temperature of 30 °C led to a promising result for the final pollutant concentration considered as response function a removal rate higher than 90 % being recorded.

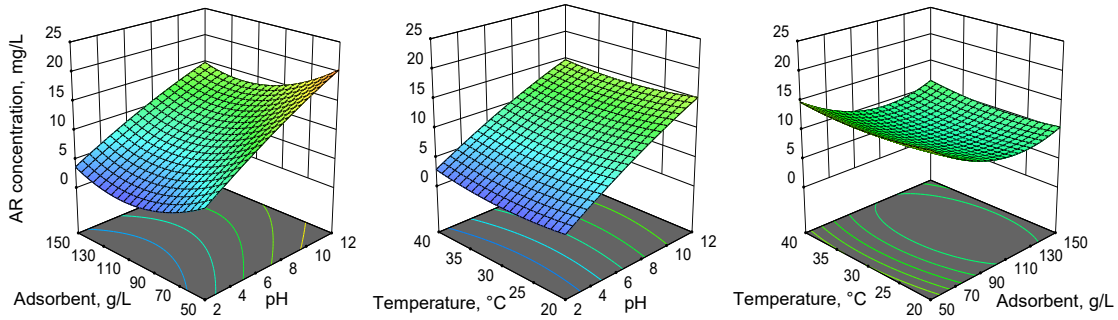

Figure 1. RSM 3D representations of the effect of *p*H, adsorbent dose and temperature on the final concentration of Acid red 66

Conclusions: The outcomes of this research allowed for confidence in the fact that the obtained hydrogel composite is a promising one and that it can be successfully utilized as an alternative to more expensive materials currently employed for removing pollutants from aqueous solutions.

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EXPLORING THE STRUCTURE AND PROPERTIES OF CU-ENHANCED HEA COATINGS DEPOSITED BY DC MAGNETRON SPUTTERING

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Keywords: high-entropy alloy coatings; copper enhancement; DC magnetron sputtering; corrosion resistance

Introduction: High-entropy alloy (HEA) coatings are promising candidates for improving corrosion and wear resistance in harsh environments[1]. In this work, Cu-enhanced CuCrFeMnNi HEA coatings were deposited by DC magnetron sputtering and characterized structurally, mechanically, and electrochemically. The influence of copper content (5 wt.% and 10 wt.%) on coating performance, particularly in marine conditions, was systematically evaluated.

Materials and methods: CuCrFeMnNi high-entropy alloys (HEAs) containing 5 wt.% and 10 wt.% Cu were synthesized and used as sputtering targets. Thin films were deposited on 304L stainless steel and silicon substrates via DC magnetron sputtering at varying power levels (200 W, 250 W, and 300 W). The coatings were structurally characterized using SEM-EDS, XRD, and AFM. Mechanical performance was evaluated by microhardness testing and scratch adhesion tests. Corrosion behavior was assessed through linear polarization measurements in 3.5 wt.% NaCl solution [2].

Results: DC magnetron sputtering produced dense, uniform HEA coatings with good adhesion on 304L stainless steel. SEM-EDS confirmed homogeneous elemental distribution, while XRD patterns indicated nanocrystalline structures with dominant FCC phases. AFM analysis showed low surface roughness, increasing slightly with higher deposition power. Scratch testing demonstrated strong adhesion, with no coating delamination observed. Vickers microhardness measurements revealed improved hardness for coated samples compared to the uncoated substrate. Electrochemical tests showed significantly enhanced corrosion resistance in NaCl solution, with the 10 wt.% Cu coating deposited at 300 W exhibiting the highest polarization resistance and lowest corrosion rate.

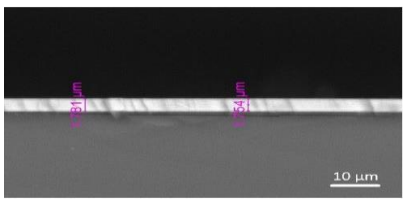

Figure 1. Cross section SEM image of HEA coating on silicon substrate

Conclusions: Cu-enhanced high-entropy alloy coatings deposited via DC magnetron sputtering demonstrated improved mechanical and corrosion performance compared to the uncoated substrate. The 10 wt.% Cu coatings exhibited the best overall properties, achieving superior hardness, strong adhesion, and enhanced corrosion resistance in marine-simulated environments. The results highlight the potential of Cu-containing HEA coatings as effective protective layers for metallic components operating in aggressive conditions.

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FABRICATION OF RE-ZrO_2 BASED MULTILAYER COATINGS VIA EB-PVD FOR HIGH-TEMPERATURE APPLICATIONS

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Keywords: rare earth zirconate RE-ZrO2; structural properties; thermal stability; thermal conductivity

Introduction: The present study focuses on the hydrothermal synthesis and structural evaluation of co-doped zirconia ceramic materials with enhanced thermal and chemical stability, suitable for high-temperature protective coatings. The main objective is to develop and characterize a rare-earth (RE)-co-doped ZrO_2-based material with controlled phase composition and thermal properties, further processed into dense compact pellets for use as evaporation sources in the fabrication of multilayer coatings via Electron Beam Physical Vapor Deposition (EB-PVD).

Materials and methods: Nanostructured (1-x)ZrO_2-x(RE_2O_3) (x= 0.2; RE= La, Nd, Sm, Gd, Yb) powders were obtained by hydrothermal synthesis at 200°C and 100 atm for 2h. The dried powders were pressed into pellets using a hydraulic uniaxial press, followed by thermal treatment at 1500°C to induce densification and phase transformation in the structure. The cylindrical pellets were subsequently employed as evaporation targets in an EB-PVD system equipped with multi-source crucibles. Thin film deposition was conducted on Ni-based superalloy and silicon substrates, previously degreased and ultrasonically cleaned, under high vacuum (10^{-6} mbar) and elevated substrate temperature (400°C).

Results: XRD analyses performed on the synthesized powders revealed a phase evolution from a mixed monoclinic/tetragonal/cubic composition to a fully stabilized cubic structure after thermal treatment at 1500 °C. BET surface area measurements on the powders showed a significant decrease from ~140 m^2/g (as-synthesized) to <1 m^2/g after sintering, indicative of substantial grain growth and densification. SEM analysis of the thermally treated powders further confirmed the development of dense microstructures, while subsequent EB-PVD experiments using these powders as evaporation sources resulted in well-adherent multilayer oxide coatings. The thermophysical characterization of sintered samples revealed low thermal conductivity (0.61 $W \cdot m^{-1} \cdot K^{-1}$), low thermal diffusivity (0.34 mm^2/s), and specific heat capacity of 0.42 J/g·K. The use of doped ZrO_2 pellets enabled stable evaporation rates (0.5–1.4 Å/s) and the formation of complex oxide architectures.

Conclusions: The RE-co-doped ZrO_2 system exhibits excellent structural stability and thermal insulation performance due to the stabilization of the cubic phase. The integration of hydrothermal synthesis, thermal treatment for consolidation and EB-PVD deposition demonstrates a scalable route for fabrication high-performance multilayer coatings in advanced thermal protection systems.

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ASSESSMENT OF GRANITE WEATHERING UNDER ACCELERATED SALT CRYSTALIZATION CYCLES

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Keywords: granite; natural stone; salt crystallization; degradation

Introduction: Granite, a widely utilized natural stone, is renowned for its aesthetic qualities and exceptional mechanical strength, making it a preferred material for both interior and exterior architectural applications. Its enduring use since antiquity underscores its appeal and structural robustness [1-2]. Salt crystallization poses a significant threat to granite's structural integrity, as cyclic dissolution and recrystallization of salts within the stone's pore network can induce micro cracking and progressive deterioration under fluctuating environmental conditions. Evaluating granite's resistance to salt crystallization is therefore crucial for assessing its long-term durability and suitability for architectural applications [3-4].

Materials and methods: The objective of this study is to assess the degradation behavior of three types of granite—Rosa Aswan (RA), Gray Granite (GT), and Beige Granite (BG)—under salt crystallization cycles, using 5%, 12% and 25% Na_2SO_4 solutions similar to UNI EN 12370:2019. The specimens were immersed in the salt solution for 2 hours at 20.0 ± 2 °C, followed by oven-drying for at least 16 hours at 60 ± 5 °C. After drying, they were cooled to room temperature for 2 hours before commencing the next cycle. Initially, the specimens were subjected to 15 cycles in accordance with standard test protocols. However, given granite's low open porosity and the minimal weight loss and decay observed during the first set of cycles, a second series of 15 cycles was conducted. Consequently, each specimen underwent a total of 30 salt crystallization cycles before characterization.

Results: Gray Granite (GT) exhibited the highest susceptibility to salt crystallization, with mass loss values ranging from 0.05 to 0.06, while Beige Granite (BG) showed the greatest resistance, with mass losses ranging from 0.003 to 0.025. The 5% and 12% Na_2SO_4 solutions caused negligible changes, but the 25% solution significantly impacted GT, promoting micro cracking and feldspar alteration.

Conclusions: The salt crystallization test effectively highlighted the variability in granite's resistance to salt-induced degradation, with GT being the most susceptible and BG the least affected. The results indicate that granite, despite its generally low porosity, can undergo significant deterioration under prolonged exposure to concentrated salt solutions. The 25% Na_2SO_4 solution was particularly destructive, underscoring the importance of assessing granite's durability in environments where high salt concentrations are anticipated.

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SILVER-ENHANCED LAYERED DOUBLE HYDROXIDES: A POTENTIAL CATALYST FOR METHYLENE BLUE DEGRADATION

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Keywords: methylene blue (MB); photocatalysis; silver-modified LDH; layered double hydroxides (LDHs)

Introduction: Methylene blue (MB) is a widely used thiazine dye that poses significant challenges in heritage conservation and architectural restoration due to its strong staining properties on porous stone surfaces. Commonly employed in diagnostic studies to assess moisture distribution and pore structure, MB can inadvertently stain stone substrates, complicating restoration efforts. Conventional cleaning methods may be ineffective or damaging, highlighting the need for advanced remediation strategies. Recently, nanomaterial-based photocatalysts (NMs-PCAs) have gained attention for their ability to degrade organic dyes under light irradiation[1]. Layered double hydroxides (LDHs), particularly those modified with silver, exhibit exceptional photocatalytic performance, leveraging their high surface area, quantum confinement effects, and surface plasmon resonance[2].[3]. This study explores the application of silver-modified LDHs for the photocatalytic degradation of MB on stone surfaces, demonstrating significant advancements in non-invasive dye removal techniques for conservation purposes.

Materials and methods: In order to evaluate the photocatalytic properties of ZnAl(Ag)LDH, we defined several set ups: first the methylene blue was immobilized in an acrylic gel then the gel was applied on gypsum test bricks as follows: 1) the gel was applied on an untreated brick, 2) the gel was applied on a brick, previously treated with a dispersion of LDH in water, 3) the gel was applied on an untreated brick and after it dried, it was treated with the LDH dispersion, 4) the gel without methylene blue was applied on a brick, 5) the brick was treated only with LDH dispersion, all the test bricks were exposed to UV radiation for 20 hours to assess the methylene blue photodegradation. The change in color and gloss was measured for all the test bricks.

Results: The control bricks (blank gel and LDH-only) exhibited minimal to no changes in color or gloss. however, the following observations were made: LDH pre-treated brick with MB Gel - The brick showed a shift in the b* value from blue toward yellow, indicating MB degradation. MB Gel Followed by LDH Treatment - The brick displayed a reduction in blue coloration, suggesting partial MB degradation. Despite variations in b* values, the total color difference (ΔE) showed no significant differences across MB-treated samples, suggesting that LDH treatment influences the degradation mechanism but does not substantially alter the final color outcome. Gloss: Small variations in gloss were observed across all samples, but these changes were inconsistent and could not be correlated with the LDH treatment or MB degradation.

Conclusions: This study highlights the potential of silver-modified ZnAl(Ag)LDH as a photocatalyst for methylene blue (MB) degradation on gypsum bricks, although further optimization is needed. Shifts in b* values suggest MB photodegradation under UV light, though ΔE similarities indicate the LDH application sequence affects the mechanism. Gloss and control samples remained stable, confirming minimal surface impact. Future Objectives: Future work will test other photocatalysts (e.g., LDHs, metal oxides), additional dyes (e.g., indigo, rhodamine B), and UV-Vis spectroscopy to quantify MB degradation, aiming for effective, non-invasive restoration strategies.

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A NOVEL STOCHASTIC PLATFORM FOR THE SIMULTANEOUS DETERMINATION OF FUSIDIC ACID AND BETAMETHASONE IN REAL SAMPLES

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Keywords: stochastic platform; fusidic acid; betamethasone

Introduction: Fusidic acid, an antibiotic, and betamethasone, a corticosteroid with anti-inflammatory properties, are two active ingredients frequently used in combination for the treatment of superinfected dermatitis and other skin disorders. However, betamethasone can cause negative effects to the skin in extended topical therapy[1]. Moreover, when unintentionally introduced into aquatic ecosystems, these drugs may have damaging effects on aquatic animals' physiological and behavioral functions and may disrupt the trophic chain[2,3]. For this reason, water drug levels can be monitored to help identify pollution sources and implement mitigation actions to reduce their harmful impacts. Therefore, a portable stochastic platform based on a polyaniline modified screen printed electrode modified with a calixarene was developed, being the first electrochemical approach for the simultaneous determination of fusidic acid and betamethasone.

Materials and methods:Fusidic acid and betamethasone solutions were prepared using the serial dilution method in phosphate buffer solution (PBS), pH 5.0. A stochastic sensing platform based on 4-tert-butylcalix[4]arene 10^{-3} M drop casted onto a polyaniline-modified screen-printed carbon electrode was used for the simultaneous determination of fusidic acid and betamethasone. Stochastic measurements were performed by chronoamperometry at a constant potential of 0.5 V vs. Ag/AgCl. Pharmaceutical cream and surface water samples were used to study the applicability of the proposed electrochemical platform.

Results: Very wide linear concentration ranges and ultra-trace limits of quantitation were recorded for both analytes: $1.0 \times 10^{-17} - 1.0 \times 10^{-4}$ mol L^{-1} and 1.0×10^{-17} mol L^{-1} for fusidic acid, and $1.0 \times 10^{-18} - 1.0 \times 10^{-3}$ mol L^{-1} and 1.0×10^{-18} mol L^{-1} for betamethasone. Furthermore, the proposed platform was effectively applied to topical cream and surface water samples, resulting in recovery values above 90% and relative standard deviation values lower than 0.1%.

Conclusions: A polyaniline-modified screen-printed carbon electrode incorporating a calix[4]arene was developed as a stochastic sensing platform for the simultaneous determination of fusidic acid and betamethasone. The proposed platform enables fast, on-site analysis without cross-contamination and holds promise for monitoring the purity of the raw active substances as well as the quality of their pharmaceutical formulations. The platform can also be reliably used for the assay of water quality parameters.

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ENANTIOSELECTIVE DETERMINATION OF CYSTEINE IN WHOLE BLOOD SAMPLES USING A NOVEL 2D ELECTROCHEMICAL SENSOR

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Keywords: electrochemical determination; cysteine enantiomers; square wave voltammetry

Introduction: Cell metabolism, development, and differentiation functions depend on amino acids, which are necessary for protein synthesis[1]. Furthermore, their D and L enantiomers play different biological roles, with altered levels of D-amino acids being associated with cancer among other disorders, hence emerging as biomarkers[2,3]. Cysteine is a thiol-containing semi-essential amino acid directly involved in carbon and sulfur metabolism[4]. H_2S, a product directly synthesized from the catabolism of D-cysteine, has been linked to the pathogenesis of different types of cancer. Low levels of endogenously generated H_2S facilitated tumor cell growth, while elevated levels seem to have protective effects[5]. A novel 2D electrochemical sensor based on a screen-printed carbon electrode was proposed for the sensitive and selective determination of cysteine enantiomers. The construction of the electrode involves a simple single-step electrodeposition and electrocopolymerization of silver nanoparticles embedded into a Sunset Yellow and L-methionine copolymer.

Materials and methods: Square wave voltammetry (SWV), cyclic voltammetry (CV), and electrochemical impedance spectroscopy (EIS) were used to analyze the electrochemical behavior of the modified electrode, while the morphological properties were studied using scanning electron microscopy (SEM). Wettability analysis was conducted by evaluating water contact angles. The activated screen printed electrode was modified by drop casting a solution containing 6.0 mM $AgNO_3$, 0.1 M KNO_3, 1.0 mM L-methionine, and 1.0 Sunset Yellow and performing a simultaneous electrodeposition-electrocopolymerization by applying 9 CV cycles in the potential range of -0.6 to 1.6 V at a scan rate of 0.05 V/s. L- and D-cysteine solutions with concentrations ranging from 0.001 to 100.0 μM were prepared using successive dilutions and buffered with pH 7.0 phosphate buffer solution (PBS). Whole blood samples from healthy individuals and patients confirmed with colorectal and pulmonary cancer were used to study the applicability of the electrode.

Results: SWV studies revealed a 1.28 I_L/I_D current intensity ratio for L-cysteine to D-cysteine, a wide linear range (0.001 to 100.0 μM), and a 0.33 nM detection limit. An enhanced affinity for L-cysteine was confirmed by both contact angle measurements and higher sensitivity. Furthermore, the proposed electrode successfully measured the enantiomeric ratio in non-racemic mixed solutions. Finally, the electrode was applied for the enantioselective determination of cysteine in real samples, obtaining recovery values within acceptable limits.

Conclusions: The proposed electrode is easily and rapidly prepared, demonstrating reliable enantioselective determination of cysteine enantiomers with broad linear ranges and nanomolar detection limits. Its applicability was confirmed through accurate analysis in non-racemic mixtures and whole blood samples, allowing its use as a screening test for early diagnosis of colorectal and pulmonary cancer.

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MORPHOLOGICAL EFFECTS ON IONIC CONDUCTIVITY IN SOLID POLYMER NANOCOMPOSITE ELECTROLYTES

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Keywords: solid polymer nanocomposite electrolytes; iron oxide nanoparticles; sulfonated polystyrene

Introduction: Perfluorosulfonic acid (PFSA) polymers, such as the benchmark Nafion®, are consistently used as proton exchange membranes (PEMs) in fuel cells and batteries. However, PFSA polymers' high price, environmental safety issues and reduced lifetime have motivated the search for adequate alternatives. This work investigates two systems: a neat sulfonated polystyrene random copolymer (PS-S_x) and a blend of PS-Sx mixed with sulfonated PS grafted iron oxide nanoparticles (PS-S_x NP). First system aims to provide increased ionic conductivity, whereas the second one aims to provide increased mechanical strength and ionic conductivity, and offer insights into ion mobility through percolated domains.

Materials and methods: Polymeric solutions of varying sulfonation degrees were spin coated and doctor bladed on silicon wafers, glass substrates, and interdigitated gold electrodes (IDEs). Their thicknesses have been measured using calipers and confirmed via SEM (Scanning Electron Microscopy). Some substrates have been previously exposed to UV in a UV chamber for the formation of O bonds to the substrates, that would help the adhesion of these films to said substrates. Other methods used to characterize these films are DSC (Differential Scanning Calorimetry), TGA (Thermogravimetric Analysis) and EIS (Electrochemical Impedance Spectroscopy).

Results: Random copolymer films' conductivities were characterized with electrochemical impedance spectroscopy (EIS). Conductivity values were determined for PS-S_x with sulfonation levels ranging from 0.7 mol% to 47.9 mol% as a function of relative humidity (RH, 30%, 60%, 90%) at 40°C. The highest sulfonation level of PS showed a conductivity value of 0.04 S/cm at 90% RH, half that of Nafion®. Sulfonation degrees were confirmed by thermal analysis measurments like DSC and TGA. Scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM) were used to image the surface of the films coated onto IDEs.

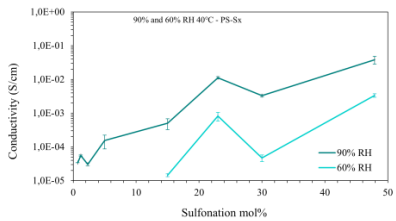

Figure 1. Impedance values of PS-Sx films as a function of humidity and sulfonation

Conclusions: While a sulfonated polystyrene random copolymer alone does not surpass the values of the commercially available proton exchange membrane Nafion®, there is promise in the development of an improved polymer nanocomposite system based on sulfonated polystyrene. Such system could

become one that incorporates inorganic nanoparticles which would further increase mechanical properties and would enable tuning of ion mobility.

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IMPACT OF VARIOUS BIOGLASS COMPOSITIONS ON THE DEVELOPMENT OF TRICALCIUM PHOSPHATE-BASED SCAFFOLDS

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Keywords: β-TCP; bioglass; strontium ion dopped; scaffolds; replication method

Introduction: Cellular materials stand out as materials with a porous microstructure, consisting of solid and void networks. These materials are defined as having a high porosity of 70% and are composed of an interconnected porous network of solid supports or plates, forming the edges and faces of the pores/cells [1]. The present study investigates the use of tricalcium phosphate (TCP) combined with various types of bioglass (BG) for the development of scaffolds aimed at bone regeneration [1,2]. The scaffolds were fabricated using the replica method, wherein the parameters of the immersion solution were systematically modified to optimize scaffold properties [3]. Emphasis was placed on assessing the effects of different bioglass compositions, including both doped and undoped variants, to enhance the mechanical strength, bioactivity, and biocompatibility of the final scaffolds [4].

Materials and methods: The XRD analysis confirmed the formation of the predominant phases in both materials (β-TCP and bioglass), emphasizing their structural crystallization. In the immersion solution, used in the replica method, we employed different concentrations of bioglass (0%, 25%, and 50%) to evaluate the influence of bioglass content on the compressive strength and overall material properties of the scaffolds.The obtained scaffolds were characterized using XRD to identify the crystalline structure of the components and to confirm the presence of strontium within the composite. Additionally, SEM analysis was performed to examine the microstructural features of the scaffolds, focusing on the influence of strontium ions on porosity and compressive strength. This analysis aimed to assess the effect of bioglass incorporation on the mechanical and structural properties of the synthesized scaffolds.

Results: In the replication method used for obtaining scaffolds intended for hard tissue regeneration, we observed an improvement when incorporating bioglass. The presence of strontium within the bioglass structure induced changes in the ceramic properties and significantly increased the compressive resistance of the scaffold. These findings highlight the beneficial role of bioglass composition, particularly strontium doping, in optimizing the material properties for biomedical applications.

Conclusions: During this study, we investigated the influence of parameter variations in the immersion solution used for scaffold synthesis. The characterization of the bioglass utilized in scaffold fabrication revealed a favorable interaction with simulated body fluid and cell lines, suggesting an improvement in the biocompatibility of the resulting scaffolds. The most promising results were obtained for the scaffolds containing 50% bioglass, which exhibited enhanced mechanical and biological properties. Further studies will focus on evaluating the biocompatibility properties of the obtained scaffolds to ensure their suitability for biomedical applications.

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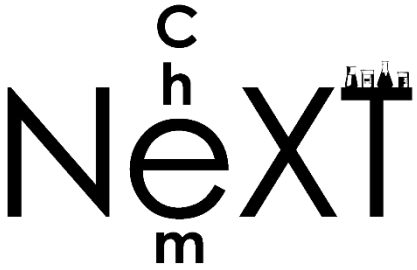
Section 2 - Bioresources, biotechnologies and biorefining



CoMo/γ-Al2O3 CATALYST FOR HYDROTREATED VEGETABLE OIL (HVO) SYNTHESIS

IN-VITRO AND IN-VIVO TOXICITY ASSESSMENT OF MANGANESE DOPED GRAPHENE OXIDE AND REDUCED GRAPHENE OXIDE SYNTHESIZED FROM A. TERMINALIA FRUITS WITH HYDROTHERMAL TREATMENT

INTEGRATED PROCESS FOR VALORIZING SPENT SUBSTRATE FROM THE CULTIVATION OF PLEUROTUS MUSHROOMS

EXPLORING THE BIOACTIVE POTENTIAL OF GRAPE POMACE IN WATER KEFIR FERMENTATION

IRON (III) MODIFIED TiO2 PHOTOCATALYST FOR RHODAMINE B DEGRADATION UNDER LED LIGHT IRRADIATION

UTILIZATION OF REED WASTE FOR ECO-PACKAGING PRODUCTION

BIOACTIVE MUCOADHESIVE NANOFORMULATION ENRICHED WITH SELENIUM NANOPARTICLES PHYTOSYNTHESIZED BY AN AQUEOUS SEA BUCKTHORN LEAF EXTRACT

TENSIOACTIVE PROPERTIES OF SHILAJIT AND ITS APPLICATION IN ESSENTIAL OIL NANOEMULSIONS

EXPRESSING SELENITE-PROCESSING PEPTIDES AT THE SURFACE OF YEAST CELLS

CoMo/γ-Al_2O_3 CATALYST FOR HYDROTREATED VEGETABLE OIL (HVO) SYNTHESIS

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Keywords: Co-Mo catalyst; gamma alumina; impregnation; hydrotreated vegetable oil; fuel

Introduction: The current context of the increased energy demand and also the depletion of oil resources made it necessary to search for alternative fuels, that are both sustainable and durable. Fuels obtained from biomass could be a viable replacement for fossil fuels. Crude vegetable oil cannot be used directly in engines because of its physico-chemical properties, but through the hydrotreating process, it can be converted into a fuel known as Hydrotreated Vegetable Oil(HVO) [1].This work shows the preparation of the CoMo/γ-Al_2O_3catalyst in our laboratory and the results and catalyst testing by palm oil hydrotreating.

Materials and methods: The catalyst was prepared using a commercial γ-Al_2O_3 support and solutions of the corresponding Co and Mo metal salts precursors by the incipient wetness impregnation method. The porosimetry of the resulting catalyst by N_2 adsorption-desorption analysis (BET method) and by Scanning Electron Microscopy (SEM) combined with Energy Dispersive X-Ray Analysis (EDX) to evaluate the surface structure, texture, and the elements distribution [2, 3]. XRD analysis, using a diffractometer Rigaku Ultima IV (Tokyo, Japan) with a vertical goniometer was used to determine the present polycrystalline phases.
Hydrotreating experiments were carried out in a laboratory continuous tubular Parr reactor. The hydrotreated products were subsequently analyzed using an Agilent 7890A GC-MS system, and compounds identification was performed based on the NIST database.

Results: BET porosimetry, SEM microscopy and XRD analysis of the CoMo/γ-Al_2O_3 catalyst provided clear evidence of a uniform dispersion of the active catalytic species on the support. GC-MS results indicate the formation of a complex mixture of compounds following the hydrotreating process, highlighting the catalyst's multifunctional activity. Specifically, the catalyst facilitates deoxygenation, mild hydrocracking and isomerization reactions.

Conclusions: The laboratory-prepared CoMo/γ-Al_2O_3 catalyst was tested to obtain hydrotreated vegetable oil in a laboratory fixed-bed tubular reactor. Also, the nitrogen adsorption-desorption, SEM and XRD analysis confirmed the presence of active species for the HVO processus in the incipient wet impregnation method.

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IN-VITRO AND *IN-VIVO* TOXICITY ASSESSMENT OF MANGANESE DOPED GRAPHENE OXIDE AND REDUCED GRAPHENE OXIDE SYNTHESIZED FROM *A. TERMINALIA* FRUITS WITH HYDROTHERMAL TREATMENT

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Keywords: T. arjuna; graphene oxide; reduced graphene oxide; manganese; tissue engineering; toxicity test

Introduction: Naturally derived biomaterials have garnered significant interest in tissue regeneration and organ function enhancement due to their biocompatibility and sustainability. Biomaterials such as graphene oxide (GO) and reduced graphene oxide (rGO), which are derived from graphite, significantly increase cell-biomaterial interaction and osteogenesis of bone tissue.

Materials and methods: In this research, GO and rGO were synthesized for the first time using graphite derived from the *T. Arjuna* plant. Furthermore, GO and rGO were doped with manganese (Mn^{2+}) ions via hydrothermal treatment to enhance their applicability in tissue engineering. L-ascorbic acid was used to reduce GO to rGO for 700 °c WF, and the resulting materials were characterised through absorption spectra analysis [1].

Results: The successful synthesis marked a significant step towards assessing the safety and biocompatibility of emerging graphene derivatives for biomedical applications. Cytotoxicity studies on MG-63 and L929 cells demonstrated that Mn^{2+}doped GO and rGO exhibit above 85% cell viability, indicating good biocompatibility. *In vivo* studies revealed that biochemical and haematological parameters stayed within the reference range, showing no hematotoxicity compared to the control [1].

Conclusions: Overall, this study presents a sustainable and environmentally friendly method for synthesizing Mn^{2+} doped graphene materials from *T. Arjuna*. The results indicate that the samples demonstrate potential as a viable scaffold for bone regeneration applications.

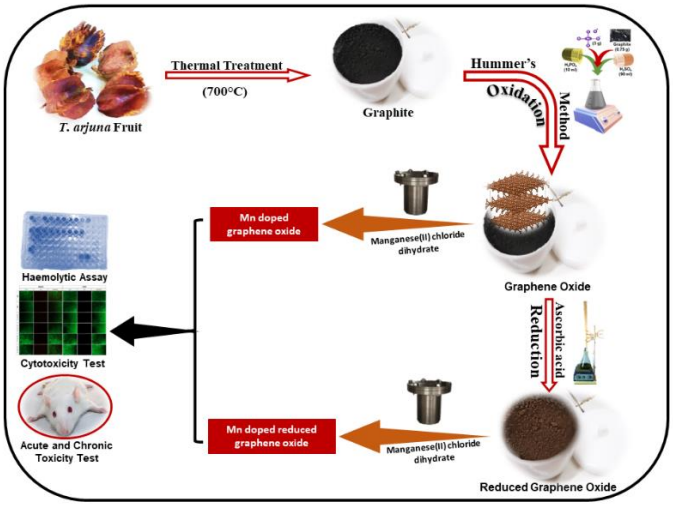

Figure 1. Optimal Manganese-doped GO and rGO synthesised from dried *T. arjuna* fruit

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INTEGRATED PROCESS FOR VALORIZING SPENT SUBSTRATE FROM THE CULTIVATION OF PLEUROTUS MUSHROOMS

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Keywords: anaerobic digestion; biogas; biochar; pyrolysis

Introduction: This work refers to an integrated multi-directional approach for the valorization of exhausted substrate, resulting from the cultivation of lignocellulosic fungi of the genus *Pleurotus* (Spent *Pleurotus* Substrate, SPS), by carrying out an initial anaerobic digestion to obtain biogas, followed by parallel processing of the resulting solid digestate through thermal processes, pyrolysis, to obtain biochar, and of the liquid digestate fraction for nutrient recovery[1, 2].

Materials and methods: Anaerobic digestion was carried out in an incubation unit, equipped with an automatic stirring/mixing system and temperature control, which allows the monitoring of biogas produced. The liquid and solid digestate resulting from the anaerobic digestion were subjected to further processing, by recuperating the nutrients present in the liquid fraction for fertilizer production, while the solid digestate was subjected to pyrolysis in a semi-continuous tubular reactor under nitrogen atmosphere.

Results: Enzymatic pretreatment on SPS had a positive effect, increasing the speed of the anaerobic digestion process, with a plateau being reached after 48 hours compared to 72-96 hours, as well as increasing the average volume of methane recorded, 290 NmL compared to 260 NmL. Samples of the solid digestate fraction, freeze-dried and grounded, were used to carry out the pyrolysis process, in a semi-continuous tubular reactor, under nitrogen atmosphere. Heating was provided by an electrical resistance; the temperature being monitored throughout the process. The yield of pyrolysis products is 51% biochar, 28% pyrolysis oil and 21% gaseous fraction

Conclusions: This integrated approach for valorizing SPS, eliminates the need to manage significant amounts of residues and environmental problems associated with long-term storage, while the produced biogas can be used for energy generation. The versatility and adaptability of the proposed integrated system allows the use of the SPS in combination with other types of substrates and waste, being applicable to the individual needs of the user.

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EXPLORING THE BIOACTIVE POTENTIAL OF GRAPE POMACE IN WATER KEFIR FERMENTATION

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Keywords: functional foods; bioactive compounds; multibiotic; fermented beverage; antioxidant activity

Introduction: Recently, consumer interest in functional foods has highlighted the potential of fermented products for their health-promoting properties. Water kefir, a non-dairy fermented beverage, contains a diverse microbiota and bioactive compounds, although it remains relatively unexplored [1]. In parallel, grape pomace - a nutrient-rich by-product of the wine industry - is often discarded despite its high fiber and antioxidant content. This study investigates the incorporation of grape-pomace in water kefir fermentation to develop a functional beverage with enhanced nutritional value [2]. The approach aims to improve gut health while contributing to sustainable by-product valorization, in line with circular bioeconomy principles.

Materials and methods: The fermentation of water kefir enriched with grape pomace (WKGP) was optimized with Response Surface Methodology (RSM) by using the Central Composite Design (CCD), considering fermentation time and pomace concentration as independent variables. Design-Expert software (v.11.0.5.0) was used for the experimental planning and statistical analysis. The effects on total polyphenol, flavonoid, hydroxycinnamic acid, and anthocyanin contents, as well as antioxidant activity (DPPH, FRAP, CUPRAC) were evaluated. Additionally, D-/L-lactic acid levels and residual carbohydrates were analyzed. The biological activity was assessed by investigating the antimicrobial and prebiotic effects, as well as the cytocompatible behaviour (CCK-8 and LIVE/DEAD assays) and in vitro antioxidant potential.

Results: Fortification of water kefir with 1.5% grape pomace (WKGP) resulted in significant parameter increases compared to the control without grape pomace (WK): at 1.5% grape pomace, polyphenol levels were four times higher, flavonoids increased threefold, and hydroxycinnamic acids increased more than fourfold. Antioxidant activity increased approximately four times using the FRAP method, and the DPPH and CUPRAC methods showed a twofold increase in antioxidant activity. Lactic acid concentrations (L-lactic and D-lactic) increased during fermentation, with higher values observed in WKGP compared to WK. The increased carbohydrate content observed in WKGP relative to WK is attributed to the incorporation of grape must, a by-product well known for its high levels of dietary fiber and fermentable sugars.WKGP significantly stimulated the growth of *L. reuteri* and *L. salivarius*, with a maximum at 186.89 ± 1.61% of untreated control for *L. reuteri* at a concentration of 30 mg/mL after 24 hours and at 108.59 ± 1.37% of untreated control for *L. salivarius* after 72 hours. Additionally, WKGP exhibited broader antimicrobial activity than WK. Due to the bioactive compounds, WKGP demonstrated anti-oxidant characteristics *in vitro* and showed high cytocompatibility .

Conclusions: Fortification of water kefir with grape pomace significantly enhances its phenolic profile, antioxidant activity, probiotic growth, and antimicrobial effect, while maintaining high cytocompatibility. These findings highlight the potential of grape pomace to improve the functional properties of water kefir, with implications for the development of more effective multibiotic products.

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IRON (III) MODIFIED TiO_2 PHOTOCATALYST FOR RHODAMINE B DEGRADATION UNDER LED LIGHT IRRADIATION

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Keywords: TiO_2, photocatalysis; iron (III) oxides; LED light irradiation; Rhodamine B

Introduction: In the context of increasing water contamination by synthetic dyes, photocatalysis has emerged as a promising solution for wastewater treatment. This study aims to evaluate the photocatalytic activity of TiO_2 (P25) modified with different amounts of iron (III) (1%, 2%, 4%, 8%) oxides under LED light exposure for the degradation of Rhodamine B (RhB), a widely used model pollutant [1].

Materials and methods: Photocatalysts were synthesized by dispersing P25 in ethylene glycol, followed by addition of $FeCl_3 \cdot 6H_2O$ and glycerin. The mixtures were microwave-treated (Discover 2.0) at 160 °C for 10 min. After washing with water and drying, the samples were embedded in a styrene-acrylic paste. Pastes were deposited onto glass slides using the Dr. Blade method [2]. Characterization was performed using FTIR and UV-Vis diffuse reflectance spectroscopy (DRS), color coordinates (L*, a*, b*) were determined, and Tauc plots for optical band gap estimation were carried out. Photocatalytic tests were conducted under LED light exposure using RhB solutions (6 mg/L), and spectrophotometric monitoring their absorbance over time [3].

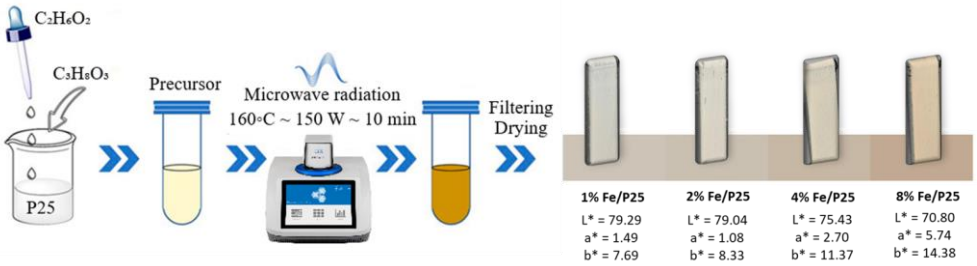

Figure 2. Microwave-assisted synthesis of Fe(III) oxides-TiO_2 (P25) heterojunctions and visual appearance of coatings at varying iron (III) amounts

Results: FTIR spectra confirmed the successful modification of TiO_2. UV-Vis DRS analysis showed a progressive red-shifted absorption edge with increasing iron (III) content and a decrease in band gap values. Color measurements revealed increased chromatic intensity at higher amounts of iron (III). Photocatalytic tests indicated that the iron (III) amount significantly influences degradation efficiency, samples containing an amount of iron (III) in the range 2-4% exhibiting the highest activity, attributed to improved light absorption and reduced recombination of electron-hole pairs.

Conclusions: Iron (III) modification of TiO_2 enhances photocatalytic activity, with optimal performance observed at intermediate doping levels (2–4%). These results highlight the potential of Fe(III)/P25 materials in dye pollutant removal under LED light irradiation.

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UTILIZATION OF REED WASTE FOR ECO-PACKAGING PRODUCTION

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Keywords: reed plant; eco-packaging; cellulose; sustainable materials; paper production

Introduction: This research project aims to explore the potential of the reed plant (*Phragmites australis*), which grows abundantly in the Atyrau region of Kazakhstan, as a sustainable and eco-friendly raw material for the production of paper-based packaging products. The primary objective is to reduce environmental pollution caused by seasonal reed fires and to utilize the plant's high cellulose content to develop biodegradable packaging alternatives.

Materials and methods: The project investigates the chemical composition of reeds and their suitability for eco-packaging production. Laboratory experiments were conducted to extract cellulose using an alkaline hydrolysis method (NaOH treatment) followed by mechanical pulping. Various parts of the reed plant (stems, leaves, and flowers) were tested, and samples were produced with and without the addition of starch for reinforcement. The resulting paper-like materials were evaluated for texture, strength, flexibility, and absorbency, and compared to conventional eco-paper on the market.

Results: The experimental analysis demonstrated notable differences in texture, strength, and flexibility between the materials obtained from different parts of the reed plant. Samples derived from reed flowers produced a thicker and denser paper, similar to thin cardboard, whereas materials from stems and leaves resulted in a softer, more flexible product suitable for eco-packaging applications. Water absorbency tests confirmed that all samples could absorb moisture, making them biodegradable and environmentally compatible. Functional testing showed that a single eco-package with a size of 20×8 cm made from reed-based paper could hold two mobile phones without tearing, demonstrating practical durability. The table below summarizes the physical characteristics and performance of the materials based on the reed part used:

Part of Reed used	**Properties of Obtained Material**
Reed flowers	Dense, cardboard-like structure. Cuts well with scissors. High water absorbency. Low flexibility but can be folded.
Stems and leaves	Soft, brown-colored, very flexible. Easy to cut and glue. Resembles commercial eco-paper.
Strength of sample	A 20×8 cm package successfully held two mobile phones without tearing.
Initial biomass used	25 g
Final paper mass produced	15g

Conclusions: These findings confirm the potential of reed waste as a low-cost, sustainable raw material for eco-packaging, offering both environmental and economic advantages.

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BIOACTIVE MUCOADHESIVE NANOFORMULATION ENRICHED WITH SELENIUM NANOPARTICLES PHYTOSYNTHESIZED BY AN AQUEOUS SEA BUCKTHORN LEAF EXTRACT

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Keywords: hydrogel; bacterial nanocellulose; fungal chitosan; SeNPs; gingival dysbiotic biofilm

Introduction: In the treatment of oral mucosal disorders there are several factors that prevent the therapeutic agent from adhering to the target site. Thus, for long-term adherence, the therapeutic agent should have excellent mucoadhesive properties [1]. Both never-dried bacterial nanocellulose (NDBNC) and chitosan (CS) are biocompatible and biodegradable biopolymers. Due to its fibrillar structure, NDBNC can be a carrier for various therapeutic agents and CS exhibits high antimicrobial activity [2]. Phytosynthesized selenium nanoparticles (SeNPs) have unique properties that result from their biosynthesis process and have been shown to exhibit significant antioxidant and antimicrobial activities [3]. The aim of the study was to develop a bioactive mucoadhesive nanoformulation based on NDBNC from Kombucha fermentation and fungal CS enriched with SeNPs photosynthesized by an aqueous sea buckthorn leaf extract (SeNPsSb) – Se-HNF, that promotes the dispersal of gingival dysbiotic biofilm and supports tissue regeneration.

Materials and methods: Human gingival fibroblasts (HGF-1, ATCC, CRL-2014) were used for the cytocompatibility studies. The cell viability was assessed 24h post-Se-HNF treatment by Cell Counting Kit-8 (CCK-8) and LIVE/DEAD assays. Cell morphology was highlighted by labeling of actin filaments with Alexa Fluor 488-coupled phalloidin and by staining the nuclei with 4′,6-diamidino-2-phenylindole (DAPI). The *in vitro* antioxidant activity was carried out by labeling and quantification of total intracellular reactive oxygen species (ROS) with 2′,7′-dichlorodihydrofluorescein diacetate (H_2DCFDA). For the investigation of the antimicrobial activity, the following microbial strains were used: *Bacillus cereus* NCTC 10320, *Enterococcus faecalis* ATCC 29212, *Staphylococcus aureus* ATCC 25923 and *Candida albicans* ATCC 10231. The Se-HNF hydrogel was physico-chemically characterized by Scanning Electron Microscopy (SEM), mucin binding efficiency measurement, Fourier transform infrared spectroscopy (FTIR), X-Ray Diffraction (XRD), rheology, contact angle and surface tension analyses.

Results: The Se-HNF hydrogel with 2.5 µg/mL SeNPsSb (2.5Se-HNF) had the contact angle on the glass surface smaller (52.82 ± 1.23°) than that obtained on the polystyrene surface (73.85 ± 0.39°). The surface tension was 97.6 ± 0.47 mN/m. The mucin-binding efficiency of 2.5Se-HNF was approximately 78% at a hydrogel/mucin ratio of 90 (w/w). SEM images revealed morphological changes after hydrogel interaction with mucin. By characteristic peak shifting, the FTIR and XRD analyses highlighted the interaction between 2.5Se-HNF and mucin. The rheological analysis evidenced a pseudoplastic behavior. A 25 µg/mL 2.5Se-HNF dose (2.5Se-25HNF) exhibited a high degree of cytocompatibility, without changes in HGF-1 cell morphology. The hydrogel base did not show *in vitro* antioxidant activity, whereas 2.5Se-25HNF led to a significant reduction in ROS level (about 50% compared to the positive control, C+). Moreover, 2.5Se-25HNF showed a high potential to reduce the microbial growth.

Conclusions: Due to the high degree of cytocompatibility, antimicrobial, and *in vitro* antioxidant activities, together with significant mucin binding efficiency and rheological properties that support the

mucoadhesive potential, the Se-HNF hydrogel could be an excellent candidate for the treatment of oral mucosal disorders.

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TENSIOACTIVE PROPERTIES OF SHILAJIT AND ITS APPLICATION IN ESSENTIAL OIL NANOEMULSIONS

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Keywords: humic substances; emulsion stabilizer; Thymus vulgaris; quinone; nanosized droplets

Introduction: Shilajit is a dark brown exudate derived from the rocky rhizospheres of specific mountainous regions. It consists of a complex blend of organic humic substances alongside diverse plant and microbial metabolites [1]. The humic substances - classified into humic acids, fulvic acids, and humins based on their alkali/acid solubility - are a heterogeneous fraction of organic matter known for their colloidal properties [2]. Thyme essential oil has quinone as its main active ingredient and is believed to trigger semi-volatile signaling, activating tissue-level responses and defense mechanisms when applied as foliar treatments in the context of pest management [3]. This study explores the tensioactive properties of Shilajit as a viable delivery system for quinone from *Thymus vulgaris* essential oil.

Materials and methods: Shilajit was kindly provided by Pro Natura SRL (Otopeni, Romania), *Thymus vulgaris* essential oil was sourced from Solaris (Bucharest, Romania), and fractionated coconut oil (medium-chain triglycerides) was obtained from MAYAM Elemental (Oradea, Romania). Tween 85 was purchased from MP Biomedicals (Ohio, USA). Double distilled water was produced in our laboratory.
FT-IR spectroscopy (IRTracer-100 spectrometer, Shimadzu, Kyoto, Japan) was used to identify the functional groups present in Shilajit. Spectra were recorded in the range of 400 to 4000 cm^{-1}, with a resolution of 4 cm^{-1} and 45 scans per sample. The tensioactive properties and critical micellar concentration of Shilajit were evaluated by measuring surface tension using the pendant drop method, at various Shilajit concentrations (OCA 50, DataPhysics Instruments GmbH, Stuttgart, Germany). The emulsions were prepared following a method previously described by Ostertag [4], which involves gradually titrating the aqueous phase containing Shilajit into the organic phase composed of fractionated coconut oil, *Thymus vulgaris* essential oil, and Tween 85 as surfactant, under continuous stirring. Optical microscopy was used to determine the coarse emulsion droplet size (Leica DM1000 LED, Leica Microscopy, Wetzlar, Germany). Droplet size and Zeta potential were measured immediately after preparation and 100-fold dilution with water using Dynamic Light Scattering (Amerigo Particle Size & Zeta Potential Analyzer, Cordouan Technologies, Pessac, France). Each measurement was conducted in triplicate, and the results were reported as mean values ± standard deviation.

Results: The FTIR spectrum of Shilajit confirmed its complex molecular structure rich in oxygenated functional groups such as hydroxyls, carboxyls, carbonyls, and aromatics, supporting the presence of humic and fulvic acids. Shilajit decreased the surface tension of water from 96.52 to 54.25 mN/m, as the Shilajit concentration increased from 0.05 to 10% (w/v), having a critical micellar concentration of 1.3% (w/v). An optimization strategy was developed and implemented to substantially reduce the droplet size of a coarse emulsion, initially characterized by a mean diameter of 6.688 ± 0.76 μm, as determined via optical microscopy. The formulation parameters were adjusted, including the composition of the organic and aqueous phases, the surfactant properties and the homogenization conditions. Throughout these adjustments, stable nanoemulsions were produced, with a significantly reduced dropplet size of 220.37 ± 2.37 nm and a Zeta potential value of -17.83 ±2.98mV following a low-energy phase inversion synthesis method.

Conclusions: Shilajit behaviour as a tensioactive agent was proven, owing to its humic and fulvic acids composition. At concentrations that exceeded its critical micellar concentration, it can serve as stabiliser in oil-in-water emulsions prepared using a phase inversion method.

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EXPRESSING SELENITE-PROCESSING PEPTIDES AT THE SURFACE OF YEAST CELLS

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Introduction: Incorporation of selenium in the form of selenoproteins (glutathione peroxidase, thioredoxin, iodothyronine) has confirmed the essentiality of this element for homeostasis maintenance, since these proteins are involved in crucial oxidative stress defense mechanisms [1]. However, the toxicity of selenium still discloses the issue of the problematic balance between underdose and overdose. Yeasts emerge as optimum biological systems for production of zero-valent nano-selenium, the least toxic form of selenium [2]. Yeast surface display of reducing or nano-stabilizing cysteine-rich proteins, e.g., metallothioneins, hydrophobins or ceratoplatanins, could be employed as an efficient alternative for selenium nanoparticles (SeNPs) with enhanced stability, while potentially diminishing the biological cellular stress involved in the production of these nanostructures [3]. The current study aims to genetically manipulate *Saccharomyces cerevisiae* yeast cells for the production of customized SeNPs, through expression of heterologous selenite-processing polypeptides on the extracellular surface.

Materials and methods: The *S. cerevisiae* metallothionein-encoding gene *CUP1* and some metal-binding subsequences were amplified by standard Polymerase Chain Reaction (PCR). The hydrophobin coding sequences were amplified using Reverse Transcription-PCR (RT-PCR) from first strand cDNA obtained from *Trichoderma reesei QM6a* fungal mRNA. All sequences were cloned into pYD1 vector, a standard vector used for expressing recombinant proteins at the surface of yeast cells. Some of the chimeric constructs were transformed into *S. cerevisiae* yeast cells. The *S. cerevisiae* transformants were grown in sodium selenite (Na_2SeO_3)-supplemented media, in order to investigate their response to selenite exposure. Fluorescent microscopy was used to monitor the expression of the heterologous proteins, based on green fluorescent protein (GFP) which was fused to the sequences of interest. Electronic microscopy assisted by Energy Dispersive X-ray (EDX) was used to assess the morphology of the cells exposed to Na_2SeO_3 and the elemental composition.

Results: The size of the PCR products resulted after the amplification of *CUP1* and its subsequences ranged between ~ 0.7-0.9 kb and the amplification of hydrophobin sequences produced fragments of ~ 0.5 kb, in accordance to expected values. The recombinant gene expression was confirmed by fluorescence microscopy images. Electronic microscopy, in correlation with EDX analysis and macroscopic features of Na_2SeO_3 exposed yeast cells confirmed the formation of biogenic SeNPs. Moreover, the micrographs showed that there were no significant morphological changes of the genetically modified yeast cells.

Conclusions: Cysteine rich sequences of fungal origin have been successfully cloned into pYD1 surface display vector. Heterologous expression for some of these genes in *S. cerevisiae* was confirmed. The transformants produced SeNPs. More comprehensive research into the influence of cysteine rich protein overexpression on the response of selenium exposed yeast cells stands as an innovative future perspective.

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