Book of Abstracts

No. 21/2025

The International Symposium “Priorities of chemistry for a sustainable development”

PRIOCHEM

Organized byINCDCP - ICECHIM, under the aegis and with the support of the Romanian Ministry of Education and Research and National Authority for Research, under the patronage of the Academy of Romanian Scientists

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The International Symposium
"**Prio**rities of **chem**istry for a sustainable development"
PRIOCHEM, XXIst edition

15-17 October 2025, Bucharest, Romania Hallmark event by INCDCP - ICECHIM Bucharest

The original title (in Romanian): Simpozionul Internațional
„Prioritățile chimiei pentru o dezvoltare durabilă” PRIOCHEM
Edited by: INCDCP - ICECHIM Bucharest, Romania

ISSN 2601 - 419X and ISSN-L 2601 - 4181 - English ed., CD-ROM, other Electronic Supports ISSN 2601 - 4181 and ISSN-L 2601 - 4181- English ed., Print

ISSN 2601 - 4203 and ISSN-L 2601 - 4181 - English ed., Online

ISSN 2285 - 8334 and ISSN-L 2285 - 8334 - Romanian ed., Print

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FOREWORD

It is our great pleasure to present the **Book of Abstracts** for the **XXIst International Symposium "Priorities of Chemistry for a Sustainable Development" (PRIOCHEM XXI)**, hosted by the National Institute for Research & Development in Chemistry and Petrochemistry – **ICECHIM Bucharest**. This edition carries a special significance: it celebrates both the scientific vitality of our community and the **75th anniversary of ICECHIM**, an institution that has consistently connected Romanian research to European and global networks.

PRIOCHEM has evolved into a trusted platform where fundamental and applied chemistry meet engineering, life sciences, materials science, digital technologies and cultural heritage conservation. The symposium's guiding idea—*chemistry as an engine for sustainable progress*—is reflected across the contributions gathered here, spanning climate and energy, circular bioeconomy and biorefinery, advanced and multifunctional materials, health and wellbeing, as well as the stewardship of natural resources and the built heritage. Beyond disciplinary labels, these pages testify to a shared commitment: turning excellent science into solutions with measurable societal impact. With 228 participants from 24 countries, PRIOCHEM XXI achieved record attendance, confirming the international recognition of the event. The 86 international participants represented universities, research institutes, and companies from Republic of Moldova, Bulgaria, the United Kingdom, Brazil, Turkey, Armenia, Poland, Slovenia, Malaysia, India, Croatia, Indonesia, Italy, Greece, Nigeria, Kazakhstan, Germany, Azerbaijan, Jordan, Saudi Arabia, Egypt, and France. The impressive number of participants at the International Symposium PRIOCHEM is based on the institute's notoriety, the outstanding results achieved in recent years and the pleasant atmosphere that people are welcomed with every year.

This year's program blends **plenary lectures** from distinguished scholars with **oral communications**, **interactive e-poster sessions**, and **special training activities** devoted to scientific publishing and research integrity. We are particularly proud of the continued success of **Tech Talks – Meetings with Mentors**, a dedicated arena for early-career scientists to engage candidly with innovators and entrepreneurs. By focusing on *technology transfer—its real opportunities and its very real obstacles* (from regulatory frictions and fragmented IP pathways to cultural attitudes toward risk and collaboration), Tech Talks invites our community to move from insight to implementation. Identifying such barriers, openly and precisely, is a prerequisite for building the bridges that turn laboratory results into scalable products and services.

Complementing the core scientific sessions, a series of **satellite workshops** fostered hands-on exchanges among academia, industry, regional development actors and public bodies. The workshops addressed topics such as research valorisation, financing instruments in the European R&I ecosystem, environmental protection and water quality, agri-food safety, smart biomaterials for construction, and digital methods in plant and heritage sciences. Together, they underline a defining feature of PRIOCHEM: an **ecosystem approach** that matches scientific excellence with policy relevance and industrial uptake.

We warmly acknowledge the strategic role of the **Romanian Chemical Society (SChR)**—a long-standing ally in shaping the scientific agenda, mentoring young researchers and celebrating excellence through the Society's awards. We extend our sincere appreciation to all our **partners and supporters** —the **Romanian Ministry of Education and Research - Romanian Authority for Research (ANC)**, the **Academy of Romanian Scientists**, **Radio Romania Cultural,** the **C.D. Nenițescu Foundation,** and the **Association for Development and Integrative Education for the Future**—as well as to our **sponsors and exhibitors** (**Metrohm Romania, MDPI Romania, New Protocol Group, NANOTEAM, Phanos, and AMEX**), whose engagement and confidence have greatly contributed to the success and visibility of this event.

In line with our sustainability pledge, this edition adopts a **hybrid format** and **e-poster** technology to broaden participation while reducing the event's footprint. We also embrace **open science practices**, encouraging authors to disseminate their findings widely and responsibly. Selected contributions will be considered for publication in collaborative venues following rigorous peer review, further amplifying the visibility of the work presented here.

To all **authors and participants**—from students to senior researchers—thank you for your trust and for the intellectual energy you bring to PRIOCHEM. We invite readers to explore this volume not only as a record of current progress, but as a roadmap for new collaborations. May these abstracts spark conversations, inform projects and catalyse the cross-sector alliances that sustainable development requires.

On behalf of the Organising and Scientific Committees, we wish you an inspiring reading and a fruitful symposium.

The organizers

PLENARY SESSIONS

Plenary session

Prof. Dr. Fabiana ARDUINI

Tor Vergata University, Italy

Fabiana Arduini is a Full Professor at Department of Chemical Science and Technologies, University of Rome “Tor Vergata”, founder of start-up SENSE4MED, DG at ISO9001 Certified Laboratory LabCap, University of Rome "Tor Vergata”, Editor of Green Analytical Chemistry Journal, Elsevier, Associated Editor of Microchemical Journal, Elsevier, Specialty Chief Editor Micro- and Nano- Sensors, Frontiers in Sensors.

Her research activity deals with the development of miniaturised electrochemical devices mainly using screen-printed electrodes modified with nanomaterials and paper-based analytical tools applied in environmental, biomedical, agrifood, and defense sectors, with over 200 articles published in peer-review journals, H index 62, Scopus source, > 10 patents, coordinators of several national/international projects including Horizon Europe Pathfinder project Phoenix-OoC (March 2024- February 2027). Her name is listed in the top 2% of most cited researchers in the world.

PAPER-BASED ELECTROCHEMICAL (BIO)SENSORS AS SUSTAINABLE ANALYTICAL TOOLS

In this lecture, I will present the tipping points in the roadmap of electrochemical paper-based analytical (epads) devices followed by my research group in the last 10 years. If we started initially to use paper in fabricating sustainable devices, being paper cost-effective and environmentally friendly, during the last 10 years, we have demonstrated that paper can be used to deliver pump and reagent-free microfluidic epads with unconventional configurations like origami for detection of several target analytes in different matrices belonging to various sectors, namely agrifood, environmental, security, and biomedical ones. Furthermore, epads have also broken several barriers in printed electrochemical devices, demonstrating the reliability of detecting the target analytes in the aerosol phase and on the solid surface without any additional sampling device.

Dr. Alvina AVAGYAN

Scientific Centre of Vegetable and Industrial Crops,
Darakert, Ararat marz, Armenia

Dr. Alvina Avagyan has nearly 30 years of experience in the conservation and sustainable use of crop diversity. She currently serves as a Lead Researcher and Genebank Manager at the Scientific Center of Vegetable and Industrial Crops. Dr. Avagyan is a breeder and co-author of several varieties of emmer wheat and vegetable crops and has published over 110 research papers in this field. She holds a PhD in Biology and graduated from the Faculty of Biology of Yerevan State University and the Armenian Agricultural Institute.

In 2012, Dr. Avagyan was awarded the N.I. Vavilov Medal in recognition of her contributions to the conservation of plant genetic resource collections. Her professional affiliations include membership in the Council of the International Society for Horticultural Science and the IUCN Species Survival Commission. She also serves as the National Coordinator for the European Cooperative Programme for Plant Genetic Resources (ECPGR) and as the National Focal Point for EURISCO. Her extensive experience includes serving as an international expert in numerous projects implemented by the FAO, European Union, World Bank, and UNDP.

EARLY STEPS AND EMERGING RESULTS IN THE INTRODUCTION OF MULTIFUNCTIONAL PLANT VARIETIES IN ARMENIA

Alvina AVAGYAN[1*], Radu Claudiu FIERASCU[2], Laura TADEVOSYAN[1], Gayane MARTIROSYAN[1]

[1]*Scientific Centre of Vegetable and Industrial Crops, Darakert, Ararat marz, Armenia*
[2]*The National Institute for Research & Development in Chemistry and Petrochemistry- ICECHIM,*
Bucharest, Romania
*contact: alvinaav@hotmail.com

Climate change poses serious challenges to the resilience and sustainability of agricultural systems in Armenia. As an adaptive measure, crop diversification and the cultivation of multifunctional plant species and varieties with spicy, therapeutic, and nectar-bearing traits offer opportunities to strengthen agricultural sustainability and promote their integration into functional foods and apiculture. Among the promising yet underutilized plants in the country are hyssop (*Hyssopus officinalis* L.), Moldavian dragonhead (*Dracocephalum moldavica* L.), and crown daisy or edible chrysanthemum (*Glebionis coronaria* (L.) Cass.).

To advance the introduction of multifunctional plants with aromatic–spicy, melliferous, and medicinal properties and to promote their use in functional food and beekeeping, an assessment of the functional value and agronomic performance of different breeding varieties was initiated. The selection of study material was preceded by an analysis of plant genetic resource information systems and online databases of national genebanks, focusing on available modern breeding varieties, their characterization data, and accessibility for stakeholders. The cultivars evaluated included ‘Ametist,’ ‘Moldavia,’ ‘Gorynych,’ ‘Sultan,’ and ‘Gorgona’ of *Dracocephalum moldavica*; ‘Lazur,’ ‘Lekar,’ ‘Accord,’ and ‘Iney’ of *Hyssopus officinalis*; and ‘Tay-tay,’ ‘Ishiban,’ ‘Mirazh,’ and ‘Zhozephina’ of *Glebionis coronaria*, with the aim of characterizing their agronomic traits and biologically active compounds.

Phenological observations showed that all studied varieties of the three species successfully passed through all developmental stages and produced fully mature seeds. With differences of only 2–3 days, the cultivars ‘Tay-tay’ and ‘Ishiban’ of edible chrysanthemum, ‘Moldavia’ and ‘Ametist’ of Moldavian dragonhead, and ‘Lekar,’ ‘Lazur,’ and ‘Gorynych’ of hyssop exhibited a longer growing season compared to the other varieties. Morphological analysis revealed overall uniform growth patterns, with only minor differences in plant height, inflorescence size, and leaf dimensions across cultivars of each species.

The assessment of total phenolic content (TPC), total flavonoid content (TFC), and phenolic acid levels to evaluate the nutritional and functional potential of Moldavian dragonhead and hyssop was performed using spectrophotometric methods and revealed clear differences among cultivars of each species. In *Dracocephalum moldavica*, the cultivar ‘Gorynych’ exhibited the highest concentrations of TPC (45.2 mg gallic acid equivalents per gram dry weight, GAE/g DW), TFC (27.1 mg quercetin equivalents per gram dry weight, QE/g DW), and phenolic acids (30.5 mg caffeic acid equivalents per gram dry weight, CAE/g DW), followed by ‘Ametist’ (28.7 mg CAE/g DW) and ‘Moldavia’ (27.2 mg CAE/g DW). The cultivars ‘Sultan’ and ‘Gorgona’ showed lower values, though the differences were not statistically significant.

In *Hyssopus officinalis*, TPC values also demonstrated noticeable variation. The cultivar ‘Accord’ had the highest TPC (51.4 mg GAE/g DW), while ‘Lazur’ (49.7 mg GAE/g DW), ‘Lekar’ (49.2 mg GAE/g DW), and ‘Iney’ (48.1 mg GAE/g DW) displayed slightly lower but comparable values. A similar pattern was observed for TFC. ‘Accord’ again presented the highest content (29.8 mg QE/g DW), followed by ‘Lazur’ (28.1 mg QE/g DW), ‘Iney’ (27.5 mg QE/g DW), and ‘Lekar’ (26.8 mg QE/g DW). For phenolic acids, moderate differences among varieties were recorded. The cultivar ‘Accord’ showed the highest concentration (34.2 mg CAE/g DW), followed closely by ‘Iney’ (33.0 mg CAE/g DW), ‘Lekar’ (32.4 mg CAE/g DW), and ‘Lazur’ (31.5 mg CAE/g DW).

The demonstrated optimal performance of the studied plants under Armenian conditions indicates their potential for commercial cultivation in the country, taking into account agricultural productivity, environmental sustainability, and functional value.

PD Dr. rer. nat. Martin KILO

Fraunhofer Institute for Silicate Research ISC, Bronnbach branch, Germany

Dr. Martin Kilo is a Senior Scientist at the Fraunhofer Institute for Silicate Research (ISC), Bronnbach branch, Germany, where he leads research activities in glass conservation and materials science. He holds a doctorate in Chemistry from the University of Bayreuth, where he studied heterogeneous catalytic reduction of CO and CO_2 under the supervision of Professors A. Wokaun and A. Baiker.

His career includes positions at the Technical University of Clausthal, the Fraunhofer ISC in Würzburg, and a temporary professorship in Glass Technology at TU Bergakademie Freiberg, where he also served as Dean of Studies. Martin's expertise spans glass technology, heterogeneous catalysis, and mineral materials, with significant contributions to the conservation of glass heritage and the development of sustainable materials. He has conducted research stays at leading institutions including École des Mines Nancy, Keele University, the University of Cambridge, and the Indian Institute of Science Bangalore. He is Chair of the HVG-DGG Glass Forum, Expert in Chemical Analysis of Glass Wool for EUCEB, and co-founder of GlasCampus Torgau. He was also actively involved in organizing international events during the United Nations International Year of Glass 2022.

GLASS DOSIMETERS FOR MONITORING THE CLIMATE IN CULTURAL HERITAGE

M. KILO*, G. MAAS-DIEGELER, S. ROTA, J. LEISSNER

IZKK – International Convention Centre for Cultural Heritage Preservation, Bronnbach 28
97877 Wertheim, Germany,
*martin.kilo@isc.fraunhofer.de, www.izkk.de

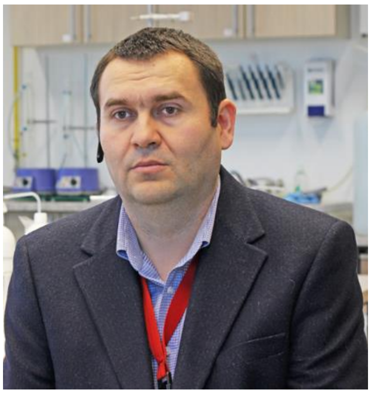
Glass dosimeters consist of glass which is highly corrosive and can react with the atmosphere to form various corrosion products. Depending on the composition of the base glass, the integral dosimeters are more sensitive to the type and amount of corrosive gases.

For the use as glass dosimeters, the glass is molten, cut into slides, and then placed at special positions both in-house as well as outdoor. Furthermore, they can be also put into showcases, and even in particular places making up the showcase (e.g. inside the ventilation system). After expositing the dosimeters for times between 1 to 12 month, the dosimeters are analysed in the lab using IR spectroscopy, optical microscopy and sometimes scanning electron dosimeter. The result of the investigations gives an integral measure on the corrosive environment during the time of exposition.

In the present paper, we present results obtained with different glass dosimeters at locations in churches ´, in industrial heritage objects, and inside different showcases.

As a result, it is shown that the climate in churches can be different at different locations even in the main hall of the church. Furthermore, it is shown that different showcases can be very corrosive, leading to significant degradation to the objects on display. Finally, at industrial sites it can be observed that the location to the weather is corrosive, depending of the local geometrical situation.

Such studies will be even more important provided the climate change will continue to change the climate both outdoor, but for several cultural heritage objects also indoor



Prof. Dr. Habil. Anton FICAI

National University of Science and Technology POLITEHNICA of Bucharest / The Academy of Romanian Scientists, Romania

Anton FICAI (born 1981) is full professor and PhD advisor in the Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA Bucharest being actively involved in both academic and scientific life of the university. His major academic interests are related to Composite Materials for Medicine, NanoBioMaterials for Tissue Engineering and Drug Delivery Systems.

The research interests are much broader, having the chemical approaches in the center, and cover the following topics: tissue engineering; drug delivery systems; multifunctional materials; composite materials; coatings, antimicrobial / antitumoral materials; nanoparticles synthesis and characterization; surface modification; etc. Till now, over 370 scientific papers, from which over 330 ISI papers and 24 books or chapters (including 3 edited books) were published along with 28 patent applications (10 of them being already released). Valedictorian of UPB, former participant and laureate of the National Chemistry Olympiads he was awarded with over 150 Gold Medals, Special Awards or Best Paper Awards and recently, he was awarded with the Special Award for Transfer of the Research Results into Economy during the First edition of the “Gala Cercetării Româneşti”. He is also full member of The Academy of Romanian Scientists and several professional societies.

MESOPOROUS SILICA: AN EMERGING ACTIVE MATERIAL FOR FUTURE APPLICATIONS!

**Dan-Adrian VASILE[1-3], Gabriela PETRISOR[1-4], Rucsandra DUMITRESCU[1-3],
Ludmila MOTELICA[1-5], Natalia DRAGUT[1], Angela SPOIALA[1-3,5], Roxana TRUSCA[2,3],
Ovidiu OPREA[1-4], Dan MIHAIESCU[1-3], Coralia Bleotu[4,5], Denisa FICAI[1-4], Anton FICAI[1-4*]**

[1]Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology Politehnica Bucharest, 060042 Bucharest, Romania
[2]National Center for Micro and Nanomaterials, National University of Science and Technology POLITEHNICA Bucharest, 060042 Bucharest, Romania,
[3]Research Center for Advanced Materials, Products and Processes, National University of Science and Technology Politehnica Bucharest, 060042, Bucharest, Romania,
[4]Academy of Romanian Scientist, Bucharest, Romania
**Contact: anton.ficai@upb.ro*

The history of the mesoporous silica started in 1992 and, during the ~3 decades of intensive research and development many synthesis and modification techniques were developed and consequently new applications were identified, in various field such as medicine, energy or environmental protection. The presentation, is mainly focused our recent advances in the field of synthesis of these mesoporous materials via the classical sol-gel route and their chemical modification. The use of greener synthesis routes will be also presented an being in line with the actual EU trends by using starch instead of the classical CTAB. Regardless the synthesis, these mesoporous materials were loaded with a wide range of agents in order to develop materials with potential applications in: the treatment of dysbiosis, food supplements, drug delivery systems, latent fingerprint development, environmental applications, especially pollutants removal; etc. For all these applications a special attention will be paid to the materials design, including the synthesis itself, the chemical surface modification and loading of the proper active agents (dyes, polyphenols, antibiotics, natural oils/extracts, etc.).

Keywords: grafting materials; composite materials; smart drug delivery; personalized medicine.

Acknowledgments: The authors are acknowledging the support of the project 29ROMD/20.05.2024: “Nanostructured bone grafts with predetermined properties”.

Prof. Dr. Ridha DJELLABI
Alfaisal University, Riyadh, Saudi Arabia

Ridha Djellabi is a chemist with interests and expertise in processes and systems for sustainable environmental remediation and energy generation. He is ranked one of the World's Top 2 % Scientists issued by Stanford University & Elsevier since 2022.

Ridha Djellabi received his PhD from Badji-Mokhtar University (Annaba, Algeria) in Analytical Chemistry and Environment. A Part of his thesis was conducted at the University of Milan, Italy. He carried out a postdoc at LSRE- University of Porto, Portugal. After that, Ridha worked at RCEES, the Chinese Academy of Sciences (Beijing, China) and Shenzhen University (China). Then, he worked as researcher at the University of Milan, Italy. Ridha worked as Personal Docent i Investigador at Universitat Rovira I Virgili, Tarragona in Spain. Currently, Ridha is assistant professor of chemistry at Alfaisal University, Riyadh in Saudi Arabia. He co-authored more than 120 scientific publications, patent and several book chapters.

SOLAR SUPERHEATED STEAM FOR STERILIZATION AND H_2 GENERATION

Ridha DJELLABI
Department of Chemistry, College of Science and General Studies, Alfaisal University, Riyadh, Saudi Arabia
Email : rdjellabi@alfaisal.edu

Solar-to-steam generation (SSG) is an emerging green technology with promising potential for various environmental and energy applications. The concept of solar photothermal water evaporators relies on the accelerated heating of the air water interface while minimizing the heating of bulk water, through the use of floating materials that efficiently convert solar energy into heat. In this approach, the design and engineering of materials and systems play a crucial role in enhancing photothermal conversion efficiency and water evaporation under natural sunlight.

In this talk, we will discuss the fundamental mechanisms of SSG and the key factors that influence heat localization and steam generation. The application of SSG for sterilization and green H2 production will be discussed.

Particular emphasis will be placed on the configuration of SSG systems and the selection of photothermal nanomaterials to generate superheated steam (>100°) under low solar light intensity, highlighting their effective application to generate green H_2 without the use of critical metals and for steam sterilization.

Keywords: Solar-to-steam generation; Solar steam sterilization; H_2 generation; Energy transition; Circular economy.

[1] R. Djellabi, Ridha, et al. Journal of Environmental Chemical Engineering 12.6 (2024): 114253.
[2] R. Djellabi, Chemical Engineering Journal, 431, 134024.

Prof. Ahmad Ali H. OMARI

Jordan University of Science and Technology, Jordan

Professor Ahmad A. Ahmad (Omari) is a Full Professor at the Department of Physics, Jordan University of Science and Technology, where he has served in multiple academic and leadership positions, including Head of the Department of Applied Physics and Dean of the Hafr Al-Batin College of Technology in Saudi Arabia.

With a PhD in Chemical & Materials Engineering and Physics of Thin Films and Nanotechnology from the University of Nebraska–Lincoln, his research interests focus on thin films fabrication and characterization, nanotechnology, optical coatings, biomedical alloy coatings, polymers, and energy-related applications. He authored over 150 scientific papers in international journals and has supervised or co-supervised more than 45 master's students.

Professor Omari has been recognized as one of the world's Top 2% Scientists in 2024 according to the Stanford/Elsevier global ranking and was honored by the Jordanian Physicists Association as a Distinguished Physicist in Jordan. His expertise spans across advanced thin film deposition techniques, nanocomposites, catalysis, and water treatment, with applications ranging from renewable energy to biomedicine.

ELECTROCHEMICAL PERFORMANCE OF Er-DOPED TITANIA FILM FOR ENERGY STORAGE APPLICATIONS

Qais M. AL-BATAINEH*, Ahmad A. AHMAD*, Ahmad MIGDADI.
Dept. of Physics, Faculty of Science, Jordan University of Science and Technology, P.O. Box 3030, Irbid 22110, Jordan
* Corresponding author: qais.albataineh@tu-dortmund.de and sema@just.edu.jo

Developing efficient and sustainable energy storage systems is critical for the advancement of modern technologies. Supercapacitors, offering high power density and long cycle life, are pivotal in this domain. This work investigates the potential of using Er-doped titania films as electrode materials for supercapacitors. The physical properties of Er-doped titania film compared to undoped titania film were investigated through detailed characterization. Electrochemical characterization revealed that Er-doped titania exhibits remarkably enhanced specific capacitance, rate capability, and energy density in both KOH and H2SO4 electrolytes, accompanied by improved cycling stability. More specifically, the specific capacitances of the undoped titania film are 133.7 and 94.9 $F \cdot g^{-1}$ at a scan rate of 50 $mV \cdot s^{-1}$ in KOH and H2SO4 electrolytes, respectively. Introducing Er ions into titania films, increasing the specific capacitance to 171.5 and 104.0 $F \cdot g^{-1}$ in KOH and H_2SO_4 electrolytes, respectively. These findings offer crucial insights into how rare-earth doping can effectively tailor the properties of metal oxide films, thereby contributing to the design of next-generation energy storage devices.

Keywords: Energy storage applications; Supercapacitors; Titania (TiO2); Er-doped titania; Specific capacitance.

Dr. Mahmoud H. Abu ELELLA
Cairo University, Egypt
University of Reading, United Kingdom

Dr. Mahmoud H. Abu Elella is a Lecturer in Polymer Chemistry at the Department of Chemistry, Faculty of Science, Cairo University, Egypt. He received both his M.Sc. and Ph.D. in Polymer Chemistry from the same institution. Recently, he joined the School of Chemistry and Pharmacy, University of Reading, UK, as a Postdoctoral Researcher from May/2021 to March/2025. With over 12 years of research experience in Polymer Science, his work has focused on the synthesis and development of polymer formulations, including grafted copolymers, hydrogels, scaffold materials, polymer nanocomposites, nanoparticles, nanostructured lipid nanoparticles, polymer-coated liposomes, nanoemulsions, polymer-coated silica nanoparticles, and spray-dried microparticle powders for biomedical applications. He has also developed mucoadhesive inhalable polymeric powders using two-fluid and three-fluid nozzle spray drying techniques for pulmonary and nasal drug delivery.

He has a strong record of interdisciplinary collaboration, project leadership, scientific publication (50+ papers and 25 book chapters, h-index 30), and grant-supported research. He has been recognized among the World's Top 2% Scientists (2023-2025). Experienced in regulatory compliance, analytical characterization, and academic-industry knowledge transfer. He has actively presented his research at several international conferences and seminars and serves as a peer reviewer for leading journals, including Carbohydrate Polymers, Chemical Engineering Journal, International Journal of Biological Macromolecules, and ACS Sustainable Chemistry & Engineering.

RECENT ADVANCES IN MODIFIED CHITOSAN-BASED DRUG DELIVERY SYSTEMS FOR TRANSMUCOSAL APPLICATIONS

Mahmoud H. Abu ELELLA[1,2]
[1]*Chemistry Department, Faculty of Science, Cairo University, Giza, 12613, Egypt*
[2]*School of Pharmacy, University of Reading, Reading RG6 6AD, United Kingdom*

Recently, transmucosal drug delivery (TDDSs) have been extensively studied because they protect therapeutic agents from degradation; improve drug residence time at the mucosal membranes; and facilitate sustained drug release for a prolonged period. Chitosan is a well-researched polymeric excipient due to its biocompatibility, non-toxicity, biodegradability, mucoadhesive, antimicrobial, and low immunogenicity. Its limited mucoadhesiveness in the physiological environment necessitated its chemical modification. This review highlights the recent advances in the chemical modification of chitosan with various chemical groups to generate functionalized chitosan derivatives, such as thiolated, acrylated, methacrylated, boronated, catechol, and maleimide-functionalized chitosans, which exhibit superior mucoadhesive capabilities compared to the parent chitosan. Moreover, it presents various prepared dosage forms, including tablets, hydrogels, films, micro/nanoparticles, and liposomes/niosomes, for drug administration through different mucosal routes, such as oral, buccal, nasal, ocular, colonic, intravesical, and vaginal routes.

The reported data from preclinical studies of these pharmaceutical formulations have revealed the controlled and target-specific delivery of therapeutics because of their formation of covalent bonds with thiol groups on the mucosal surface. All functionalized chitosan derivatives exhibited long drug residence time on mucosal surfaces and sustainable drug release with excellent cellular permeability, drug efficacy, and biocompatibility. These promising data could be translated from the research laboratories to the clinics with consistent and intensive research effort.

Dr. Eng. Gianluca VISCUSI

University of Salerno, Italy

Dr Gianluca Viscusi graduated in Chemical Engineering in 2016 with full honors at the Department of Industrial Engineering of the University of Salerno. Since 2015, he has been a teaching assistant of Fundamentals of Chemistry. After spending a 5-month period in the CSIC center of Valencia (Erasmus project), he participated in the Research and Innovation Staff Exchange of Graphene 3D project spending research periods in Sichuan University (Chengdu, China) and Mackenzie Presbyterian University (San Paolo, Brazil). In 2021, he got his PhD, in Industrial Engineering, which concerns the design, production and characterization of novel materials obtained from sustainable polymers and hemp fibers. Currently, he is a Fellow researcher and Adjunct Professor of Chemistry at the Department of Industrial Engineering (University of Salerno).

His main research topics concern:

- Relation between microstructure and physical properties of polymers and polymeric composites.
- Design, fabrication and characterization of physical properties of natural fibers based composites
- Production of nanocomposites and micro composites obtained through electrospinning as sustainable systems for tissue engineering and water remediation applications
- Application of Mechanochemistry to design advanced materials
- Synthesis of novel smart materials for removing pollutants from water effluents

Up to now, he is the author of more than 80 publications (Scopus Identifier: 57195350368).

GREEN APPROACHES TO DESIGN NOVEL ADSORBENTS FOR WATER DECONTAMINATION

Prof. Dr. Francois-Xavier PERRIN

University of Toulon, France

After graduating in chemical engineering from the University of Marseille, Prof. Dr. Francois-Xavier PERRIN completed a doctorate at the University of Besançon in France working on the electropolymerization of phenol derivatives and heterocyclic compounds

In 1998, he joined the MAPIEM Laboratory in the University of Toulon. Professor since 2011, he is currently head of the chemistry department at the University of Toulon and head of the physical chemistry and durability of materials research group in Mapiem laboratory. His research activity covers heterogeneous organic matrix systems, with a particular focus on the implementation of functional 1D or 2D nanofillers, notably those based on conductive polymers and nanocarbons

CEMENTITIOUS COATINGS: A REALISTIC PROTECTIVE ALTERNATIVE TO ORGANIC COATINGS?

Dr hab. Michał CEGLOWSKI

Adam Mickiewicz University, Poznań, Poland

Michał Cegłowski graduated from the Faculty of Chemistry at Adam Mickiewicz University, Poland, in 2011 and received his Ph.D. from the same institution in 2015. Following his doctoral studies, he completed a PostDoc at Ghent University in the laboratory of Prof. Richard Hoogenboom. He is currently an Associate Professor of Chemistry at Adam Mickiewicz University, where he leads a research group focused on developing functional and selective adsorbents for solid-phase extraction. His work emphasizes designing materials – ranging from molecularly imprinted polymers, which are tailored for the selective recognition of specific molecules, to hybrid organic-inorganic materials – that can be used in combination with analytical techniques to quantify persistent organic pollutants. Michał has served as the principal investigator and grant holder for six research projects, contributing to advancements in analytical chemistry and environmental monitoring.

ADDRESSING TRACE CONTAMINANT CHALLENGES: NOVEL APPLICATIONS OF POROUS ADSORBENTS AND MOLECULARLY IMPRINTED POLYMERS IN AMBIENT MS

Dr hab. Michał CEGŁOWSKI, prof. UAM
Department of Supramolecular Chemistry, Faculty of Chemistry, Adam Mickiewicz University, Poznań, Poland
e-mail: michal.ceglowski@amu.edu.pl

The proliferation of trace organic contaminants - including pharmaceuticals, personal care products, herbicides, and industrial chemicals - in environmental water sources poses a significant challenge to public health and ecological stability. Traditional analytical methods for these compounds often require complex, time-consuming sample preparation steps involving extraction, separation, and purification, which limits their utility for rapid screening and in-field analysis.

This lecture presents the development and application of novel functional polymeric materials designed to overcome these challenges. This work focuses on two primary classes of materials: porous adsorbents synthesized via High Internal Phase Emulsion (HIPE) and, most notably, Molecularly Imprinted Polymers (MIPs). These materials are engineered using versatile and highly functionalizable polymer backbones, including poly(2-oxazoline)s (PAOx) and polyethyleneimine (PEI). By strategically incorporating specific functional groups, we create tailored molecular recognition sites that exhibit high selectivity and strong binding affinity for target trace-level analytes.

A key innovation of this work is the synergistic coupling of these highly selective adsorbents with ambient ionization mass spectrometry (MS), specifically Flowing Atmospheric-Pressure Afterglow (FAPA-MS). This approach combines selective analyte preconcentration directly on the polymer with rapid, direct-readout quantification, effectively eliminating extensive sample preparation.

The successful application of this MIP-MS methodology for the sensitive detection of a diverse range of contaminants will be demonstrated, including herbicides (e.g., 2,4,5-T, 2,4-D, picloram), pharmaceuticals (e.g., indomethacin, diclofenac), and explosives (e.g., picric acid, RDX, PETN). The engineered MIPs consistently show significantly higher adsorption capacities (q_m) and selectivity factors compared to their non-imprinted polymer (NIP) counterparts. This enhanced performance translates to excellent analytical figures of merit, with detection limits (LODs) reaching the nanomolar level. Crucially, the methodology has been validated in complex real-world matrices, including river and wastewater samples, demonstrating high recovery rates, accuracy, and reliable precision. This research establishes a powerful and adaptable strategy for developing next-generation analytical tools for critical applications in environmental protection, forensic science, and public health monitoring.

INVITED LECTURES

Invited Lectures

Mădălina - Elena ARGĂSEALĂ
Senior Expert, ROHEALTH – The Health and Bioeconomy Cluster

Mădălina - Elena Argăseală has over 20 years of experience in drafting and implementing project proposals. She has been active in the quadruple-helix medical and bioeconomy ecosystem since 2011 and has been involved in international projects since 2009.

She also has experience in strengthening institutional capacities, developing public policies, organizing economic missions, and supporting the development of startups and spinoffs. Her expertise covers multiple fields of interest, such as the development of socio-economic research methodologies, collection and analysis of qualitative and quantitative data, cost-effectiveness analysis, cost-benefit analysis, public policy design in the health sector, and the development of community programs for health prevention.

EUROPEAN FUNDING OPPORTUNITIES IN THE BIOECONOMY AND BEYOND: INSIGHTS AND SUCCESS STORIES

Emily YOUNG
Journal Manager, Frontiers in Materials

Emily Young joined Frontiers in early 2017, first supporting the launch of new titles as well as the strategic development and expansion of established titles. She has worked with over 50 different journals, though largely supporting those within the chemical and materials science fields.

Since February 2020 she has been the Journal Manager of Frontiers in Materials (JIF 2.9, CiteScore 5.6), a multidisciplinary materials science journal that explores the breadth of materials science and engineering. Emily has also been Journal Manager for a number of younger titles, including: Frontiers in Sensors (2020 - 2023); Frontiers in Membrane Science and Technology (2024); Frontiers in Coatings, Dyes and Interface Engineering (2024); and Frontiers in Catalysis (2024). She was based in Lausanne, Switzerland for over 7 years, relocating to the UK in 2024. Emily completed a Bachelors with Honors in History with a Year Abroad at the University of Birmingham, UK - her international year was spent at Wilfrid Laurier University, Canada. Her studies focused on various aspects of European, Asian, US, and Canadian history.

TIPS AND TRICKS AND IMPORTANCE OF OPEN-ACCESS PUBLISHING

emily.young@frontiersin.org

This fast-paced session covers Open Access publishing, how quality is safeguarded throughout the publication process, and practical tips to publish with confidence. We introduce OA routes and Frontiers' model, including how Institutional Partnerships support the transition to OA, and outline strategies to increase research visibility and reach. We then unpack how credible OA journals uphold quality—editorial triage, transparent peer-review workflows, research-integrity checks (e.g., plagiarism screening, image/data forensics), and industry collaborations—plus how to use AI ethically to support, not replace, human decisions. Finally, we share practical tips for selecting the right journal, preparing a rigorous and transparent manuscript, avoiding common rejection pitfalls, and boosting discoverability and impact (e.g., Frontiers' article level metrics). The session is ideal for early and mid-career researchers, though offers valuable insights for individuals at any career stage.

Eng. Iustina BOSTAN
Journal Relations Specialist, MDPI Romania

Eng. Iustina Bostan graduated in Biotechnical Engineering from Babeş-Bolyai University, Faculty of Biology, in Cluj-Napoca, Romania. She began her career at MDPI in 2021 as an Editor for the journal Gels, where she quickly gained extensive editorial experience.

Through dedication and continuous professional growth, she advanced to the role of Journal Relations Specialist, being responsible for maintaining strong collaboration with external Editors and ensuring that academic integrity and transparency in editorial processes are upheld. She now also serves as a Senior Conference Representative for MDPI.

ETHICAL ISSUES IN PUBLISHING

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

(Oral presentations)

1. *POLYMERIC BIOMATERIAL BASED THIOCOLCHICOSIDE & FOLIC ACID LOADED NANOCOMPOSITE: INVITRO AND IN-VIVO ASSESSMENTS*
2. *FAPA-MS ENHANCED BY MOLECULARLY IMPRINTED POLYMERS FOR TARGETED ENVIRONMENTAL ANALYSIS*
3. *THE DESIGN AND DEVELOPMENT OF SOME FLUOROQUINOLONES WITH ACTIVITY AGAINST MULTIDRUG RESISTANT MICROORGANISMS*
4. *A COMPUTATIONAL STUDY OF THE EFFECTIVENESS OF TERT-AMYL METHYL ETHER AND ETHYNYLCYCLOPENTANOL AS OCTANE-BOOSTING ADDITIVES IN GASOLINE*
5. *ULVA LACTUCA – A SOURCE OF POLYSACCHARIDES FOR GOLD NANOPARTICLES SYNTHESIS*
6. *PROPERTIES OF BIOCOMPOSITEMATERIALS CONTAINING Ag or Au NANOPARTICLES*
7. *SYNTHESIS OF DENDRITIC BIOACTIVE GLASS NANOPARTICLES AND THEIR APPLICATION IN 3D-PRINTED HYDROGELS FOR BONE TISSUE ENGINEERING*
8. *PURIFICATION STRATEGIES FOR BIOCOMPATIBLE N,P-DOPED CARBON DOTS: FROM SYNTHESIS TO SAFE MEDICAL USE*
9. *MULTIFUNCTIONAL EGGSHELL WASTE BEADS*
10. *ECO-ENGINEERED ZINC OXIDE NANOCARRIERS: A GREEN MICROWAVE-NATURAL PRODUCT STRATEGY FOR SUSTAINABLE PLATINUM-BASED CANCER THERAPY*

POLYMERIC BIOMATERIAL BASED THIOCOLCHICOSIDE & FOLIC ACID LOADED NANOCOMPOSITE: INVITRO AND IN-VIVO ASSESSMENTS

Barkat Ali KHAN[1*], Awais KAREEM[1]

[1]*Drug Delivery and Cosmetic Lab (DDCL), Gomal Centre of Pharmaceutical Sciences, Faculty of Pharmacy, Gomal University, D.I.Khan, 29050, Pakistan*

**Corresponding author: barkat.khan@gu.edu.pk*

Keywords: Thiocolchicoside, Nanocomposites, Drug delivery

Introduction: Thiocolchicoside (TCS) is widely indicated for the management of orthopedic, traumatic and rheumatological inflammatory conditions. However, hepatic first pass metabolism and poor permeability greatly hinders its oral bioavailability. In addition, rheumatoid arthritis (RA) patients receiving TCS therapy have progressively depleted folate reserves[1,2].

Materials and methods: The present study was aimed to enhance TCS efficacy through development of nanocomposites by high sheared homogenization co-loaded with folic acid for transdermal delivery. The optimized TCS-FA nanoemulgel was further characterized for thermodynamic stability, zeta analysis, FTIR, drug content, viscosity, spreadability, in-vitro drug release and ex-vivo permeation studies. Additionally, carrageenan induced hind paw edema was used to estimate in-vivo anti- inflammatory activity in animal model.

Results: The optimized formulation exhibited good thermodynamic stability with no phase separation or creaming. pH was within physiological skin pH range i.e. 4.5-5.5. The findings of size, PDI, surface charge and drug content were also within acceptable limits. FTIR demonstrated compatibility between drug and excipients used in nanoemulgel formulation. The nanoemulgel indicated optimum viscosity and spreadability to be applied conveniently over the skin. The nanoemulgel released 85.93±1.77% of TCS and 65.39±1.12% of FA after 12 h. Similarly, 80.19±4.65% of TCS and 69.96±5.39% of FA were permeated through skin after 12h. In-vivo anti-inflammatory effect was confirmed by greater potential of optimized formulation to inhibit paw edema significantly ($p<0.05$; ANOVA) compared to the control and standard group.

Conclusions: It could be concluded that topical administration of nanocomposites resulted in adequate amounts of folic acid delivery, demonstrating the enhanced anti-inflammatory potential of TCS with FA in RA and can be a safe and effective alternative to the conventional oral therapy.

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FAPA-MS ENHANCED BY MOLECULARLY IMPRINTED POLYMERS FOR TARGETED ENVIRONMENTAL ANALYSIS

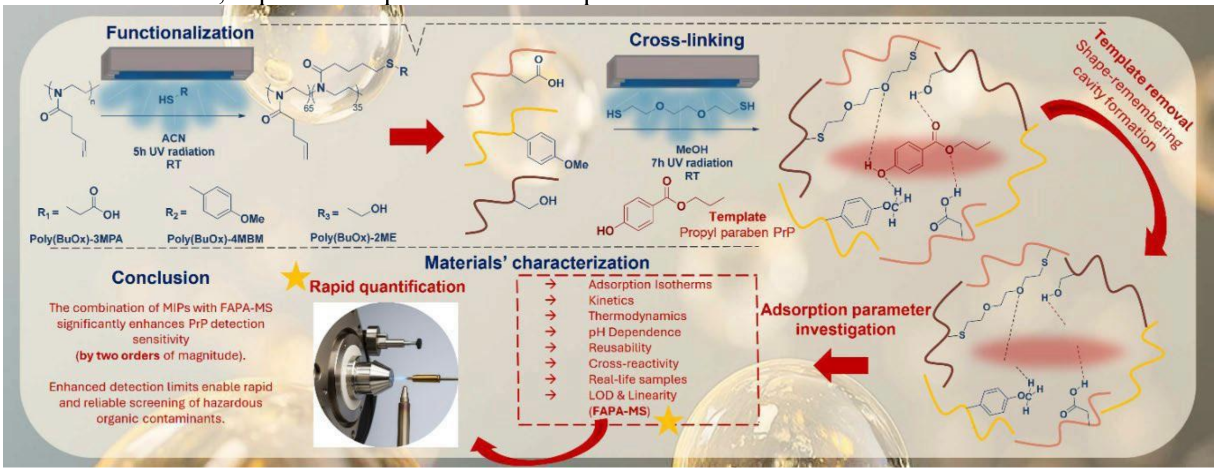
Aleksandra LUSINA [1*], Michał CEGŁOWSKI [1]
[1]Adam Mickiewicz University, Uniwersytetu Poznańskiego 8, Poznań, Poland
**Corresponding author: aleksandra.lusina@amu.edu.pl*

Keywords: Molecularly Imprinted Polymers; FAPA-MS Technique; Environmental Water Treatment

Introduction: Molecularly Imprinted Polymers (MIPs) are synthetic materials engineered to selectively recognize target analytes through cavities complementary in size, shape, and chemical functionality. Their excellent selectivity, stability, and reusability make them promising candidates for real-time, cost- effective environmental monitoring [1]. The work focuses on the integration of MIPs with Flowing Atmospheric-Pressure Afterglow Mass Spectrometry (FAPA-MS) - a rapid, preparation-free technique that develops sensitive and selective sensors for the detection of environmentally relevant contaminants, including herbicides (MCPA) [2], fluorinated surfactants (PFOS), explosives (RDX) [3], and preservatives (propylparaben) [4].

Materials and methods: MIPs were synthesized using a non-covalent imprinting approach, with target molecules serving as templates during polymerization. For detection, FAPA-MS was used to analyze MIP-extracted analytes directly from complex matrices without prior sample preparation. The technique allows real-time ionization and mass spectrometric detection in ambient conditions.

Results: The MIP-FAPA-MS system demonstrated high selectivity and sensitivity towards the target compounds. The system enabled direct detection of analytes in water and solid-phase environmental samples within seconds. The combination of MIPs and FAPA-MS offers a powerful platform for next- generation environmental sensors, capable of rapid and accurate pollutant detection in real-world conditions.



The combination of MIPs with FAPA-MS significantly enhances PrP detection sensitivity (**by two orders** of magnitude).

Enhanced detection limits enable rapid and reliable screening of hazardous organic contaminants.

Conclusions: The integration of MIPs with FAPA-MS offers a highly effective platform for the selective, rapid, and preparation-free detection of trace environmental contaminants. The developed MIP-based sensors demonstrated excellent selectivity and sensitivity toward various target compounds, including herbicides, fluorinated surfactants, explosives, and preservatives. The results confirm the potential of MIP-FAPA-MS systems to improve pollutant detection in complex environmental matrices and contribute to more effective environmental protection strategies.

Acknowledgements*: This work was supported by the National Science Centre, Poland, under grant number 2020/37/B/ST5/01938.*

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THE DESIGN AND DEVELOPMENT OF SOME FLUOROQUINOLONES WITH ACTIVITY AGAINST MULTIDRUG RESISTANT MICROORGANISMS

Lucia PINTILIE [1*], Maria MAGANU [2], Constantin DRAGHICI [2], Miron Teodor CAPROIU [2], Mădălina-Diana GABOREANU [3], Ioana-Cristina MARINAS [4]

[1]National Institute for Chemical-Pharmaceutical Research and Development 112 Vitan Av., Bucharest-3, Romania
[2]Institute of Organic and Supramolecular Chemistry „Costin D. Nenițescu" București ,
202B Splaiul Independenței, district 6, Romania
[3] University of Bucharest, Faculty of Biology, Department of Botany and Microbiology, 90 Panduri Street, Bucharest 5, Romania
[4] University of Bucharest, University of Bucharest Research Institute, Department of Life, Environmental and Earth Sciences, 90 Panduri Street, Bucharest 5, Romania
**Corresponding author: lucia.pintilie@gmail.com*

Keywords: fluoroquinolones, drug design, molecular docking, antimicrobial agents.

Introduction: The resistance developed by bacteria threatens virtually all classes of antibacterial agents. The economic impact of antibiotic resistance is considerable and will continue to grow. The EU estimates that antibiotic resistance causes 600 million days of lost productivity every year. According to the World Bank, without limiting antibiotic resistance, the annual costs could become as massive as those of the global financial crisis that began in 2008. Moreover, the sustainable development goals for 2030, ending poverty, ending hunger, ensuring a healthy lives, reducing inequalities and revitalizing global partnerships - are likely to remain unrealized. "A post-antibiotic era means the end of modern medicine as we know it. Things as common as strep throat or a child's scraped knee could kill again." (Margaret Chan-Director General WHO-2012). The identification of a new molecule with activity against multidrug-resistant microorganisms and its development into a new drug would be an important step in the fight against antibiotic resistance, leading to the improvement of the health status and life expectancy of the population, the reduction of medical costs, increasing productivity.

Materials and methods: The paper presents original contributions in the drug design, molecular docking, synthesis [1] and evaluation of antimicrobial activity of some fluoroquinolones [2,3]. The obtained compounds have been analyzed by physicochemical methods (1H-NMR, 13C-NMR, IR, thin layer chromatography). The antimicrobial activity has been evaluated against Gram-positive (*S. aureus,*
E. faecalis) and Gram-negative (*K. pneumoniae, P. aeruginosa*) microorganisms.

Results: The study of antimicrobial activity revealed the ability of the synthesized fluoroquinolones to inhibit the growth of microorganisms, especially Gram-positive bacteria (*S. aureus, E. faecalis*), but also Gram-negative ones (*K. pneumoniae, P. aeruginosa*).

Conclusions: An increased antibacterial activity was observed in compounds FPQ202, FPQ203, FPQ205 and FPQ 206. The significant microbicidal effect was observed in FPQ200 and FPQ205 on S. aureus and only in FPQ200 and FPQ201 on *E. faecalis*.

***Acknowledgements**: This work was carried out through the NUCLEU Program within the National Research Development and Innovation Plan 2022-2027, carried out with the support of MCID, project no. PN 23-28 0101*

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A COMPUTATIONAL STUDY OF THE EFFECTIVENESS OF TERT-AMYL METHYL ETHER AND ETHYNYLCYCLOPENTANOL AS OCTANE-BOOSTING ADDITIVES IN GASOLINE

Rakhymzhan KOSSANOV [1*], Yessengali GILAZHOV [1], Amanzhan SAGINAEV [1], Amangeldi ABILKHAIROV [1]
[1] *Atyrau University of Oil and Gas*
**Corresponding author: rakhymzhankossanov@gmail.com*

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

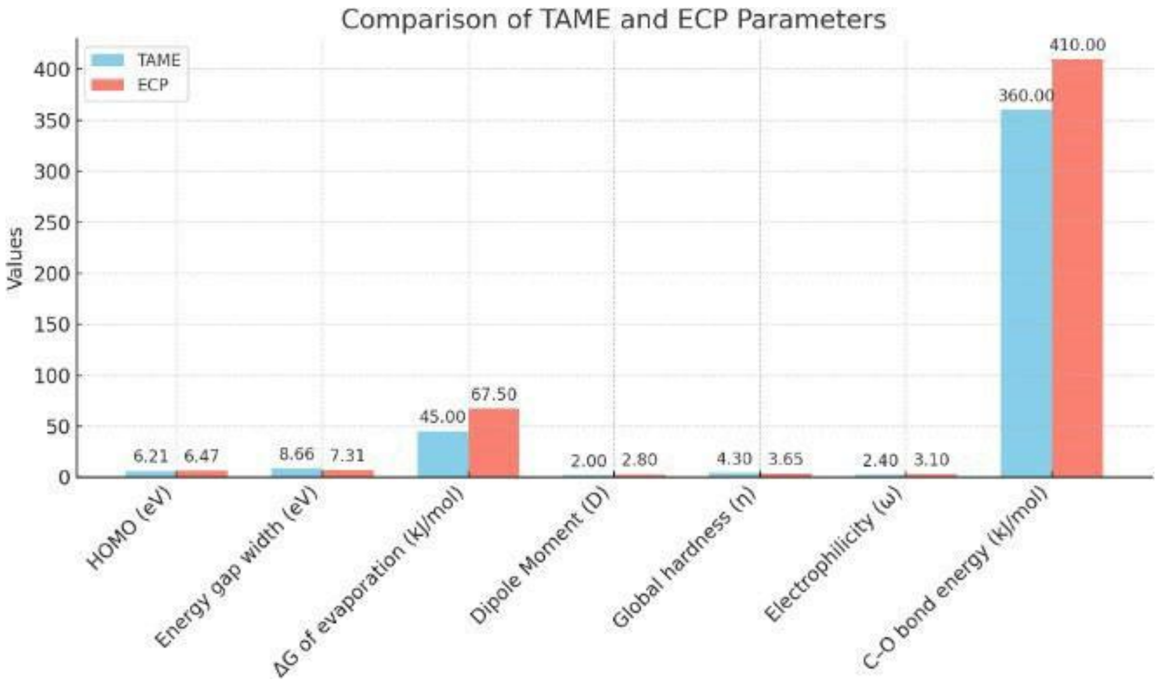
Introduction: Contemporary high-compression engines demand fuels with strong resistance to knocking in order to prevent incomplete combustion, mechanical damage, and higher exhaust emissions, all of which undermine engine performance and durability. To address this, antiknock additives are incorporated at the refining stage and may also be used by consumers to regulate gasoline's octane rating, particularly when engine deposits trigger knocking [1]. In light of stricter environmental regulations, the refining industry is moving toward fuels that combine enhanced efficiency with lower ecological impact, targeting reduced emissions of CO, NO_x, and unburned hydrocarbons.

Materials and Methods: This literature-based section of the master's thesis focuses on evaluating tert-amyl methyl ether (TAME) and ethynylcyclopentanol (ECP) as potential gasoline additives. The purpose is to provide a theoretical analysis of their capability to improve fuel octane numbers. The review considers their role in combustion, antiknock performance, and influence on gasoline's physicochemical properties. Emphasis is placed on the molecular structure of TAME and ECP and their interactions with fuel components. Findings from this research may aid in designing more efficient and environmentally sustainable fuel formulations.

At present, MTBE remains the dominant oxygenate globally, with production and consumption levels reaching approximately 26.5 million tons [5]. Typically, oxygenates are used at concentrations of 3–15% by volume, while the overall oxygen content in gasoline should not exceed 2.7%. At such levels, these additives do not require modifications to existing engine designs.

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?

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



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.

Acknowledgements: *This research was supported by the Nazarbayev Intellectual school and Atyrau University of Oil and Gas.*

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ULVA LACTUCA – A SOURCE OF POLYSACCHARIDES FOR GOLD NANOPARTICLES SYNTHESIS

Miruna-Ioana SAVA [1], Mihaela DEACONU [2*], Cristian MATEI [1], Daniela BERGER [1]

[1]Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA Bucharest, 1-7 Gheorghe Polizu Str., district 1, Bucharest, Romania

[2]CAMPUS Research Institute, National University of Science and Technology POLITEHNICA Bucharest, 313 Splaiul Independenței, district 6, Bucharest, Romania

**Corresponding author: mihaela.deaconu@upb.ro*

Keywords: Ulva lactuca, polysaccharides, nanoparticles, gold

Introduction: *Ulva lactuca* is a naturally occurring green alga found in marine ecosystems. In the Black Sea it is particularly abundant, especially on the Romanian coast. The principal and most valuable component resulting from the processing of this alga is ulvan, a sulphated polysaccharide with potential biological activities, including antioxidant, anticancer, anticoagulant, or anti-inflammatory effects [1]. The aim of the study was to obtain gold nanoparticles through a green synthesis method usingulvan.

Materials and methods: Ulvan was extracted in water from dried *Ulva lactuca* under high autogenous pressure. An estimation of molecular weight of the extracted polysaccharide was performed using DLS. The extract was characterised by FTIR spectroscopy and SEM-EDX investigation. The thermal stability was assessed with DSC and the ash content was evaluated from TGA. The structural characterization of the extracted ulvan was performed by assessing the amount of sulfated groups, and the content of carbohydrates and uronic acids. The last two were evaluated from the hydrolized extract and they were quantified as glucose equivalents and glucuronic acid, respectively.

Results: The extraction yield of ulvan was 8.5%, and the extract showed a high carbohydrate content (61.6 %) and high content of uronic acids (29.5 %). FTIR spectroscopy confirmed the presence of sulfated groups, which are specific for ulvan. The extract exhibited thermal stability up to 100 °C, which makes it particularly suitable for manufacturing processes requiring high temperatures. Gold nanoparticles were synthesized in the presence of ulvan extract, under various conditions.

Conclusions: *Ulva lactuca* is a sustainable source of bioactive compounds, with its primary polysaccharide, ulvan, exhibiting structural and functional characteristics suitable for biomedical applications. The extracted polysaccharide contains high amounts of carbohydrates and uronic acids, along with sulfated sugar units. These results support the use of ulvan in the fabrication of advanced materials based on gold nanoparticles for biotechnology applications.

Acknowledgements: The authors are grateful for the financial support from UEFISCDI (Romania) through the project no. 48PED/2025.

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PROPERTIES OF BIOCOMPOSITEMATERIALS CONTAINING Ag or Au NANOPARTICLES

Alin G. GHEORGHE [1], Mihaela DEACONU [1,2], Ana-Maria BREZOIU [1], Ana-Maria SECIU [3],
Bogdan TRICĂ [3], Cristian MATEI [1], Daniela BERGER [1*]

[1]Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA
Bucharest, 1-7 Polizu Street, 011061 Bucharest, Romania
[2]CAMPUS Research Institute, National University of Science and Technology Politehnica Bucharest, 313
Splaiul Independenței, 060042 Bucharest, Romania
[3]National Institute of R&D for Biological Sciences, 296 Splaiul Independetei, 060031 Bucharest, Romania
[4]INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania
**Corresponding author: daniela.berger@upb.ro*

Keywords: metallic nanoparticles; mesoporous silica; wild bilberry leaves extract

Introduction: Recently, mesoporous silica nanoparticles functionalized with organic moieties and/or modified with inorganic nanoparticles have been used as carriers due to their tunable surface properties, large pore volume, ability to accommodate a large amount of bioactive substances, and biocompatibility.[1] Gold nanoparticles (AuNPs) are widely used in diagnostic and treatment approaches, such as point-of-care testing [2] or photothermal therapy [3], while silver nanoparticles (AgNPs) are well known for their antimicrobial potential.[4] Our research focused on the synthesis of colloidal AuNPs and AgNPs, which were subsequently loaded onto mesoporous silica nanoparticles functionalized with 3-mercaptopropyl and 3-aminopropyl groups, respectively. The resulting silica-based materials were used as carriers for polyphenols from an ethanolic extract prepared from wild bilberry leaves.

Materials and methods: The polyphenolic extract was obtained by extraction under additional argon pressure and then characterized by spectrometric determination of the total polyphenol and flavonoid content, as well as the radical scavenging activity. Components of the wild bilberry leaves extract were quantified by high-performance liquid chromatography. The extract was incorporated into mesopores of silica support modified with Ag or Au by impregnation, followed by solvent evaporation under vacuum. The silica-type supports were characterized by X-ray diffraction, FTIR spectroscopy, thermal analysis, scanning and transmission electron microscopy, and nitrogen adsorption-desorption isotherms recorded at 77 K.

Results: The extract encapsulated in Au or Ag modified mesoporous silica did not show cytotoxicity on human HaCat keratinocytes up to a treatment dose of 50 µg/mL. An improved antioxidant activity of the extract incorporated in the proposed mesoporous silica carriers modified with Ag or Au nanoparticles was demonstrated on human HaCat keratinocytes compared to the free extract. In the case of the sample containing Au NPs, a better anti-inflammatory potential was determined than that of the sample containing Ag NPs by reducing the amount of TNF-α cytokines secreted by inflamed THP-1 monocytes.

Conclusions: The developed biocomposite materials based on Ag and Au NPs with antioxidant, anti-inflammatory properties and good biocompatibility could be included in formulations for topical applications.

Acknowledgements*: Financial support from UEFISCDI, project no. 48PED/2025 is highly appreciated.*

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SYNTHESIS OF DENDRITIC BIOACTIVE GLASS NANOPARTICLES AND THEIR APPLICATION IN 3D-PRINTED HYDROGELS FOR BONE TISSUE ENGINEERING

Andreea Luiza MIRT [1,2,3*], **Esin TUNCEL** [2], **Mihaela CILTEA-UDRESCU** [1],
Gabriel VASILIEVICI [1], **Anton FICAI** [3], **Aldo R. BOCCACCINI** [2]
[1] *INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania*
[2] *Institute of Biomaterials, University of Erlangen–Nuremberg, Cauerstraße 6, 91058, Germany*
[3] *National University of Science and Technology POLITEHNICA Bucharest,*
313 Splaiul Independenței, 060042 Romania
**Corresponding author: luiza.mirt@icechim.ro*

Keywords: bioactive glass, hydrogel, scaffolds, 3D printing

Introduction: Bone diseases and injuries such as osteoporosis, osteomyelitis and fractures remain major clinical challenges, especially with an aging population. Bone tissue engineering provides a pathway by combining biomaterials, cells, and signaling factors for creating scaffolds that mimic native bone [1]. Hydrogels composed of natural polymers, particularly when reinforced with bioactive glasses, have gained attention due to their biocompatibility and ability to support osteogenesis and angiogenesis [2]. In this study, we focus on the synthesis of dendritic mesoporous bioactive glass nanoparticles (DMBGNs) and their application as functional additives for 3D-printed hydrogel scaffolds.

Materials and methods: DMBGNs were synthesized by a dual surfactant templating approach, first preparing dendritic mesoporous silica nanoparticles (DMSNs) and subsequently incorporating calcium ions [3]. Alginate dialdehyde–gelatin (ADA–GEL) hydrogels were prepared following the established protocol at FAU Institute of Biomaterials [4], into which DMBGNs were embedded prior to printing. The resulting inks were tested for rheological behavior and processed using a 3D printer to fabricate multilayer constructs.

Results: Synthesis yielded flower-like dendritic nanoparticles with large surface area and high porosity. When embedded in ADA–GEL, these nanoparticles maintained their mesoporous structure and bioactivity, promoting apatite formation in SBF. Structural analyses (FTIR, XRD, SEM) confirmed crosslinking and uniform integration into the hydrogel, while printability assessments demonstrated good performance, making it a promising candidate for 3D-printed scaffolds in tissueengineering.

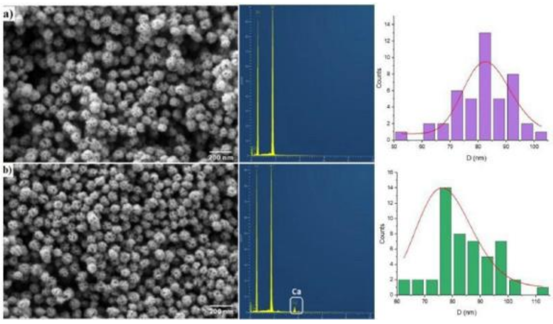

Figure 1. SEM and EDX spectrum of a) DMSNs and b) DMBGNs

Conclusions: We demonstrate a successful strategy for coupling the synthesis of dendritic bioactive glass nanoparticles with the fabrication of 3D-printed hydrogel scaffolds. Incorporation of ion-modified nanoparticles improved mechanics, bioactivity and printability, with lower ion concentrations showing the most promising balance of properties. These findings highlight the potential of dendritic bioactive glass nanoparticle-based hydrogels as multifunctional inks for bone tissue engineering.

Acknowledgements: *The authors acknowledge the financial support from Bayerische Hochschulzentrum für Mittel-, Ost- und Südosteuropa (BAYHOST)) and the infrastructure provided by the Institute of Biomaterials, FAU. This work was carried out through the PN 23.06 Core Program - ChemNewDeal within the National Plan for Research, Development and Innovation 2022-2027, developed with the support of Ministry of Research, Innovation, and Digitization, project no. PN 23.06.02.01 InteGral*

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PURIFICATION STRATEGIES FOR BIOCOMPATIBLE N,P-DOPED CARBON DOTS: FROM SYNTHESIS TO SAFE MEDICAL USE

Olena ARTIUSHENKO [1], Aldair VERGEL RANGEL [2], Volodymyr ZAITSEV [1,3*], Marcos Tadeu COUTO [4], Annielle Mendes Brito da SILVA [5]

[1]Pontifical Catholic University of Rio de Janeiro, 225 Marquês de São Vicente St., Rio de Janeiro, Brazil
[2]National University of La Plata, Av. 7 No. 776, La Plata, Buenos Aires, Argentina [3]National University of Kyiv-Mohyla Academy, 2 Hryhoriya Skovorody St., Kyiv, Ukraine [4]Federal Institute of Rio de Janeiro, 550 University City (UFRJ), Rio de Janeiro, Brazil [5]Oswaldo Cruz Foundation, 4365 Av. Brasil, Rio de Janeiro, Brazil
**Corresponding author: vnzaitsev@puc-rio.br*

Keywords: carbon dots; luminescence; purification; column chromatography

Introduction: Carbon dots (CDs) are promising nanomaterials for biosensing, imaging, drug delivery, and photocatalysis, but their synthesis often yields large amounts of molecular fluorophores (up to 98 wt.%), leading to data misinterpretation. Over half of 550 studies reviewed by Essner et al. reported insufficient purification [1,2]. Dialysis, the most common method, is slow (≤120 h) and inefficient for water-insoluble impurities or size-based separation. Column chromatography offers higher resolution but is rarely applied. Here, we present a rapid, eco-friendly chromatographic purification method and validate its efficiency using ^{1}H NMR, which is more reliable for detecting molecular contaminants than conventional XPS, AFM, or TEM.

Materials and methods: N,P-co-doped carbon dots were synthesized hydrothermally from citric acid, ethylenediamine, and phosphoric acid at 180 °C for 8 h, filtered, and purified either by 3-week dialysis or silica column chromatography with water elution, followed by Soxhlet extraction.

Results: r-NPCDs showed broad UV–vis absorption and blue-green emission. FTIR/XPS confirmed surface functionalization and N/P doping. ^{1}H NMR revealed complete removal of molecular by- products after chromatography, unlike dialysis. Chromatography reduced purification time to 24 h, enabled fraction separation, and produced the cleanest, most well-defined nanoparticles as confirmed by AFM.

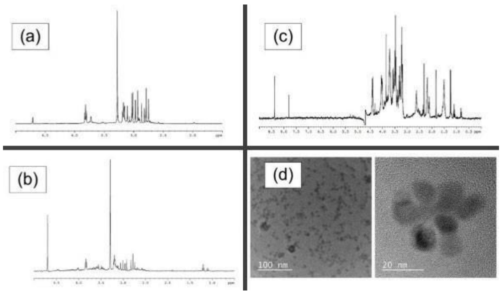

Figure 1. ^{1}H NMR spectra of NPCDs : raw (a), purified by dialysis (b), purified by column chromatography (c).
Transmission electron microscopy (TEM) image of c-NPCDs purified by column chromatography (d).

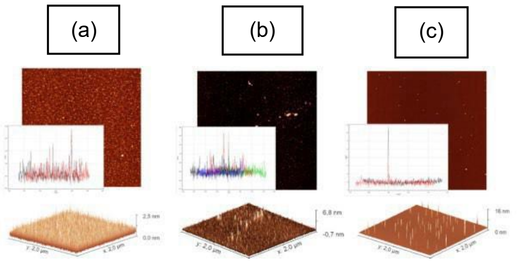

Figure 2. AFM spectra of NPCDs: raw (a), purified by dialysis (b), purified by column chromatography (c).

Conclusions: We report a fast, eco-friendly purification method combining column chromatography with Soxhlet extraction for carbon dots. The process takes <8 h, uses ~1 L of water and 7 g of silica, and yields highly pure material as confirmed by ^{1}H NMR. Compared with dialysis (72 h, >30 L water), it is faster, cleaner, and removes residual contaminants more effectively. EcoScale and AGREEprep analyses show higher sustainability, allowing up to 21 samples per day with lower energy use and waste generation, enabling scalable production of medical-grade carbon dots.

Acknowledgements*: The authors are thankful for the financial support provided by CNPq and FAPERJ.*

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MULTIFUNCTIONAL EGGSHELL WASTE BEADS

Yerkebulan ZHASULANULY [1*]
[1]*Nazarbayev Intellectual School of Science and Math in Atyrau, Kazakhstan*
**Corresponding author: yerkebulanzhasulanuly@gmail.com*

Keywords: eggshell, alginate, CO_2 capture, SO_2 neutralization, colorimetric sensor, waste valorization

Introduction: Affordable, circular sorbents that simultaneously remediate multiple gaseous pollutants and provide user feedback are lacking, particularly for low-resource settings and classroom environments. I propose a multifunctional composite based on food-waste eggshell ($CaCO_3$) and renewable sodium alginate that: (1) provides a porous matrix for CO_2 uptake, (2) neutralizes SO_2 to immobilized sulfite/sulfate salts, and (3) reports local acidification via embedded pH-sensitive dye. This integration of waste valorization, pollutant remediation and visible sensing targets accessible mitigation and monitoring at distributed emission points.

Materials and methods: Eggshells were washed, dried (100 °C), and milled to <50 µm. A mild alkaline activation (0.1 M NaOH, 10 min rinse) was used to increase surface basicity without high-temperature calcination. Sodium alginate (2% w/v) was homogenized with eggshell powder at a mass ratio of 2:1 (eggshell:alginate) and extruded dropwise into 2% $CaCl_2$ to form crosslinked beads. Natural anthocyanin extract (red cabbage, ~2% w/w relative to solids) was mixed into the alginate solution for colorimetric sensing.

Characterization methods (planned) included SEM, BET surface area, XRD, FTIR and TGA. Gas uptake tests were performed in a sealed 1 L chamber under controlled conditions (10% CO_2/N_2, 25 °C, 50% RH) and SO_2 exposure was simulated using sodium bisulfite aerosols and low-concentration SO_2/air mixtures. CO_2 and SO_2 loadings were measured gravimetrically and by ion chromatography; dye response was evaluated by visual inspection and smartphone image analysis (RGB to ΔE).

Results: Physical/chemical characterization: SEM shows an interconnected alginate network embedding crushed $CaCO_3$ particles; BET surface area = 28 ± 4 $m^2 \cdot g^{-1}$; XRD confirms predominant calcite phase ($CaCO_3$) with alginate signatures in FTIR; TGA indicates stable beads to ~200 °C.

CO_2 uptake: under 10% CO_2 at 25 °C and 50% RH, composite beads exhibited an initial uptake of ~0.75 mmol $CO_2 \cdot g^{-1}$ (≈33 $mg \cdot g^{-1}$) within 60 min, with ≈90% of uptake achieved in the first 30 min.

SO_2 neutralization: simulated SO_2 exposure (≤100 ppm) produced rapid acid neutralization to sulfite/sulfate products with an observed neutralization capacity of ~0.50 mmol $SO_2 \cdot g^{-1}$ (verified by ion chromatography and XRD showing sulfite/sulfate peaks after exposure). Neutralization efficiency reached ~85% of theoretical stoichiometry under the tested conditions.

Colorimetric sensing: anthocyanin-doped beads exhibited a clear and reproducible color shift (purple → pink → pale) when local pH dropped due to SO_2 uptake; the perceptible ΔE threshold corresponded to ~0.25–0.35 mmol $SO_2 \cdot g^{-1}$, providing a visible indicator of partial exhaustion. CO_2 alone induced weaker color shifts under ambient concentrations; dye response was therefore most reliable as an SO_2 exhaustion indicator. Regeneration & stability: simple alkaline re-conditioning (0.1 M NaOH soak, rinse) partially restored CO_2 uptake (~60% recovery after one cycle); structural integrity remained over three cycles in bench trials, though capacity decreased progressively — further optimization is required.

Conclusions: These theoretical results show that eggshell–alginate beads can function as low-energy, circular sorbent platform combining modest CO_2 uptake, efficient SO_2 immobilization, and an immediate visual exhaustion cue. The system avoids high-temperature calcination, uses abundant waste feedstock, and can be fabricated with simple lab equipment—making it suitable for educational demonstrations and distributed pre-treatment. Key limitations include limited reversible CO_2 capacity without high-energy regeneration and dye sensitivity primarily to acid gases rather than low ambient CO_2. Future work will optimize eggshell activation, improve porosity (templating), explore catalytic oxidation to convert sulfite→sulfate in situ, and calibrate smartphone-based quantification for field use.

Acknowledgements*: We would like to express our sincere gratitude to our research supervisor, Chemistry teacher Gulziya Saparbekovna, for her guidance and support throughout the course of this project.*

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ECO-ENGINEERED ZINC OXIDE NANOCARRIERS: A GREEN MICROWAVE–NATURAL PRODUCT STRATEGY FOR SUSTAINABLE PLATINUM-BASED CANCER THERAPY

Hatem A.F.M. HASSAN [1], Nada K. SEDKY [2], Mohamed S. NAFIE [3], Noha Khalil MAHDY [2], Iten M. FAWZY [4], Toka WALEED FAYED [2], Eduard PREIS [5], Udo BAKOWSKY [5*], Sherif ASHRAF FAHMY[5]

[1] Medway School of Pharmacy, University of Kent, Chatham Maritime, Kent ME4 4TB, UK
[2] School of Life and Medical Sciences, University of Hertfordshire Hosted by Global Academic Foundation, R5 New Garden City, New Administrative Capital, Cairo 11835, Egypt
[3] Department of Chemistry, College of Sciences, University of Sharjah, Sharjah 27272, United Arab Emirates
[4] Department of Pharmaceutical Chemistry, Faculty of Pharmacy,
Future University in Egypt, Cairo 11835, Egypt
[5] Department of Pharmaceutics and Biopharmaceutics, University of Marburg, Robert-Koch-Str. 4, 35037 Marburg, Germany
**Corresponding authors: ubakowsky@aol.com, sherif.fahmy@pharmazie.uni-marburg.de*

Keywords: sustainable nanomedicine; zinc oxide nanocarriers; green chemistry; platinum prodrugs; breast cancer

Introduction: Developing greener nanomaterials is central to sustainable medicine [1]. Here, we designed zinc oxide nanocarriers produced by a microwave-assisted, gambogic acid-mediated synthesis that avoids toxic solvents and reduces energy input. The platform was engineered to deliver asplatin (Asp), a dual-action platinum(IV) prodrug releasing cisplatin and aspirin, aiming to enhance therapeutic efficacy while reducing systemic toxicity.

Materials and methods: ZnO nanoparticles were biosynthesized using gambogic acid as a renewable reductant and stabilizer under microwave irradiation, yielding crystalline particles. Morphology and physicochemical properties were assessed by XRD, TEM, UV–Vis, and zeta potential analysis. Biological performance was evaluated in vitro using MDA-MB-231 triple-negative breast cancer cells and in vivo using Ehrlich carcinoma-bearing mice.

Results: The green synthesis yielded crystalline ZnO nanostructures (~24 nm, XRD; Figure 1) with high Asp entrapment efficiency (79.5 ± 5.7%). TEM confirmed spherical particles of 55–85 nm. Release studies demonstrated strong pH-responsiveness, with ~80% Asp released at pH 5.2 versus ~25% at pH 7.4 over 48 h.

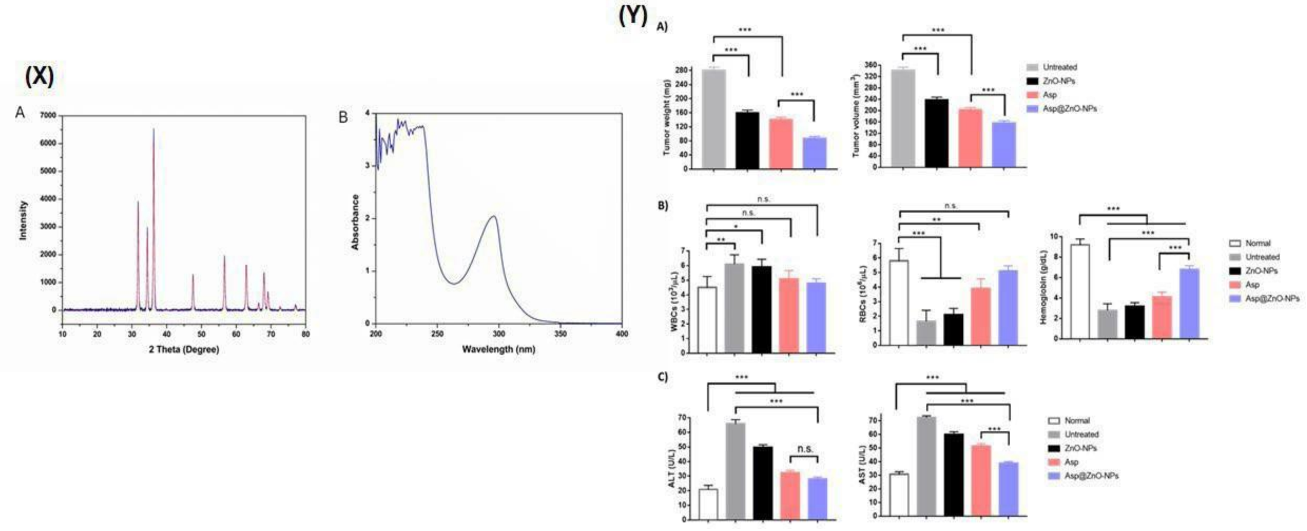

Figure 1. (X) *Physicochemical characterization of green-synthesized ZnO nanocarriers: XRD profile confirming crystalline structure and TEM micrograph showing spherical morphology. (Y) In vivo antitumor efficacy of Asp@ZnO-NPs: tumor volume reduction in Ehrlich carcinoma-bearing mice and associated improvements in biochemical markers (ALT/AST).*

In vitro, Asp@ZnO-NPs reduced the IC_{50} of Asp nearly threefold (5 ± 1 µg/mL vs. 13.8 ± 1.1 µg/mL), and flow cytometry revealed a pronounced increase in late apoptotic fractions. In vivo, treatment with Asp@ZnO-NPs suppressed tumor growth to 156 ± 8 mm^3 (Figure 2), compared with Asp alone (202 ± 8 mm^3) and untreated controls (343 ± 10 mm^3). Hematological assessment demonstrated restoration of Hb and near-normal RBC/WBC counts. Biochemical assays showed reduced ALT and AST activities, reflecting mitigated hepatic injury. Histopathology further confirmed extensive tumor necrosis and preserved liver tissue in treated groups, underscoring both efficacy and biosafety [2].

Conclusions: This eco-friendly platform demonstrates how renewable natural products and energy- efficient synthesis can deliver multifunctional nanocomposites with superior biomedical performance. By combining sustainable materials chemistry with advanced drug delivery, Asp@ZnO-NPs exemplify a greener yet more potent alternative to conventional platinum-based chemotherapies, resonating with Horizon Europe's vision for sustainable innovation.

Acknowledgements*: Dr. Sherif Fahmy acknowledges support from the Alexander von Humboldt Foundation, Germany.*

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

(Poster presentations)

1. *PARA-OLEUM FLUID (POF): A NOVEL MAGNETIC NANOTECHNOLOGY FOR INCREASED OIL RECOVERY FROM CONTAMINATED SOIL AND OIL SPILL INCIDENTS*
2. *WASTE-TO-ENERGY: THE POTENTIAL OF RDF FUEL AND ITS APPLICATION IN WASTE RECYCLING*
3. *THE WATER FILTER "ANSAQUA"*
4. *EVALUATION OF PEGANUM HARMALA EXTRACT AS A NATURAL SHAMPOO INGREDIENT*
5. *A GREEN APPROACH TO ZNO DYE-SENSITIZED SOLAR CELLS: FABRICATION WITH NATURAL EXTRACTS*
6. SO_2*LUTION: AN INNOVATIVE PORTABLE DEVICE FOR AIR PURIFICATION*
7. *A MINI-TESTER FOR THE DETERMINATION OF PROCESSES IN FOOD PRODUCTS*
8. *INNOVATIVE TECHNOLOGIES FOR SCALABLE FABRICATION OF GRAPHENE: A MULTIFUNCTIONAL MATERIAL FOR ENVIRONMENTAL PROTECTION*
9. *DEVELOPMENT OF ELECTROSTATIC FILTERS FOR REDUCING SULFUR EMISSIONS AT THE ATYRAU OIL REFINERY*
10. *ECO-FRIENDLY BANANA PEEL INSOLES*
11. *ECO-FRIENDLY STARCH PRODUCTION*
12. *ALUMINA BASED NICKEL-IRON CATALYST FOR METHANE PYROLYSIS. SYNTHESIS AND STRUCTURAL PECULIARITIES*
13. *SUSTAINABLE PROTECTION OF ARCHITECTURAL HERITAGE THROUGH SILANE-NANOPARTICLE HYBRID TREATMENTS*
14. *COMPUTATIONAL DENSITY-FUNCTIONAL THEORY (DFT) OF REACTIVE OXYGEN SPECIES (ROS) AND INTERFERING SPECIES - COMPARISON WITH EXPERIMENTAL VIBRATIONAL SPECTROSCOPY*
15. *EFFICIENT CADMIUM RETENTION FROM POLLUTED WATER USING NOVEL ADSORBENT MATERIALS*
16. *MORPHOLOGY AND TEXTURAL PROPERTIES OF CATION EXCHANGED*

CLINOPTILOLITE

17. *STUDY OF IBUPROFEN RETENTION ON VARIOUS ADSORBENTS*
18. *SYNTHESIS, CHARACTERIZATON, ADME AND DFT STUDIES OF SOME PYRIMIDINE COMPOUNDS*
19. *SEMI-INTERPENETRATED POLYMER NETWORK HYDROGELS WITH Mo-MXenes FOR TUNABLE ELECTROMAGNETIC INTERFERENCE SHIELDING*
20. *Fe-MODIFIED BIOCHAR: FROM AGRICULTURAL WASTE TO CATALYTIC MATERIAL*
21. *THE ANTIBACTERIAL AND ANTIVIRAL ACTIVITIES OF AN HYDROGEL FUNCTIONALIZED WITH A 2-NAPHTHYL- DIHYDROPYRIMIDINE DERIVATE*
22. *PROCESSING METHODS FOR THE VALORIZATION OF SPENT COFFEE GROUNDS – A REVIEW*
23. *ENHANCING THE THERMAL STABILITY OF THERMOPLASTICS USING NATURAL PHENOLIC ANTIOXIDANTS*
24. *SILANE-FUNCTIONALIZED SERICITE AS A HYBRID SUPPORT FOR THE IMMOBILIZATION OF BIOACTIVE COMPOUNDS FROM RED CLOVER*
25. *BIOPOLYMERIC MEMBRANE BASED ON COLLAGEN AND RETINOL FOR HYDRATION AND REGENERATION OF THE SKIN*
26. *POLYMER COMPOSITES ENDOWED WITH MAGNETIC FEATURES*
27. *POLYMER MEMBRANES MODIFIED WITH SILANOL MOIETIES*
28. *DEVELOPMENT OF TOPICAL FORMULATION CONTAINING LIPOSOMES LOADED WITH ECHINACEA PURPUREA: PHYSICOCHEMICAL PROPERTIES AND POLYPHENOL RELEASE DYNAMICS*
29. *DEVELOPMENT AND CHARACTERIZATION OF SENOTHERAPEUTIC-LOADED LIPOSOMES AS AN ANTI-AGEING NANOCARRIER*
30. *MICROPLASTIC GENERATION FROM ARTIFICIAL TURFS - A REVIEW*
31. *INTERACTION OF MULTIFUNCTIONAL POLYMERIC COMPOSITES BASED ON JELLYFISH POLYPEPTIDES, ALOE POLYPHENOLS AND SODIUM ALGINATE WITH SKIN CELLS*

32. STUDY OF THE INFLUENCE OF AQUEOUS MEDIA ON THE CHARACTERISTICS OF PLASTIC PACKAGING

33. MXENE–POLYMER NANOCOMPOSITES AS VERSATILE PLATFORMS FOR ADVANCED FUNCTIONAL MATERIALS

34. VOLTAMMETRIC DETERMINATION OF DIAZEPAM

35. ALUMINA-BASED Ni-Fe CATALYST FOR CARBON DIOXIDE REFORMING: STRUCTURAL AND THERMODYNAMIC FEATURES, CATALYTIC PERFORMANCE

36. BIOSENSING PLATFORMS WITH ADVANCED NANOCOMPOSITES FOR NON-INVASIVE MONITORING OF BIOMARKERS IN BIOLOGICAL FLUIDS

37. BOSEAN: PURIFICATION OF WATER BODIES FROM OIL POLLUTION

38. DEVELOPMENT OF ANTIMICROBIAL CLAYS AS ADDITIVES FOR SPECIAL MATERIALS WITH POTENTIAL USE IN CULTURAL HERITAGE

39. DIAZABICYCLO[2.2.2]OCTANE-DERIVED IONIC LIQUID AS A SUSTAINABLE CATALYST FOR THE SYNTHESIS OF HETEROCYCLES AND THEIR β-LACTAMASE INHIBITORY POTENTIAL

PARA-OLEUM FLUID (POF): A NOVEL MAGNETIC NANOTECHNOLOGY FOR INCREASED OIL RECOVERY FROM CONTAMINATED SOIL AND OIL SPILL INCIDENTS

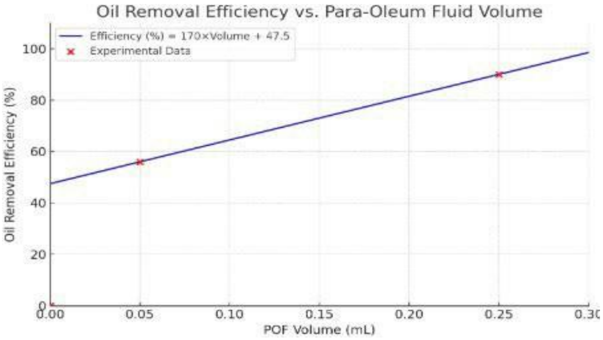
Aizere ANDOSSOVA [1], Asif ABBAS SYED [1*]
[1] Department of Chemistry, Nazarbayev Intellectual School, Atyrau, Kazakhstan
**Corresponding author: asifchem143@gmail.com*

Keywords: biodegradable cleaners, waste valorization, natural surfactants, sustainable chemistry, antimicrobial activity

IntoductionThe persistence of oil contaminants in terrestrial and aquatic environments is a persistent environmental challenge worldwide, and conventional remediation methods are often inadequate and leave toxic residues. This work presents an innovative magnetically responsive nanotechnology known as Para-Oleum Fluid (POF), which is a novel method for oil recovery from oil-contaminated soils and treatment of surface oil spills.
Material and method: POF are colloidal suspensions of oil-dissolving paramagnetic nanoparticles that have high affinity for oil and magnetic responsiveness, leading to effective hydrocarbon separation under external magnetic fields. POF was used at three concentrations in an oil-contaminated soil controlled lab setting: 0 drops (control), 1 drop, and 5 drops. To attract the oil-POF complexes, a neodymium magnet coated with plastic was utilized, and the remaining oil was then quantified to determine the effectiveness of the separation.
Results: Consequently, an obvious positive correlation between POF volume and oil removal was noted:

POF Volume (drops)	Residual Oil (mL)	Oil Removed (mL)	Efficiency (%)
0 (Control)	5.0	0.0	0%
1	2.2	2.8	56%
5	0.5	4.5	90%

Defined: x = Volume of POF in mL; y = Oil removal efficiency in %; m = 170; y=mx+c; Efficiency (%)=170×POF volume (mL)+47.5



Conclusion: These findings highlight the magnetic sensitivity and strong oil-affinity of POF, which enhance hydrocarbon aggregation and extraction.
Besides its success in laboratory conditions, Para-Oleum Fluid has a range of benefits: it is reusable, nontoxic, and effective in both soil and water environments, and easily adapted for large-scale use. Having the twin applications of both soil remediation and oil spill clean-up qualifies it as a feasible, scalable, and environmentally friendly technology for future use in industrial and disaster-relief applications.
Further research will explore field-scale performance, environmental compatibility, and cost-efficiency, but current results establish POF as a next-generation solution in magnetic oilremediation.

Acknowledgements*: The authors thanks to Nazarbayev Intellectual School , Atyrau, for research support*

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WASTE-TO-ENERGY: THE POTENTIAL OF RDF FUEL AND ITS APPLICATION IN WASTE RECYCLING

Amanat CHAPAY 1*

[1]*Nazarbayev Intellectual School of Science and Math in Atyrau, Kazakhstan*

**Corresponding author:* teapay_a@atr.nis.edu.kz

Keywords: RDF, waste-to-energy, additives, sustainable chemistry

Introduction: Across the world, mountains of household waste are rising faster than cities can deal with. In Atyrau and Kazakhstan, this challenge feels especially urgent. Illegal dumps and unmanaged landfills are spreading across the region and our country leaching toxins into the soil, polluting rivers and affecting people's health. And traditional fixes like burying trash no longer work. Landfills swallow up valuable land and release greenhouse gases. Unregulated incineration fills the air with dioxins and acidic fumes. Communities need a smarter approach, one that turns waste into something useful instead of leaving it as a burden.

One promising path is Refuse-Derived Fuel (RDF). This is a fuel created from the non-recyclable parts of everyday garbage - plastics, textiles, paper scraps, and plant residues. Compressed into briquettes RDF burns almost as strongly as coal, making it a potential substitute for fossil fuels. It can cut landfill volumes by up to 90%, a huge gain for regions like Atyrau where polygons are overflowing. But when burned in its raw form, RDF releases harmful products, such as hydrogen chloride from PVC plastics, sulfur oxides from rubber, and toxic organic compounds like dioxins can all form in the furnace. These emissions undermine RDF's promise and make people wary of using it.

This research takes a different approach. Instead of depending only on costly solutions such as scrubbers or filters, we ask: what if the fuel itself could help clean its own smoke? By blending in small amounts of common chemicals, we can redesign RDF to capture pollutants right from the moment they form. For example, calcium carbonate and calcium hydroxide neutralize acidic gases by turning them into stable salts. Kaolin (natural clay) locks heavy metals like lead and cadmium into the ash, making them far less mobile. Iron oxide acts as a combustion catalyst, helping waste burn more completely and reducing the release of carbon monoxide and soot. Zeolites, because of their sponge-like pores absorb volatile organics before they escape into the air. In combination, these additives turn RDF into a smart fuel - one that doesn't just burn but burns cleaner.

Materials and methods: This study explores embedding chemical additives into RDF briquettes to reduce harmful emissions at the source. Calcium carbonate ($CaCO_3$) and calcium hydroxide ($Ca (OH)_2$) were selected to capture acidic gases, converting them into stable salts. Kaolin clay was investigated for its ability to immobilize heavy metals in ash. Iron oxide (Fe_2O_3) was introduced as a combustion catalyst, and zeolites were tested for their capacity to absorb volatile organics. Analytical modeling of combustion was carried out to evaluate emission reductions and changes in ashcomposition.

Results: reliminary modeling shows that blending RDF with additives significantly improves its environmental profile. Addition of 10% calcium carbonate reduced sulfur dioxide emissions by over 40%. Kaolin decreased the leaching potential of lead and cadmium in ash by around 40%. Iron oxide improved carbon burnout by 7%, enhancing both efficiency and reducing soot. Zeolites effectively reduced volatile organic compounds. Importantly, the ash left after combustion was enriched with oxides of calcium, silica, and alumina - chemically stable materials suitable for incorporation into cement and bricks.

Conclusions: The integration of simple chemical additives into RDF briquettes transforms waste into a "smart fuel" that not only burns efficiently but also minimizes its own emissions. This approach links waste management, energy production, and construction into a practical model of the circular economy. For Atyrau, where rising waste volumes and energy demand converge, additive-enhanced RDF presents an opportunity for cleaner energy, reduced landfill dependency, and sustainable regional development.

Acknowledgements*: The author thanks Nazarbayev Intellectual School of Atyrau for academic support and guidance.*

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THE WATER FILTER "ANSAQUA"

Ansagan KABDELOVA [1*]

[1]Nazarbayev Intellectual School of Science and Math in Atyrau, Kazakhstan

**Corresponding author: ansagankabdelova@gmail.com*

Keywords: affordable ,ions, egg shell, water purification, heavy metals

Introduction: Water is a vital resource, and access to clean water is crucial for human health. Water filters purify water from various contaminants, including bacteria, viruses, chemicals, heavy metals, and more, making it safe for drinking and daily use while enriching it with essential ions. By reducing the amount of plastic bottles used for drinking water, water filters also help decrease environmental pollution caused by plastic waste. Additionally, they can lower the costs associated with purchasing bottled purified water, which is particularly important for low-income families.

The importance of developing an affordable filter, which does not compromise on quality, has become evident. The cheapest filters available to the general public often cost around 4 USD, while higher-end multi-stage filters are often unaffordable for many households. Therefore, the creation of an effective and affordable water filter is a pressing issue.

Materials and methods: To identify the issue, a survey was conducted among residents; organoleptic methods were used to assess the physical quality of water samples, while the chemical composition was analyzed through the “KrisMas+” laboratory. The quantitative composition of ions was calculated using titration methods, and the filter housing was produced using a 3Dprinter.

Results: -The concentration of ions in the filtered water did not exceed the standards set by SanPin, confirming the effectiveness of the filter. The reduction in concentrations of iron, chloride, and nitrate ions, along with the increase in sulfate and phosphate ions, demonstrates the positive impact of the eggshellbased filter on water composition.

- The mass ratios of the filter components affect the ion concentrations in water. The most effective mass ratio was determined to be zeolite (40 g): shungite (80 g): eggshell (40 g), or 1:2:1.
- The accessibility of the filters was assessed through cost calculations, revealing that the cost of the “AnsAqua” filter is 0.4 USD.

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

Table 2: Comparison of heavy metal concentrations before and after filtration

	$PbCl_2$	$ZnCl_2$	$AgNO_3$
Initial mass of precipitate in the solution	0,02 g	0,05 g	0,04 g
Final mass of precipitate in the solution purified through the filter	0,009 g	No precipitate formed	No precipitate formed

Conclusions: **:** In conclusion, I can say that my "AnsAqua" filter showed positive results as I had predicted. At the end of my work, I achieved my goal of demonstrating, through physical and chemical analysis, that by using eggshells as a component of the filter, I could create an affordable filter that purifies water and enriches it with beneficial ions. The main advantages of my filter are its low cost and high quality. I believe that by using this filter, many issues can be addressed, including:

- Reducing plastic bottle usage to protect the environment.
- Lowering water purchasing costs for low-income families.
- Preventing infectious diseases by filtering water in small communities. My future plans include:
- Investigating the macro and microelements of water using modern methods.
- Testing the long-term effectiveness of the filter.

Recommendations: Installing the "AnsAqua" filter in homes, restaurants, public places, and rural areas.

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Acknowledgements: *This research was supported by the Nazarbayev Intellectual school chemistry lab resources and the KrisMas+ analytical facility. No external funding was received.*

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EVALUATION OF PEGANUM HARMALA EXTRACT AS A NATURAL SHAMPOO INGREDIENT

Ayaulim AMANGOSQYZY [1], Rakhymzhan KOSSANOV [1], Asif ABBAS SYED [1*]
[1]Nazarbaev Intellectual school of Science and Math in Atyrau, Kazakhstan
**Corresponding author: rakhymzhan44@gmail.com*

Keywords: Peganum harmala, natural shampoo, hair care, plant extract, bioactive compounds

Introduction: The demand for eco-friendly personal care products highlights the need for natural shampoo alternatives. Synthetic shampoos often contain additives that may damage hair or irritate the scalp, while plant-based products can be safer and more effective. This study explores *Peganum harmala* (adyraspan), a medicinal plant from Kazakhstan, as a natural shampoo ingredient.
The aim was to extract *P. harmala* compounds and assess their use in hair care. The problem addressed is that commercial shampoos may not meet expectations, whereas plant extracts preserve bioactive compounds that support scalp and hair health.

Methods: included literature review, extraction, chemical analysis, and application tests. Two methods were compared: ethanol extraction (low yield) and water-based extraction with yeast (higher yield). Filtration and distillation produced extracts rich in bioactive substances.

Composition: of *P. harmala* includes alkaloids, flavonoids, carotenoids, steroids, and triterpenes. Alkaloids (harmaline, harmine) show antimicrobial effects; flavonoids (quercetin, rutin) act as antioxidants; carotenoids support hair growth. Together, these compounds protect, strengthen, and enhance shine.
Results showed that the water-based extract kept hair clean longer, required less frequent washing, and improved shine and strength compared to synthetic shampoos. It preserved natural oils, left no residue, and performed well on natural and artificial hair.
Novelty lies in creating a safe, natural shampoo from a local plant, supporting sustainable production and reducing reliance on imports.

Table 1: Comparison of Synthetic Shampoo and *Peganum harmala* Extract

Indicator	**Synthetic Shampoo**	***Peganum harmala* Extract (Natural Shampoo)**
Composition	Chemical additives (SLS, parabens, colorants)	Alkaloids, flavonoids, carotenoids
Effect on hair	Frequent use may cause dryness and brittleness	Preserves natural oils, strengthens hair
Effect on scalp	May cause itching or irritation	Anti-inflammatory, antimicrobial
Long-term result	Hair requires frequent washing	Hair stays clean longer, shinier
Ecology	Production leaves chemical waste	Environmentally friendly, local raw material

Conclusion *P. harmala* extract proves effective for hair care—enhancing cleanliness, shine, and strength while protecting the scalp. Though extraction takes time, the benefits justify the process. Future research should optimize extraction, test stability, and explore industrial use. This project demonstrates the potential of Kazakhstan’s native plants in natural cosmetics.

***Acknowledgements**: The authors gratefully acknowledge the support of Nazarbayev Intellectual School in Atyrau city, and the guidance of teachers and mentors throughout the research project.*

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A GREEN APPROACH TO ZNO DYE-SENSITIZED SOLAR CELLS: FABRICATION WITH NATURAL EXTRACTS

Medina DAUT [1], Asif ABBAS SYED [1]

[1]*Nazarbayev Intellectual School of Science and Math in Atyrau, Kazakhstan*
**Corresponding author: daut_m@atr.nis.edu.kz*

Keywords: DSSC, Zinc Oxide(II), Natural Dyes, Hybrid Sensitizer, Plasmonic Enhancement

Introduction:This study presents the fabrication and evaluation of a low-cost zinc oxide (ZnO)-based dye-sensitized solar cell (DSSC) employing a hybrid dye composed of natural plant extracts, a copper- organic complex, and silver nanoparticles [1,2]. The aim was to improve the light-harvesting efficiency and stability of natural dyes through co-sensitization and plasmonic enhancement [3,4]. The DSSC consisted of a ZnO-coated fluorine-doped tin oxide (FTO) photoanode [5], a graphite counter electrode, and a KI/I_2 electrolyte in glycerol [6]. Preliminary testing under simulated sunlight revealed higher photocurrent and open-circuit voltage for the hybrid dye cell compared with cells sensitized solely with natural extracts [7]. These findings demonstrate that simple chemical modifications of natural pigments can significantly enhance the performance of ZnO-based DSSCs in low-resource environments [2,4,7]. **Materials and methods**: FTO glass; $Zn(NO_3)_2 \cdot 6H_2O$ or commercial ZnO; NaOH; ethanol; anthocyanin-rich plant material (e.g., red cabbage, blueberries); $CuSO_4 \cdot 5H_2O$ (copper complex); $AgNO_3$ and sodium citrate (silver nanoparticles); KI, I_2 and glycerol (electrolyte); graphite or soot (counter electrode).

ZnO Film: ZnO was prepared by precipitating $Zn(OH)_2$ from $Zn(NO_3)_2$ with NaOH, washed, dried, and ground. The paste was doctor-bladed onto FTO, dried and, if possible, annealed.

Hybrid Dye: Anthocyanins were extracted in acidified ethanol. Small amounts of $CuSO_4$ and silver nanoparticles (from $AgNO_3$ reduced with sodium citrate) were added to form a hybrid dye.

Electrolyte and Counter Electrode: KI/I_2 in glycerol served as the electrolyte. The counter electrode was FTO coated with graphite or soot.

Results: The ZnO-based DSSC sensitized with the hybrid dye (natural extract + copper complex + silver nanoparticles) showed a clear improvement in performance compared to the cell sensitized with natural extract alone. Under simulated sunlight, the hybrid dye cell produced a higher open-circuit voltage (Voc), increased photocurrent density (Jsc), and a noticeable rise in overall power conversion efficiency (η), reaching up to 0.2–0.3% compared to ~0.05–0.1% for the natural dye cell. The hybrid dye also displayed greater color stability and less degradation during testing, indicating improved durability of the sensitizer.

Conclusions: Co-sensitization with copper complex and silver nanoparticles increased light absorption and efficiency, silver nanoparticles enhanced light harvesting; copper complex improved dye stability, still low absolute efficiency but shows promise for further optimization in low-resource environments.

Acknowledgements*: List funding sources in compliance to funder's requirements.*

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SO_2LUTION: AN INNOVATIVE PORTABLE DEVICE FOR AIR PURIFICATION THROUGH CALCIUM HYDROXIDE-BASED NEUTRALIZATION

Khadisha MENDIGALIYEVA [1*]

[1]*Nazarbayev Intellectual School of Science and Math in Atyrau, Kazakhstan*

**Corresponding author:* mmkhadisha@gmail.com

Keywords: Air pollution, Gas scrubbing, Calcium hydroxide, Sulfur dioxide removal, Nitrogen dioxide reduction, Carbon dioxide capture

Introduction: Air pollution continues to be one of the most serious global environmental problems of the twenty-first century. Acid rain, urban smog, respiratory problems, and long-term climate disruption are exacerbated by harmful gaseous emissions—such as sulfur dioxide (SO_2), sulfur trioxide (SO_3), nitrogen dioxide (NO_2), and carbon dioxide (CO_2) [1,2]. Despite on-going world-wide efforts, conventional purification methods are expensive, immobile (~infrastructure-based) and industrial scale, and ill-suited to the vast urban and high-density settlements which are particularlyvulnerable.

Materials and methods:The objective of this study is to design and develop a novel device, called SO_2lution, that is compact, efficient, and portable, for purifying the atmosphere [4]. Different from traditional filters or industrial scrubbers, the SO_2lution as an "artificial tree" not only needs non-reactive air pollution occurring through the filters, but also has its inter-faces seamlessly merging into urban facilities.

The active valve consists of a high reactivity with CO_2 calcium hydroxide ($Ca(OH)_2$), with the ability to capture toxic gases and transform them into stable salts in the environment [5]. The main neutralization reactions include:

1. $Ca(OH)_2 + SO_2 \rightarrow CaSO_3 + H_2O$

SO_2 is absorbed and converted into calcium sulfite ($CaSO_3$), a harmless solid salt, plus water.

2. $Ca(OH)_2 + SO_3 \rightarrow CaSO_4 + H_2O$

SO_3 reacts to form calcium sulfate ($CaSO_4$), also known as gypsum, and water.

3. $Ca(OH)_2 + 2NO_2 \rightarrow Ca(NO_3)_2 + H_2O$

NO_2 is neutralized into calcium nitrate ($Ca(NO_3)_2$), a water-soluble salt, with water as a by-product.

4. $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

CO_2 combines with $Ca(OH)_2$ to produce calcium carbonate ($CaCO_3$), a stable mineral similar to chalk, and water.

The device comprises a corrosion resistant container of a modular construction, a compressor provided with air inlets and gas detectors and a $Ca(OH)_2$ solution container. Contaminated air is passed through a spiral tube in which it is brought into contact with the reactive medium in an effective way to neutralize the same.

Clean air is discharged into the atmosphere and the products formed ($CaSO_3$, $CaSO_4$, $CaCO_3$, $Ca(NO_3)_2$) are collected in a storage unit to be disposed of or possibly re-used. Our proposed methodology is novel in the way that it is a multidimensional solution: SO_2lution not only contributes to relieving local air pollution but is also applicable to global cities with a scalable and affordable deployment. It can be moved, so it can be installed in public spaces—schools, hospitals, parks, transport hubs—where people are most at risk of bad air quality. At the same time, the device, through a chemical efficiency and an urban landmark design, becomes a "visual reminder" of the value and the necessity of environmental actions, helping in public awareness and education [1,2].

Results: At 35 W power consumption, the prototype achieved an air throughput of 120 L/min. Sulfur dioxide removal efficiency was 84% (inlet 250 ppm → outlet 40 ppm), producing ~0.9 g/h of calcium sulfite [1]. Sulfur trioxide capture reached 91%, yielding solid gypsum [2]. Nitrogen dioxide reduction was 58% (180 ppm → 75 ppm), forming ~0.5 g/h of calcium nitrate. Carbon dioxide capture was limited to 18% (5000 ppm inlet), producing ~1.1 g/h of calcium carbonate [3,5]. These results confirm the device's selective and permanent depollution performance through the formation of benign mineral end- products.

Conclusions: Preliminary verification demonstrates that the system effectively reduces SO_2 and CO_2 concentrations in polluted air under controlled conditions. The findings suggest that large-scale application could be developed across urban, agricultural, and industrially impacted areas worldwide [4].

The *SO₂lution* system represents a low-cost, environmentally friendly approach to air pollution. Combining chemical innovation with mobility and public accessibility, it offers a realistic step towards healthier cities, cleaner air, and environmental preservation.

***Acknowledgements**:* This research was supported by Nazarbayev Intellectual School in Atyrau, Euro-Chemical Society and ICECHIM.

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A MINI-TESTER FOR THE DETERMINATION OF PROCESSES IN FOOD PRODUCTS

Madina MALIK-SHAPAGAT [1], Gulziya BEISENBEKOVA [2*]
[1]Nazarbayev Intellectual School of Science and Math, Atyrau, Kazakhstan
**Corresponding author: baisenbekova_g@atr.nis.edu.kz*

Keywords: food products, portable device, chemical processes, mini-tester, food quality

Introduction: According to the WHO`s statistics every year almost 1 in 10 people fall ill from eating contaminated food and 420 000 die as a result. Meanwhile, many foods are prematurely disposed because of the lack of accessible testing methods, leading to food waste and economic losses. The problem is relevant in our country, in Kazakshtan, which ranks 26th in global food poisoning risk for travelers.

Objective: The purpose of the project was to create a compact mini-tester for determining the processes in food products, taking into account changes in humidity, temperature, and pH during oxidation. The project aims to increase food safety and prevent premature utilization of foodproducts.

Materials and methods: The prototype was based on a commercially available soil tester, which originally included sensors for pH, humidity, and temperature. To adapt the device for food analysis, the original components were disassembled and reassembled into a newly designed cardboard frame. A 3D model was developed in Tinkercad for a future printed case. However, due to time limitations, the prototype was finalized using the cardboard structure. A small display screen was connected to the sensors for real-time data visualization.

Chemical experiments were combined with digital measurements. Starch detection was carried out with iodine solution, while food spoilage in meat was tested by monitoring ammonia release. Additional analyses included observing the effect of carbonated beverages, measuring the pH of rainwater, vinegar, and fruit juices, as well as monitoring food temperature during storage.

Results: A functional prototype of the mini-tester was successfully assembled. The device integrates a display screen with pH, temperature, and humidity sensors, allowing real-time monitoring of food samples. The cardboard housing provided stability and portability, while a 3D model was prepared for future improvement. In addition to digital measurements, the tester supported simple chemical tests. Starch detection was confirmed by iodine reaction, while the presence of ammonia released from spoiled meat was observed. The pH of various liquids, including vinegar, fruit juice, and rainwater, was measured and compared to expected values.

Conclusions: The development of a mini-tester for monitoring food spoilage processes in food products represents a significant step toward improving food safety and quality. This mini-tester enables real- time monitoring of critical environmental parameters such as pH, temperature, and humidity, which are closely associated with the food spoilage. Early detection of these changes allows for timely interventions, reducing product loss and preventing potential health risks. The device is designed to be compact and user-friendly, making it suitable for both industrial applications and domestic use. Overall, the results showed that the mini-tester can be applied as a low-cost and multifunctional tool for assessing food quality.

***Acknowledgements**:* I want to thank the chemistry teacher of Nazarbayev Intellectual School in Atyrau Beisenbekova Gulziya for her guidance and support during the project.

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INNOVATIVE TECHNOLOGIES FOR SCALABLE FABRICATION OF GRAPHENE: A MULTIFUNCTIONAL MATERIAL FOR ENVIRONMENTAL PROTECTION

Nuriya AMANGELDI [1*]
[1]*Nazarbayev Intellectual School in Atyrau, Kazakhstan*
**Corresponding author: nuriyaamangeldi08@gmail.com*

Keywords: Graphene, Activated carbon, Electrochemical exfoliation, Nanomaterials, Water purification

Introduction: This research revolves around the development of a scalable process for synthesizing graphene-based aerogels for water purification. The research focuses on countering the disadvantage of traditional production methods that discourage mass application of graphene aerogels in environmental processes, particularly the situation of oil-contaminated water such as in the Caspian Sea. Aims to create an efficient and affordable technique with 3D printing of graphene inks and freeze-drying to enhance the functionality and scalability of sorbent materials.

Methods and Materials: The method couples DIW 3D printing with sublimation drying to produce graphene-biopolymer aerogels. Polydopamine (PDA) and bovine serum albumin (BSA) were used to optimize graphene inks for improved rheology and sorption performance. 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.

Results: The synthetic aerogels displayed hierarchical porous morphology with high surface area and excellent adsorption capacity for various types of pollutants. Repetitive adsorption experiments confirmed the heavy metal removal capacity, organic pollutants, and oils. Regeneration experiments suggested reusability with minimal loss of activity, whereas the flow-through experiments suggested their applicability to actual water purification processes. Microscopic analysis revealed thin, flake-like structures indicative of graphene formation. The synthesized material exhibited distinct textural and optical characteristics compared to untreated carbon.

Conclusions: The study confirms that DIW sublimation drying and 3D printing enable the bulk production of graphene-based aerogels with enhanced sorption capacity. The study demonstrates the feasibility of producing graphene-like materials from activated carbon through electrochemical exfoliation in sulfate solution. The technology provides a low-cost and sustainable method for water purification systems and shows a promising solution to the issue of oil pollution in the aquatic ecosystem, like the Caspian Sea.

Figure 1

Figure 2

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DEVELOPMENT OF ELECTROSTATIC FILTERS FOR REDUCING SULFUR EMISSIONS AT THE ATYRAU OIL REFINERY

Nurym NURTAS [1*]
[1]*Nazarbayev Intellectual School of Science and Math in Atyrau, Kazakhstan*
**Corresponding author: nurymnurtas732@gmail.com*

Keywords: Atyrau Oil Refinery, sulfur emissions, electrostatic filter, activated carbon, ion-exchange, air pollution.

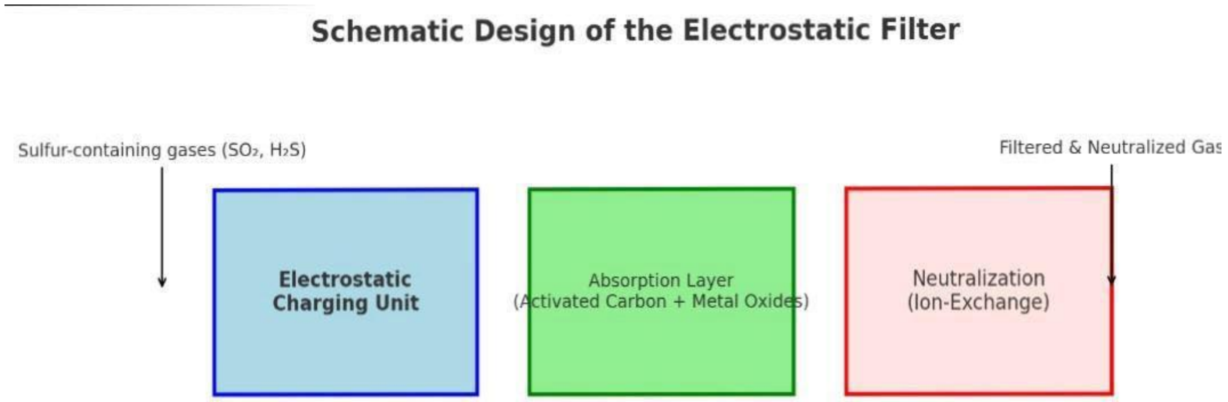
Introduction: The Atyrau Oil Refinery, one of the largest in the country, emits sulfur dioxide (SO_2) and hydrogen sulfide (H_2S), which harm air quality, human health, and nature. Long-term exposure to sulfur compounds leads to diseases, soil erosion, acid rain, and soil degradation. Existing purification methods at refineries are insufficient, making new technologies essential. Thus, in this project, a new device is used to sulfur and compound gases, knowing the harm they cause to nature, by analyzing them from various aspects.

Materials and Methods: The proposed electrostatic filter is based on a multi-component design that combines electrostatic capture with chemical neutralization and adsorption. The system includes three functional sections:

1. Electrostatic Charging Unit – in this section has a high-voltage electric field that charges sulfur-containing particles (SO_2 aerosols, H_2S droplets, dust) and these particles are attracted to collection plates and removed from the gas stream.
2. Absorption Layer (Activated Carbon + Metal Oxides) – made of activated carbon (large surface area) combined with metal oxides (ZnO, Fe_2O_3, e.g.), also this section captures gaseous sulfur compounds thought adsorption and chemisorption and it reduces SO_2 and H_2S concentrations significantly.
3. Neutralization Section (Ion-Exchange Materials) – the last section uses ion-exchange resins or alkali- treated materials and captured sulfur ions are chemically converted into stable, harmless compounds.

Table: Reduction of Sulfur Gas Concentrations

Measurement stage	SO_2 concentration (mg/m³)	H_2S concentration (mg/m³)	Overall reduction (%)
Without filter (initial)	180	95	-
After filtration (Stage 1)	60	35	60 – 65%
After filtration (Stage 2)	25	10	85 – 90%



Filtration Stage 1: In the Electrostatic + Absorbing Layer the gas mixture was passed through the first section of the filter. The electrostatic field trapped solid particles and aerosols, while the activated carbon layer absorbed part of the gaseous sulfur compounds. After this stage, SO_2 levels dropped to 60 mg/m³, and H_2S levels to 35 mg/m³, which corresponds to a 60–65% reduction.

Filtration Stage 2: In the final Neutralization section, ion-exchange materials chemically bound the remaining sulfur ions, converting them into less harmful compounds. After this stage, the concentration of SO_2 decreased to 25 mg/m³, and H_2S to 10 mg/m³. The overall reduction rate reached 85–90%, demonstrating the high efficiency of the multi-layer filtration system

Conclusions: The research successfully demonstrated the development of an electrostatic filter prototype capable of reducing sulfur emissions by up to 90%. The combination of electrostatic capture, adsorption, and neutralization mechanisms ensures comprehensive purification of refinery gases. By addressing one of the region's most urgent ecological challenges, this project provides a foundation for future implementation of innovative emission-control technologies.

***Acknowledgements**: This research was conducted with the support of the school laboratory resources. The author expresses gratitude to mentor teachers for their valuable guidance and consultations throughout the project. No external funding was received.*

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ECO-FRIENDLY BANANA PEEL INSOLES

Aiymnur TALAP [1], Madina SAMAT [1*]

[1]*Nazarbaev Intellectual school of Science and Math in Atyrau, Kazakhstan*

**Corresponding author: samad_m@atr.nis.edu.kz*

Keywords: banana peel, eco-friendly, biodegradable, antibacterial, shoe insoles, natural materials, sustainability, foot health

Introduction: Today, being eco-friendly is a big deal in science and innovation, you know? those synthetic shoe insoles are everywhere, but they're not great for the planet and don't fight off germs like the real deal does. Banana peels are a cool, eco-friendly stuff that breaks down naturally and packs a punch with healthy goodies. Studies show that it can stop bad bacteria from growing, help heal cuts and scrapes, and even get rid of plantar warts. turns out, banana peels could be a cool choice for making eco-friendly shoe insoles

Goal: Making eco-friendly, airy, and germ-fighting shoe cushions with banana skins and stuff like that.

Materials and methods:

- are used in the production of a natural fertilizer.
- is a common ingredient in homemade playdough.
- Glycerin (flexibility)
- White vinegar (antibacterial)
- Water
- Essential oils (odor control)
- Beeswax (waterproof coating)
- fabric (for extra comfy feel)

Process: They took banana peels, dried 'em up, ground 'em into powder, mixed it with cornstarch, glycerin, vinegar, and water, then shaped it into insole forms after they dried up, they got a nice layer of beeswax on top to keep water out.

Results: The insoles were super light, let air flow, soaked up sweat, and seriously cut down on smells their antibacterial powers were totally backed up by the well-known stuff about banana peels Unlike those fake shoe inserts, they break down naturally and don't harm the environment.

Conclusion: Banana peel insoles are all about being comfy, smart, and eco-friendly. They can boost foot health by stopping bacteria from growing, and at the same time, they're helping the planet. this project shows how we can turn food waste into some cool eco-friendly stuff that's actually useful

***Acknowledgements**: The authors thanks to Nazarbayev Intellectual School, Atyrau, for research support*

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ECO-FRIENDLY STARCH PRODUCTION

Elnaz SMADYAROVA [1*], Aruzhan GARIFULLA [1], Gulziya BEISENBEKOVA [1],
Erbolat KURMASHEV [1]
[1]Nazarbayev Intellectual School of Science and Math in Atyrau, Kazakhstan
**Corresponding author: smadyarova.e09@gmail.com*

Keywords: Starch, Burning reeds, Chemical processes, Conveyor production, Eco-products

Introduction: The goal of the project is to create an environmentally friendly conveyor production of starch extraction from reed roots, increasing production, and also to help reduce their harm.
Main problem: Reeds, being invasive plants, often create problems such as overgrowing water bodies and air pollution when burned in areas where they grow, especially in Central Asia. [1]
Starch was obtained through several stages in a chemical laboratory manually: cleaning, grinding, soaking, filtering and drying. With the automation of these processes, it will be possible to obtain the resource quickly and efficiently. Obtaining it from the roots of weeds is the best and most efficient way to obtain it for use in areas such as the creation of eco-materials.
Conveyor production implements several stages of starch extraction from the roots of weed plants, thereby allowing waste disposal, reducing the harm to reeds (burning, allergic reaction, overgrowth) by replacing non-ecological materials with biodegradable analogues, which will lead to a reduction in environmental pollution and the development of local sustainable production.

Materials: Fresh reed roots from the real polluted area, blender, aqueous solutions, test tubes, Benedict's solution, hydrochloric acid, iodine, flammable substance.

Methods of practical part:

1. Washing reed roots
2. Cutting crushing them into tiny pieces
3. Settling in the water, drying to powder. Native starch is known to be practically insoluble in cold water. [2]
4. Testing starch with iodine
5. Ignition on a spirit lamp
6. Breaking down starch into glucose
7. Testing with Benedict's solution.

Results:

Reaction to iodine
We dropped a couple of drops of iodine into the resulting starch mixture and observed a dark purple color, which indicates its presence. The resulting iodine-dextrin molecule absorbs light, which is the cause of the typical color reaction between iodine and starch.
Benedict's reaction to glucose solution.
When starch paste is heated with sulfuric acid, hydrolysis occurs. This process proceeds stepwise with the formation of dextrins, maltose and glucose: $C_6H_{10}O_6)_n+H_2O_{n-1}=C_6H_{12}O_6$. [3]
The use of the acid-hydrolyzed starches with high flowability of starch paste for the technical purposes in the production of plasterboard products and in the production of fiberglass.
As a result, the implementation of cold acid hydrolysis by mineral acids of starch with the preservation of starch granules is observed a decrease in viscosity, while reducing the average size of starch granules.
The greatest effect was observed in hydrochloric acid at a concentration of 0.5 n., A temperature of 50±3°C and a hydrolysis time of 6 hours. [4]
After obtaining the glucose solution, we performed the Benedict reaction (NaOH and CuSO4). The presence of up to 2% glucose in it is manifested by the formation of a reddish, yellowish or greenish precipitate, and a higher percentage of glucose leads to red precipitation, and an insignificant glucose content (about 0.05%) leads to green precipitation.
We conducted this experiment 2 times with different reed roots.
In the first experiment, we can observe a greenish tinge of the solution, which indicates a low glucose content in the solution, in the second experiment, a bright orange color, which indicates a high concentration of glucose in the solution.

Conclusion: A conveyor system for starch extraction, assembled on the basis of available components (blender, pump, washing machine centrifuge and heater), is a completely cost-effective and practical solution for home or semi-industrial conditions. With a relatively low cost of assembly, the installation can significantly reduce the time to obtain starch compared to traditional settling methods. Starch extracted from the roots of reeds can be used in the creation of bio-degradable products, like starch- based bioplastics [5], which makes it a multifunctional and sought-after resource.

Acknowledgements*: The authors gratefully acknowledge the support of Nazarbayev Intellectual School in Atyrau city, and the guidance of teachers and mentors throughout the research project*

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ALUMINA BASED NICKEL-IRON CATALYST FOR METHANE PYROLYSIS. SYNTHESIS AND STRUCTURAL PECULIARITIES

Sevinj OSMANOVA [1*], Aytakin ASGAROVA [2], Zulfiyya MAMMADOVA [1], Tamilla ABBASOVA [1], Aygun RUSTAMOVA [1], Shahla TAGIYEVA [3]
[1]Institute of Catalysis and Inorganic Chemistry, Acad. M.Naghiyev, 113, H.Javid ave., Baku, Azerbaijan
[2]Baku State University, 33, Z. Khalilov str., Baku, Azerbaijan
[3]Institute of Petrochemical Processes named after Acad. Yu.Mammadaliyev, 30, Khojali ave., Baku, Azerbaijan
**Corresponding author: sevinj.nasib.osmanli.26@gmail.com*

Keywords: Ni-Fe/alumina catalyst, methane pyrolysis, structural and thermodynamic characterization

Introduction. Alumina based Fe–Ni catalysts attract considerable attention due to their high activity and durability in methane pyrolysis. This process provides a sustainable route for hydrogen production while yielding valuable nanocarbon by-products. The catalytic behavior strongly depends on the structural and compositional features of alumina-based Fe–Ni catalysts, making their synthesis and characterization critical for optimizing performance and enabling applications in energy and nanotechnology [1,2].

Materials and methods. Catalysts were prepared by impregnating γ-AlOOH with solutions of Ni_3, Ni_5 pyrazine/pyrimidine complexes and ferrocene in CH_2Cl_2. The impregnated samples were dried at 110 °C and calcined at 850 °C for 4 h. Structural and morphological characterization was carried out using SEM/EDS, XRD, FMR, FTIR, and TG/DTA.

Results: Thermogravimetric analysis of the alumina-based Ni–Fe catalyst before and after methane pyrolysis at 800 °C shows moderate weight losses and overall structural stability. Prior to reaction, the total mass decrease was ~4.8 %, mainly due to removal of water, solvent residues, and gradual decomposition of surface ligands. After pyrolysis, the loss was reduced to ~3.5 %, and the weaker dehydration peak indicates a less hydrophilic, carbon-covered surface. No distinct phase transitions were detected by DSC up to ~1000 °C. Thermodynamic evaluation of the reaction $CH_4 \rightarrow C(s)+2H_2$ confirms that above 600 °C the process is spontaneous ($\Delta G^\circ \approx -40–70$ kJ/mol at 800 °C), making carbon deposition unavoidable. Ni_3C and Fe_3C are unstable under these conditions, so the active phase is metallic Ni–Fe, which catalyzes the growth of filamentous carbon. This form of carbon is less detrimental than encapsulating coke, ensuring only partial deactivation. Overall, the catalyst remains thermally stable up to ~1000 °C, with medium coke resistance: carbon deposits form mainly as nanofibers, while Ni–Fe alloying and the alumina matrix contribute to maintaining activity during pyrolysis.

Conclusions: Methane pyrolysis proceeds with the formation of hydrogen and solid carbon in the absence of carbon oxides, rendering this process a potentially carbon-neutral route for hydrogen production. For the reaction $CH_4 \rightarrow C(s)+2H_2$, the standard entropy change is positive ($\Delta S^\circ > 0$), while the Gibbs free energy $\Delta G^\circ(T)$ decreases markedly with increasing temperature. At 800 °C, ΔG° becomes strongly negative, indicating the thermodynamic inevitability of solid carbon (coke) deposition. Hence, methane pyrolysis is characterized by a substantial thermodynamic driving force at elevated temperatures. Iron and nickel carbides are thermodynamically unstable at 800 °C; therefore, the catalytically active phase consists of metallic Ni–Fe domains, on which filamentous carbon is preferentially formed. This morphology of carbon is less detrimental to catalyst performance, as it does not encapsulate the active metal sites, unlike amorphous or graphitic coke. Consequently, Ni–Fe catalysts promote the selective growth of filamentous carbon, thereby preserving a fraction of accessible active centers. Kinetic observations indicate that at 800 °C the Ni–Fe surface supports quasi-stationary filamentous carbon growth, which results in only partial deactivation without complete encapsulation of the particles. The observed decline in activity over several hours of operation is consistent with limited surface coking while maintaining metallic core activity. TGA/DSC analysis revealed no evidence of sintering (absence of characteristic thermal events), confirming the structural robustness of the catalyst over at least a 4-hour reaction cycle.

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SUSTAINABLE PROTECTION OF ARCHITECTURAL HERITAGE THROUGH SILANE-NANOPARTICLE HYBRID TREATMENTS

Toma FISTOS [1], Madalin Vasile COMAN[2], Denisa FICAI[3,4], Irina FIERASCU [1,5], Ionel Claudiu BADEA [2], Andrei Dragos MARCU [2], Irina Elena CHICAN [1], Cristian-Andi NICOLAE [1], Ludmila MOTELICA [3,4], Roxana Doina TRUSCA [3], Ovidiu Cristian OPREA [3,4], Anton FICAI [3,4], Radu Claudiu FIERASCU[1,3,4*]
[1]INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania
[2] Popp & Asociații S.R.L., 136 Calea Grivitei, Bucharest, Romania
[3] National University of Science and Technology POLITEHNICA Bucharest, 1-7 Gh. Polizu Str., Bucharest, Romania
[4] Academy of Romanian Scientists, Ilfov Street 3, Bucharest, Romania
[5] University of Agronomic Sciences and Veterinary Medicine of Bucharest,
59 Mărăști Blvd, Bucharest, Romania
**Corresponding author: fierascu.radu@icechim.ro*

Keywords: cultural heritage; nanostructures; silanes; stone heritage

Introduction: The conservation of built heritage faces growing challenges from environmental degradation, biodeterioration, climate change, and pollution. Traditional consolidation and protective treatments—often based on synthetic resins or non-compatible materials—may compromise the long- term durability, visual integrity, or environmental safety of historic substrates. In recent years, advancements in nanotechnology have led to innovative approaches for safeguarding and preserving cultural heritage, alongside its use in various other fields.

Materials and methods: This paper aims to be a critical review that covers aspects of using eco-friendly consolidation solutions that integrate silanes and nanoparticles in formulations compatible with stone, mortar, and lime-based heritage materials [1-3]. Nevertheless, applying these materials in outdoor settings—such as for building components and the preservation of stone-built heritage— presents several key challenges. Notably, improvements are still needed in the durability, optical clarity, and antimicrobial performance of new developed materials. Additionally, concerns related to environmental impact and potential health risks during the manufacturing process remainsignificant.

Conclusions: The integration of nanostructures is a promising pathway to develop eco-friendly consolidation treatments that effectively enhance the durability, compatibility, and protective functions of building materials and cultural heritage substrates. Continued research is essential to optimize these formulations, ensuring long-term stability, environmental safety, and practical applicability in real- world conservation scenarios.

***Acknowledgements**: This work was supported by the Ministry of Research, Innovation and Digitization (Ministry of Education and Research, National Authority for Research), CCCDI—UEFISCDI, project number PN-IV-P7-7.1-PTE-2024-0522, contract 47 PTE/2025, within PNCDI IV and by the Ministry of Research, Innovation and Digitization (Ministry of Education and Research, National Authority for Research) through INCDCP-ICECHIM Core program PN 23.06.01.01 (AQUAMAT).*

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COMPUTATIONAL DENSITY-FUNCTIONAL THEORY (DFT) OF REACTIVE OXYGEN SPECIES (ROS) AND INTERFERING SPECIES - COMPARISON WITH EXPERIMENTAL VIBRATIONAL SPECTROSCOPY

Andrei Ionut COCA [1], Paula CISMARU [1], Mircea COMAN [1], Martin MONDEK [1], Anda-Maria BAROI [2], Roxana Ioana (BRAZDIȘ) MATEI [2], Toma FISTOȘ [2], Irina Elena CHICAN [2], Irina FIERĂSCU [2,3], Radu-Claudiu FIERĂSCU [2,4], Ioana Silvia HOSU [2*]

[1]Syntech Research Agrico SRL, 1 Ioan Brezoianu Street, postal code 310370, Arad, Romania
[2]INCDCP-ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania
[3]Faculty of Horticulture, University of Agronomic Sciences and Veterinary Medicine of Bucharest, 011464 Bucharest, Romania
[4]Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA Bucharest, 313 Splaiul Independenței Str., 060042 Bucharest, Romania
**Corresponding author: ioana.shosu@yahoo.com*

Keywords: DFT; ROS; Experimental Vibrational Spectroscopy; computation; oxidative stress;

Introduction: Density Functional Theory (DFT) is a computational method used for the calculation of electron density. The negative charge is localized in the 3D space by the distribution of electronic charge, thus determining the size and the shape of the molecule/atom. The calculations were done for nitrite, nitrate, hydrogen peroxide, peroxynitrite ($ONOO^-$, both *cis* and *trans* isomers, Figure 1), peroxynitrous acid and superoxide. For the shifts in the spectra, one should take into account the influence of solvent, alkalinity and other salts formed like NaCl (even though, normally, some could be "IR transparent"). The shifts of the wavenumbers take place because certain bonds would vibrate in a specific different manner. Both ATR-FTR and Raman were used to measure the experimental spectra of vibrational spectroscopy. This kind of studies could tell us how ROS interact with different molecules such as their decomposition catalysts [1] or it could help to create a SERS sensor for ROS.

Materials and methods: The 3D molecular structure of ROS/RNS/PON and interfering species will be performed by molecular modeling specific software Gaussian 03. Fourier transform infrared (FT-IR) spectra were recorded using a ThermoScientific FTIR instrument (Nicolet 8700) equipped with a VariGATR accessory (Harrick Scientific Products, Inc.). A confocal RAMAN spectral imaging Spectroscope (Renishaw inVia Qontor) was used to determine the Raman Spectra.

Results: In this work, the presence of PON was qualitatively determined with the ATR FTIR technique, by comparison with DFT calculated spectra. The "peroxo" group from ONOO- vibrates at 875 cm^{-1} (asymmetrical stretching vibrations of O-O), and is present in its IR fingerprint region, even though other interfering species (as nitrite, nitrate, hydrogen peroxide, superoxide) vibrate in similar way, bands do not overlap (nitrite at 827 cm^{-1} - asymmetrical bending-twisting O=N-O and nitrate at 810 cm^{-1} - symmetrical bending O=N-O). Similar results were obtained for Raman.

(A) (B)

Figure 1. The *trans* isomer (A) and the *cis* isomer (B) of the $ONOO^-$ molecule represented with Gaussian 03, after the optimization of the parameters describing the structure of these molecules. The red balls are the oxygen and the blue balls are the nitrogen atoms.

Conclusions: Theoretical data are consistent with experimental data.

***Acknowledgements**: This work was supported by a grant of the Ministry of Education and Research (Ministry of Research, Innovation and Digitization), CCCDI - UEFISCDI, project number PN-IV-P7-7.1-PED-2024-1966, contract number 66PED/2025, within PNCDI IV".*

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EFFICIENT CADMIUM RETENTION FROM POLLUTED WATER USING NOVEL ADSORBENT MATERIALS

Roxana Ioana MATEI [1], Irina FIERASCU [1,2], Anda Maria BAROI [1,2], Toma FISTOS [1], Ioana Silvia HOSU [1], Irina Elena CHICAN [1], Cristina Emanuela ENASCUTA [1], Luiza CAPRA [1], Georgeta Ramona IVAN [1], Rodica Mihaela FRINCU [1], Sorin Marius AVRAMESCU [2], Radu Claudiu FIERASCU[1,3,4]*

[1]INCDCP-ICECHIM Bucharest, 202 Splaiul Independenței, Bucharest, Romania
[2] University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăști Blvd, Bucharest, Romania
[3] National University of Science and Technology POLITEHNICA Bucharest, 1-7 Gh. Polizu Str., Bucharest, Romania
[4] Academy of Romanian Scientists, Ilfov Street 3, Bucharest, Romania
**Corresponding author: fierascu.radu@icechim.ro*

Keywords: heavy metals; nanostructures; water depollution; adsorption.

Introduction: Cadmium contamination in water sources poses a significant threat to environmental and human health due to its high toxicity and persistence. Effective removal of cadmium ions from polluted waters is therefore a critical challenge for water treatment technologies. Adsorption has emerged as a promising and economical method for cadmium remediation, with various adsorbent materials demonstrating differing efficiencies based on their physicochemical properties.

Materials and methods: In this study was explored the adsorption potential of innovative nanostructured materials in a continuous system. The adsorbent was characterized before and after the process through analytical techniques (XRD, XRF, SEM); the cadmium retention was analyzed through inductively coupled plasma optic emission spectroscopy (ICP-OES). All the obtained results indicate a decrease of the cadmium concentration and an increased adsorptioncapacity.

The developed material presents some advantages as: is stable and allows the adsorption of heavy metals at ambient temperature, atmospheric pressure and in the pH range found in aqueous effluents; its synthesis is reproducible in terms of physical-structural properties; does not require high production costs; does not present secondary pollution (sludge, ash, etc.); can also be used in accidental pollution, with high concentrations of pollutant.

Conclusions: The integration of nanostructures is a promising pathway to develop new adsorbent material, removing the bottleneck of already used techniques. These findings contribute to advancing eco-friendly and cost-effective strategies for mitigating heavy metal pollution in contaminated water sources.

***Acknowledgements**: This work was supported by the Ministry of Research, Innovation and Digitization (Ministry of Education and Research, National Authority for Research) through INCDCP-ICECHIM Core program PN 23.06.01.01 (AQUAMAT).*

MORPHOLOGY AND TEXTURAL PROPERTIES OF CATION EXCHANGED CLINOPTILOLITE

Andreea IONIŢĂ [1], George Mihail TEODORESCU [1], Gabriela Mădălina OPRICĂ [1], Cătălina Diana UŞURELU [1], Gabriel VASILIEVICI [1], Zina VULUGA [1]*

[1]INCDCP ICECHIM Bucharest, 202 Splaiul Independenţei, district 6, 060021 Romania

**Corresponding author: zvuluga@icechim.ro*

Keywords: clinoptilolite; morphology; pore size; pore volume; specific surface area

Introduction: Clinoptilolite, one of the most abundant natural zeolites, has wide applications in pharmacy, medicine, environmental protection, agriculture and construction [1]. Its widespread use is mainly due to its high adsorption capacity and high ion exchange ability. The crystal structure of clinoptilolite consists of silica and aluminum tetrahedra that form a specific two-dimensional network of channels, channels A and B parallel to each other and channel C intersecting both of them. These channels are occupied by exchangeable cations, usually alkali and alkaline earth metals, and water molecules [2]. The structure of the zeolite and the type of exchanged cation affect the textural properties of the zeolite and, further, the adsorption capacity [3]. The aim of this work was to determine the morphological and textural properties of clinoptilolite as a function of the exchanged cation.

Materials and methods: Clinoptilolite from Rupea, Brasov, Romania (CR) was tribomechanically activated, purified (CRP) and subjected to cation-exchange reactions with 0.2 M cationic salt solution of alkali, alkaline earth and transition metals. The morphological characteristics of cation exchanged clinoptilolite were analyzed using a Hitachi TM4000 Plus microscope (Hitachi, Tokyo, Japan) with an accelerating voltage of 15 kV. The chemical compositions were determined using an energy dispersive X-ray spectrometer (EDX) The Brunauer-Emmett-Teller (BET) method was applied to calculate the textural properties by using NOVA 2200e Gas Sorption Analyzer (Quantachrome). The specific surface area was determined from the standard BET equation. The total pore volume was estimated from the adsorbed volume at a relative pressure p/po close to unity. The pore size distribution and mesopore volume were obtained from the desorption curve of the isotherm by applying the Barrett-Joyner- Halenda (BJH) model.

Results: Depending on the type and size (atomic radius) of the exchanged cations, the specific surface area increases by 5-20%, the pore volume decreases by up to 50%, and the pore size increases by approximately 50%. These results constitute evidence of the loading of clinoptilolite pores with exchanged cations, the results being also confirmed by SEM-EDX analyses.

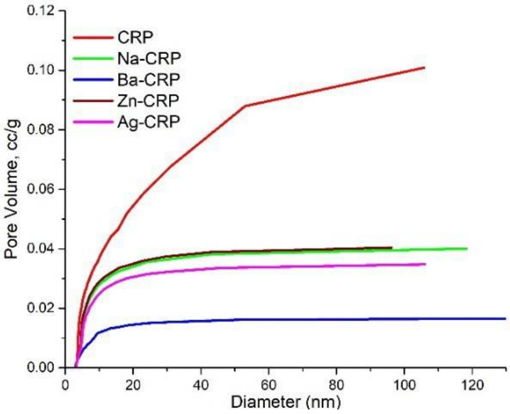

Figure 1. BET analysis of CRP samples

Conclusions: The type of cation exchanged affects the textural properties of clinoptilolite. The work will continue with the evaluation of the adsorption capacity of clinoptilolite depending on the type of cation exchanged.

Acknowledgements*: This work was supported by grant of the Ministry of Research, Innovation and Digitalization, CNCS/CCCDI-UEFISCDI, project number ERANET-M-3-SMARTCAP-1, financing contract 73/2024, within PNCDI IV and project PN 23.06.01.01./2022 AQUAMAT within PN 23.06 Core Program-ChemNewDeal*

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STUDY OF IBUPROFEN RETENTION ON VARIOUS ADSORBENTS

Florina (IONITA) LUNGU [1*], Simina Daniela STEFAN [1], Alexandra GROSU [1]

[1]Department of Analytic Chemistry, National University of Science and Technology POLITEHNICA Bucharest,, 1-7 Polizu str., district 6, Romania

**Corresponding author: florina.lungu@stud.chimie.upb.ro*

Keywords: Ibuprofen; Adsorption; Nanomaterials; Water; Pharmaceutical Pollutants

Introduction: Pharmaceutical residues, especially nonsteroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen, diclofenac, naproxen, and ketoprofen, are emerging pollutants frequently detected in wastewater, surface, and even drinking water. [1] Their presence is associated with toxic effects on aquatic ecosystems and risks to human health, which is why the development of effective removal methods is a priority. [4,5]

Materials and methods: The main purification technologies were analyzed: advanced oxidation processes (AOPs: ozonization, photo-Fenton, electro-Fenton), adsorption on carbonic materials (activated carbon, biochar, graphene, metal-organic composites), membrane processes (nanofiltration, reverse osmosis) and hybrid bio-electrochemical solutions. [2] Data sources included recent studies and reported experimental results for actual concentrations in municipal and industrial wastewater.[3]

Results: Conventional methods show limited efficiencies (<50%) in removing NSAIDs. In contrast, advanced technologies achieved superior performance: Photo-Fenton and electro-Fenton: up to 96– 100% degradation for ibuprofen and acetaminophen; [3] Ozonation and hybrid processes: partial mineralization of naproxen and ketoprofen; [4] Adsorption on graphene and modified biochar: efficiencies >90% for diclofenac and ibuprofen; Membranes (RO, NF): >85% retention for most NSAIDs. [1]

Conclusions: The removal of anti-inflammatories from water requires combined technologies, based on advanced oxidation and adsorption processes on nanomaterials. [2] A promising direction is the integration of biological treatments with AOPs, along with the use of innovative materials (hybrid aerogels, MOF composites). [3]. Their full-scale implementation is essential for reducing ecotoxicological risks and protecting water resources. [2,5]

***Acknowledgements**:*

Doctoral School, Specialization of Environmental Engineering, Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology Politehnica of Bucharest, -7 Polizu Street, 011061 Bucharest, Romania

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SYNTHESIS, CHARACTERIZATON, ADME AND DFT STUDIES OF SOME PYRIMIDINE COMPOUNDS

Maria MARINESCU [1*], Christina ZALARU [1], Alexandru-Cosmin BĂLOI [1], Ioan Cristian MIHALACHE [1], Claudia Valentina POPA [1,2*],

[1] University of Bucharest, Faculty of Chemistry, Department of Inorganic Chemistry, Organic Chemistry, Biochemistry and Catalysis, 90 Sos. Panduri, 050663, Bucharest, Romania

[2] "Cantacuzino" National Military Medical Institute for Research and Development, Pharmaco-toxicology Laboratory, 103 Splaiul Independenței, 050096, Bucharest, Romania

**Corresponding authors: popa.claudia@cantacuzino.ro; valentina.popa@chimie.unibuc.ro; maria.marinescu@chimie.unibuc.ro*

Keywords: hydrogel, 2-naphthyl- dihydropyrimidine derivate, antibacterial; antiviral.

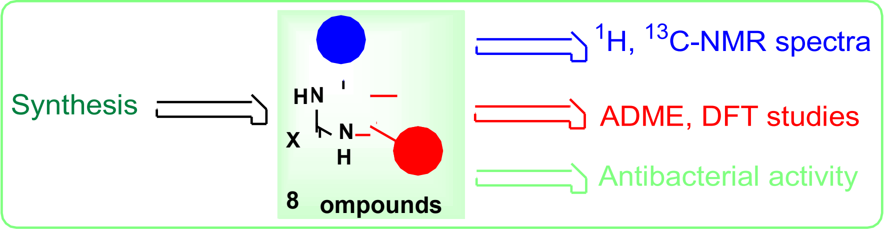
Introduction: Heterocyclic compounds represent a key class of compounds in medicinal chemistry due to their presence in both natural and synthetic compounds [1-4]. Numerous "one pot" methods are mentioned in recent literature for the synthesis of various heterocyclic compounds, particularly pyrimidines. We have proposed to desine and optimize the synthesis of substituted pyrimidines through multicomponent reactions.

Materials and methods: In order to create new tetrahydropyrimidine-benzo[*d*]imidazoles, a number of pyrimidines and tetrahydropyrimidines that were synthesized through the Biginelli condensation were subjected to either a Mannich reaction or a reaction with a benzimidazole halogen compound. The structures of all compounds were confirmed by ^{1}H, ^{13}C-NMR spectra and elemental analysis [5]. An ADME study was realized in order to find the values of the structural descriptors for the verification of Lipinski's rule as well as the values of the structural descriptors from the Weber's rule for the synthesized compounds. All compounds were evaluated by qualitative and quantitative methods against a panel of selected bacterial and fungal strains.

The GAMESS 2012 program was used to conduct a DFT investigation of the frontier molecular orbitals HOMO-LUMO and molecular structure.

Results: Mullikan atomic charges, geometric parameters of the pyrimidines and tetrahydropyrimidines computed with GAMESS, and electronic parameters like, chemical hardness, electronic chemical potential, and global electrophilicity index, were all associated with antimicrobial activity.

Conclusions: Eight pyrimidine compounds were synthesized in two steps and characterized. High antibacterial activity has been discovered to be facilitated by the molecule's symmetry and the presence of a nucleophilic group. The empirical Lipinski and Veber analyses for the synthesized compounds show good bioavailability by oral administration.



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SEMI-INTERPENETRATED POLYMER NETWORK HYDROGELS WITH Mo-MXenes FOR TUNABLE ELECTROMAGNETIC INTERFERENCE SHIELDING

Andreea MOLDOVAN [1], Aurel DIACON [1*], Gabriela TOADER [1], Martino ALDRIGO [2], Sergiu IORDĂNESCU [2], Alexandra MOCANU [2], Oana BRINCOVEANU [2], Cosmin ROMANITAN [2], Traian ROTARIU [2], Edina RUSEN [3], Ana Mihaela GAVRILA [4], Bodan TRICA [4], Alexandru MARIN [1,5]

[1]*Military Technical Academy "Ferdinand I", 39-49 G. Cosbuc Blvd., 050141 Bucharest, Romania*
[2] *National Institute for Research and Development in Microtechnologies-IMT Bucharest,*
126A Erou Iancu Nicolae, 077190 Voluntari, Romania
[3] *Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA*
Bucharest, 1-7 Gheorghe Polizu St., 1st District, 011061 Bucharest, Romania
[4] *National Research and Development Institute for Chemistry and Petrochemistry ICECHIM, Advanced Polymer*
Materials and Polymer Recycling, 202 Splaiul Independenței, 060021 Bucharest, Romania
[5] *Research and Innovation Center for CBRN Defense and Ecology,*
225 Oltenitei Ave., 041327, Bucharest, Romania

**Corresponding author: aurel_diacon@yahoo.com*

Keywords: hydrogel, MXenes, polypyrrole, electromagnetic interference shielding, EMI

Introduction: The rapid advancement of compact and highly integrated electronic systems has intensified the demand for efficient electromagnetic interference (EMI) shielding materials. Traditional metal-based shielding solutions, while effective, are often limited by their rigidity, weight, and susceptibility to corrosion. In contrast, polymer-based composites offer lightweight, flexible, and tunable alternatives suitable for next-generation electronics.MXenes, a class of two-dimensional transition metal carbides and nitrides, have emerged as promising candidates for EMI shielding due to their high electrical conductivity, layered morphology, and surface functionalization potential. Among them, Mo_2TiAlC_3-based MXenes remain relatively underexplored, particularly in hydrogel matrices [1- 5]. Hydrogels, with their water-rich, crosslinked polymer networks, provide a versatile platform for integrating conductive fillers, enabling multifunctional applications in soft electronics and biomedicine. This study presents the synthesis and characterization of semi-interpenetrated polymer network (sIPN) hydrogels incorporating Mo_2TiAlC_3 MXenes and polypyrrole (PPy) particles. The goal is to develop flexible, low-swelling materials with enhanced EMI shieldingabilities.

Materials and methods: Hydrogels were obtained via photopolymerization of hydroxyethyl methacrylate (HEMA) and acrylic acid (AA) in the presence of polyvinyl alcohol (PVA), forming a semi-interpenetrated polymer network. Mo_2TiAlC_3 MXenes were pre-dispersed in PVA using ultrasonication to promote delamination and ensure homogeneous distribution. PPy particles, serving as additional conductive components, were synthesized and co-incorporated into the hydrogel matrix. Formulations included varying MXene concentrations (0.1%, 0.2%, and 0.4 wt.%) to evaluate their influence on structural and functional properties. The resulting hydrogels were subjected to comprehensive characterization using scanning electron microscopy (SEM), transmission electron microscopy (TEM), Fourier-transform infrared spectroscopy (FT-IR), thermogravimetric analysis (TGA), X-ray diffraction (XRD), mechanical testing, and EMI shielding measurements in the X-band (8.2–12.4 GHz).

Results: The synthesized hydrogels exhibited high gel fraction values (>98%), indicative of robust crosslinking and network integrity. Swelling behavior was significantly reduced in MXene-containing samples, suggesting enhanced structural density and minimized volumetric expansion—critical for maintaining conductive pathways under hydrated conditions.

Morphological analysis confirmed uniform dispersion of Mo_2TiAlC_3 and PPy particles, with pore size distributions narrowing as MXene content increased. FT-IR spectra validated the successful incorporation of monomers and fillers, while XRD patterns revealed partial exfoliation of MXene layers, contributing to improved interfacial contact and electrical conductivity.

Thermal analysis demonstrated increased thermal stability in MXene-loaded hydrogels, with delayed degradation onset attributed to the inorganic filler network. Mechanical testing showed enhanced

compressive strength and elasticity in hydrogels containing 0.1–0.2 wt.% MXenes, whereas higher concentrations led to agglomeration and reduced mechanical performance.
EMI shielding measurements revealed that the Hgel-MX-0.1% formulation achieved the highest shielding effectiveness, driven by optimal filler dispersion and balanced conductivity. The presence of PPy further amplified absorption-dominated shielding mechanisms, reducing reflection losses and enhancing stealth characteristics.

Conclusions: This work demonstrates the successful integration of Mo_2TiAlC_3 MXenes and polypyrrole into semi-interpenetrated hydrogel networks via a scalable photopolymerization approach. The resulting materials exhibit superior viscoelastic properties, mechanical stability, and tunable EMI shielding performance. These findings highlight the potential of MXene-based hydrogels as flexible, multifunctional platforms for advanced electronic, wearable, and biomedical applications.

Acknowledgements*: This work was supported by a grant of the Ministry of Research, Innovation, and Digitization, CNCS UEFISCDI, project number PN-IV-P2-2.1-TE-2023-0806 – ctr.no. 55TE/2025, project number PN-IV-P7-7.1-PTE-2024-0466 - ctr. no. 2PTE/2025, and PN-IV-P7-7.1-PTE-2024-0498 – ctr.no. 19PTE/2025, within PNCDI IV.*

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Fe-MODIFIED BIOCHAR: FROM AGRICULTURAL WASTE TO CATALYTIC MATERIAL

Violeta-Carolina NICULESCU [1*], Ramona Raluca HANDOLESCU [1,2], Nadia PAUN [1], Claudia SANDRU [1], Sina Niculina COSMULESCU [3]

[1] *National Research and Development Institute for Cryogenic and Isotopic Technologies - ICSI Ramnicu Valcea, 4th Uzinei Street, P.O. Raureni, 240050 Ramnicu Valcea, Romania*

[2] *Doctoral School of Engineering of Animal and Plant Resources, Faculty of Horticulture, University of Craiova, 13 A.I. Cuza Street, 200585 Craiova, Romania*

[3] *Faculty of Horticulture, University of Craiova, 13 A.I. Cuza Street, 200585 Craiova, Romania*

**Corresponding author: violeta.niculescu@icsi.ro*

Keywords: agricultural waste, biochar, iron oxide, adsorption, heterogeneous catalysis

Introduction: Biochar, a carbonaceous material derived from biomass pyrolysis, has gained increasing attention for its environmental applications due to its porous structure, stability, and ability to host active species. Agricultural residues such as potato peels represent sustainable feedstocks for biochar production, offering both waste valorization and environmental benefits. Nevertheless, pristine biochar often exhibits limited adsorption capacity, mainly due to its low surface area and relatively inert surface chemistry. To overcome these drawbacks, functionalization with transition metal oxides, particularly iron oxides, has been widely investigated as a strategy to enhance sorption, redox, and catalytic properties. Recent studies demonstrated that Fe-modified biochar can serve as an efficient material for the removal of organic pollutants and heavy metals from aqueous systems, owing to the synergistic effects of porous carbon support and active Fe species [1,2]. Such hybrid materials combine the stability of the carbon matrix with the catalytic activity of iron, enabling selective adsorption and redox-based degradation pathways. In this context, the present work focuses on the synthesis and characterization of Fe-functionalized biochar derived from potato peels, aiming to highlight the structural modifications induced by iron deposition and the potential of the resulting composite for adsorption and catalytic applications.

Materials and methods: Biochar (BCC450) was impregnated with Fe salts ($FeCl_3$ and $FeSO_4 \cdot 7H_2O$) under alkaline conditions (pH 9–11), followed by filtration and drying at 80 °C, yielding FeO/BCC450. The materials were characterized by elemental analysis, BET surface area and porosity measurements, SEM-EDX, and FTIR spectroscopy to evaluate textural and chemical changes upon functionalization.

Results: Elemental and EDX analyses indicated successful incorporation of Fe (≈1.9 wt%). SEM images revealed heterogeneous morphologies with slit-like pores, while iron clusters were dispersed on the carbon matrix, partially blocking porosity. BET analysis showed a specific surface area of 18.55 m^2/g, average pore diameter of 5.71 nm, and pore volume of 0.025 cm^3/g, indicating dominant mesoporosity. FTIR spectra confirmed chemical interactions between Fe species and oxygenated functional groups, with characteristic Fe–O vibrations emerging in the 570–630 cm^{-1} region. These findings suggest that adsorption and catalytic performance rely more on Fe active sites than on physical surface area.

Conclusions: The Fe-functionalized biochar presents a mesoporous structure with limited textural development but enriched surface chemistry, making it suitable for selective adsorption and heterogeneous catalysis.

Acknowledgements: *The work has been funded by the Romanian Ministry of Education and Research, under NUCLEU Program-Financing Contract no. 20N/05.01.2023, Project PN 23150402: "Laboratory experiments valorisation in the development of technologies for the production of biofuels from agro-industrial waste" and by the Ministry of Agriculture and Rural Development–Romania, under Sectorial Plan-ADER 2026, Project ADER 6.3.7–"Applicability measures regarding the investigation of the organochlorine and organophosphorus contaminants distribution on the soil-plant-vegetable/fruit-finished product chain, following different types of soils in various areas". The authors are grateful to Adriana Marinoiu, and Anca Zaharioiu, from National Research and Development Institute for Cryogenic and Isotopic Technologies-ICSI Rm. Valcea, for specific surface area, pores distribution, and elemental analysis.*

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THE ANTIBACTERIAL AND ANTIVIRAL ACTIVITIES OF AN HYDROGEL FUNCTIONALIZED WITH A 2-NAPHTHYL- DIHYDROPYRIMIDINE DERIVATE

Claudia Valentina POPA[1,2*], Razvan NEAGU [1], Lucia-Elena IONESCU [1], Radu-Iulian TANASA [1], Diana-Mihaela POPESCU [1], Cristina-Anca SECARA [1], Maria MARINESCU [2*]

[1] "Cantacuzino" National Military Medical Institute for Research and Development, Pharmaco-toxicology Laboratory, 103 Splaiul Independenței, 050096, Bucharest, Romania

[2] University of Bucharest, Faculty of Chemistry, Department of Inorganic Chemistry, Organic Chemistry, Biochemistry and Catalysis, 90 Sos. Panduri, 050663, Bucharest, Romania

**Corresponding authors: popa.claudia @cantacuzino.ro; valentina.popa@chimie.unibuc.ro; maria.marinescu@chimie.unibuc.ro*

Keywords: hydrogel, 2-naphthyl- dihydropyrimidine derivate, antibacterial, antiviral.

Introduction: Functionalized hydrogels with antibacterial activity are an innovative solution for treating wounds resulting from thermal or chemical burns. 2-Naphthyl-dihydropyrimidine (2-naphtyl- DHPM) derivatives have many biological properties, such as: antitumour, antiviral, antimicrobial, anti- inflammatory, neuroprotective in Alzheimer's diseas activities as a result of the presence of the DHPM nucleu and also the naphthyl group [1-4].

The main objective of this study is to determine the antibacterial and antiviral activities of an hydrogel functionalized with the ethyl 4-(2-naphthyl-phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate, both obtained in our laboratories.

Materials and methods: The compound was synthetized through a multi-component Biginelli reaction. Hydrogels based on Carbopol 940, functionalized with: Biginelli hybrid, bacitracin (BAC), chloramphenicol (CFL) were obtained. To determine biological activities, dilutions were prepared from the hydrogels. Antimicrobial activity tests were performed using the adapted Kirby-Bauer diffusimetric antibiogram method (the cylinder technique, 6 mm diameter, 100 μL of volume) - for liquid samples and by drawing lines of gel on seeded plates with the bacterial strain in case of using semi-solid hydrogels. The reference strains *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922 and *Pseudomonas aeruginosa* ATCC 27853 were used. Antiviral activity screening was performed on Vero and HeLa cell lines, permissive for test viruses, adapting the SR EN 14476+A2 standard. The MTT method and L929 fibroblast cell line from mouse was used for establishing the cytotoxicity of hydrogel. Except for the determination of antiviral activity, in all cases the experimental results were compared with the results obtained for hydrogels functionalized with antibiotic (BAC or CFL).

Results: The synthetized compound determines the appearance of a bacterial inhibition zone for *S. aureus* in the case of liquid samples obtained from hydrogel (final concentration of compound = 0.4 mg/mL), for *E. coli* (at 1 mg/mL) and *P. aeruginosa* (at 4 mg/mL), if the functionalized hydrogel was applied as it is. The sample from the hydrogel functionalized with the synthesized derivative showed good antiviral activity and was negative in terms of cytotoxicity.

Conclusions: A Carbopol-based hydrogel, functionalized with synthetized 2-naphtyl-DHPM derivative was prepared and its tested antimicrobial and antiviral activities were good.

In perspective, for highlighting the potential of the hydrogel functionalized with 2-naphthyl-DHPM derivative for treating infected wounds from burn patientes, the *in vivo* studies are required.

Acknowledgements*: This work was supported by the sectoral research-development plan (PSCD) project of the Ministry of National Defense „Innovative pharmaceutical preparations with topical administration and antimicrobial activity based on new synthetic hybrid compounds".*

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PROCESSING METHODS FOR THE VALORIZATION OF SPENT COFFEE GROUNDS – A REVIEW

Ramona-Eugenia POPESCU[1*], Maria RÂPĂ [2]

[1]*Biotechnical Systems Engineering Doctoral School, National University of Science and Technology POLITEHNICA Bucharest, 313 Splaiul Independenței, 060042, Bucharest, Romania*

[2]*Faculty of Materials Science and Engineering, National University of Science and Technology POLITEHNICA Bucharest, 060042 Bucharest, Romania*

**Corresponding author: ramona.popescu1008@stud.isb.upb.ro*

Keywords: spent coffee grounds, biomass, processing, impact

Introduction: The rapid growth of the population and ongoing urbanization have resulted in excessive consumerism, the depletion of fossil resources, and an increasing generation of waste. A considerable fraction of this waste is represented by food residues, which account for approximately 8–10% of global greenhouse gas emissions [1]. In order to mitigate dependence on fossil fuels, current research efforts focus on the valorization of agricultural residues, including spent coffee grounds (SCG), as renewable feedstock for biomass-based applications. Spent coffee grounds possess a complex chemical composition (12.4% cellulose, 30–42% hemicellulose, 20–24% lignin, 10–19% proteins, 2.3–18% lipids, as well as caffeine, polyphenols, dietary fibers, and minerals), which makes them highly suitable for a wide range of sustainable uses [2,5].

Materials and methods: Various formulations containing plant-based biomass (such as SCG) have been investigated through different processing techniques, including green solvent lipid extraction [1], pyrolysis [3], hydrothermal carbonization [4], and melt processing.

Results: Studies indicated that the lipid extraction from SCG could significantly enhance the efficiency of biodiesel production, thereby reducing the environmental impact of waste management. Pyrolysis of SCG has led to carbon-rich biofuels, while torrefaction experiments, although still at the laboratory scale, demonstrated the potential for producing solid biofuels. Hydrothermal carbonization of SCG has successfully generated hydrochar with promising fuel properties.

Furthermore, optimization of SCG biorefinery processes enabled the recovery of valuable compounds such as D-mannose and bioethanol, highlighting the potential of SCG as a platform for bio-based chemicals. Melt processing approaches allowed the incorporation of SCG into formulations with applicability in the food industry, leading to the development of novel products such as fermented beverages, pasta, bread, muffins, ice cream cones, and biscuits [5].

Conclusions: SCG is a versatile and renewable biomass that can be converted into biofuels, bio-based chemicals, and food products. Its valorization reduces environmental impact, supports circular economy principles, and contributes to sustainable development. Future research should focus on process optimization and industrial-scale implementation.

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ENHANCING THE THERMAL STABILITY OF THERMOPLASTICS USING NATURAL PHENOLIC ANTIOXIDANTS

Temenuzhka RADOYKOVA [1]*, Stela GEORGIEVA [1]

[1]University of Chemical Technology and Metallurgy, 8 "St. Kl. Ohridski blvd, 1756 Sofia, Bulgaria.

**Corresponding author: nusha_v@uctm.edu*

Keywords: antioxidants, lignocellulosic material, phenolic compounds

Introduction: This study explores how the antioxidant properties of aromatic molecules, obtained from renewable resources, can improve the stability and durability of thermoplastics. By destructive processing of hydrolyzed lignocellulosic material, low molecular weight phenolic compounds were obtained, isolated, and identified by gas chromatography coupled with mass spectrometry(GC-MS).

Materials and methods: The cellulose, lignin, and ash content of the lignocellulosic materials were determined according to established methods [1-3]. The optimum conditions for alkaline treatment were based on previous research [1], [4], [5]. Triple extractions were performed using solvents with different polarities, at an organic-to-water phase ratio of 1:5, each for 2 minutes.

Results: The antioxidant activity of the phenolic compounds isolated with toluene was evaluated for their effect on the thermo-oxidative stability of model polyurethane films. Thermal stability was assessed using thermogravimetric (TG), differential thermal (DTA), and derivative thermogravimetric (DTG) analyses. The temperature points corresponding to 5%, 25%, and 50% sample weight loss (T5%, T25%, T50%) were recorded. The addition of these phenolic compounds led to increased thermal stability and a greater residue yield at 665 °C for the polyurethanes.

Fig. 1. Polyurethane samples

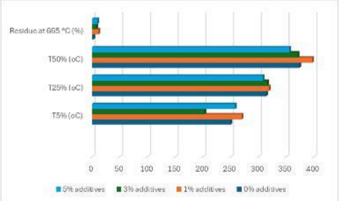

Fig. 2. Temperature point values. (0, 1, 3, and 5% toluene extract additives).

Conclusions: Introducing small amounts (1%, 3%, and 5%) of phenolic extract to the polymer matrix showed that 1% provided the most effective stabilization. Higher concentrations appeared to promote additional oxidative processes, as confirmed by FTIR and thermogravimetric analysis.

***Acknowledgements**: Scientific Research Sector at the University of Chemical Technology and Metallurgy, Sofia, Bulgaria, 403-25/2025.*

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SILANE-FUNCTIONALIZED SERICITE AS A HYBRID SUPPORT FOR THE IMMOBILIZATION OF BIOACTIVE COMPOUNDS FROM RED CLOVER

Monica Florentina RADULY [1*], **Valentin RADITOIU** [1], **Alina RADITOIU** [1], **Cristian-Andi NICOLAE** [1]
[1]*INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania*
**Corresponding author: monica.raduly@icechim.ro*

Keywords: hybrid materials, natural compounds, mineral support

Introduction: Sericite, a mica-type mineral with lamellar morphology, is primarily composed of potassium aluminum silicate. Due to its silky texture, light-diffusing capacity, and high oil absorption ability, sericite is widely employed in cosmetic formulations. In topical applications, it improves product spreadability, imparts a matte appearance, and enhances adherence to the skin without clogging pores. Its inert nature and non-irritating profile also make it suitable for sensitive skin [1-4].

Materials and methods: The surface of sericite was modified with anchoring agents to enhance the compatibility of the host matrix with organic fluorophores, employing bottom-up deposition techniques. In this study, extracts obtained under controlled temperature and pH conditions were immobilized onto sericite functionalized with 3-aminopropyltriethoxysilane (APTES) and 3-(trimethoxysilyl)propyl methacrylate (MSMA), with the aim of developing stable hybrid systems for the delivery of bioactive molecules.

Results: The modified sericite was morpho-structurally characterized and subsequently used to evaluate its interaction with natural compounds extracted from red clover (*Trifolium pratense*). Comprehensive characterization was conducted using Fourier-transform infrared spectroscopy (FTIR) and UV–Vis spectroscopy to confirm phytochemical deposition, scanning electron microscopy (SEM) to investigate surface morphology, surface areas and porosity analysis (BET) and thermogravimetric analysis (TGA) to monitor structural changes. The findings highlighted the crucial role of extraction conditions in influencing the interaction and stability of red clover compounds on silane-modified sericite. These hybrid systems show promising potential for biomedical and pharmaceutical applications, particularly in the development of bioactive coatings, targeted drug delivery platforms, and functional excipients for cosmetic formulations.

Conclusions: This synergistic approach combines the immediate optical benefits provided by sericite with the long-term dermal advantages of red clover extract, aligning with current trends toward sustainable, plant-based ingredients in cosmetics.

***Acknowledgements**: This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CCCDI - UEFISCDI, project number PN-IV-P7-7.1-PED 2024-0838, within PNCDI IV, partial and through INCDCP ICECHIM Bucharest Core Program—ChemNewDeal PN 23.06, within the National Plan for Research, Development and Innovation 2022–2027, project no. PN 23.06.01.01(AQUAMAT).*

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BIOPOLYMERIC MEMBRANE BASED ON COLLAGEN AND RETINOL FOR HYDRATION AND REGENERATION OF THE SKIN

Alexandrina RUGINĂ [1*], Gabriel Lucian RADU [1], Mihaela Marinela PĂUN [1], Cătălin IORDĂCHEL [1], Andreia ALECU [1], Elena BERTEANU [1], Ionică Mihaela ENACHE [1]

[1]INCDSB Bucharest, 296, Splaiul Independenței, district 6, 060021 Romania

**Corresponding author: alexandrina.rugina@incdsb.ro*

Keywords: biopolymer membrane, collagen hydrolysate, retinol, glycerin

Introduction: Collagen represents over 30% of the total protein mass of the body and, due to its hydrating and regenerating properties, it is one of the main constituents of membranes and bioactive matrices. Retinol is also one of the most effective anti-aging agents, promoting skin cell regeneration by stimulating the production of collagen and elastin.

The objective of this study was to create a biopolymer membrane with the role of hydrating the skin and increasing its cellular regeneration rate; the membrane consists of a solution of type I collagen and glycerin with a plasticizing role, enriched with retinol.

Materials and methods: As materials we used: type I collagen solution obtained from bovine tendons and skin by enzymatic treatment, retinol from egg yolk and genipin as a natural crosslinking agent. Type I collagen was extracted from bovine skin and tendons by the enzymatic method, using pepsin previously dissolved in 0.5M acetic acid solution [1]; isolation and extraction of retinol from egg yolk was performed by Kovalcuks' method [2]. Obtaining the gels by successively mixing the collagen solution (type I) of concentration 0.5-1%, average molecular weight 300,000 and pH 5.5-7.5 with glycerin, 50μ retinol and genipin ($p \leq 98\%$); drying the gels and obtaining the membranes. As a final step, the membranes were sterilized with UV radiation in sterile rooms.

Results: A bioactive membrane with a thickness of 1-2 mm was obtained, consisting of 100 parts of collagen solution (type I) with a concentration of 0.5-1% and average molecular weight of 300,000, 1- 1.5% glycerin, 50 μg retinol, with 0.5–2.5% genipin as a crosslinking agent.

Conclusions: The obtained biopolymer membrane has the following advantages: the process of obtaining the membrane is simple, economical and non-polluting (the substances used are generally non-toxic natural products); the raw material and substances used are accessible; the gradual release of vitamin A from the collagen membrane due to the addition of genipin as a cross-linking agent.

The natural bioactive membrane obtained is similar to a natural bioactive complex that helps hydrate the skin and regenerate cells, having applications in medicine and can also be used in cosmetics, in the form of masks.

***Acknowledgements**: Nucleu Program within the National Research, Development and Innovation Plan 2022-2027, carried out with the support of the National Research Authority, project no. 23020101: SIA-PRO, Contract no. 7N/03.01.2023.*

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POLYMER COMPOSITES ENDOWED WITH MAGNETIC FEATURES

**Elena Bianca STOICA [1], Anita Laura CHIRIAC [1], Anamaria ZAHARIA [1],
Sorin Viorel DOLANA [1], Nicolae STĂNICĂ [2], Tanța Verona IORDACHE [1], Andrei SÂRBU [1],
Andreea Gabriela OLARU [3], Teodor SANDU [1*]**
[1]INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania
[2]"Ilie Murgulescu" Institute of Physical Chemistry202 Splaiul Independenței, district 6, 060021 Romania
[3] S.C. EDAS-EXIM S.R.L., 23 Banat street, district 1 , Bucharest, Romania
**Corresponding author: teodor.sandu@icechim.ro*

Keywords: magnetite, silane moieties, hybrids

Introduction: Various industry branches release wastewaters loaded with heavy metals (HMs), requiring amendment measures. The easy separation of magnetic particles, such as magnetite, from aqueous solutions turned them into a viable means of HMs removal [1]. In time, magnetite undergoes oxidation, yielding maghemite, which is detrimental for its magnetic features [2]. The modification of magnetite with Si-OH moieties, achieved through the sol-gel process, was shown to prevent the degradation of magnetic features and thus to increase the lifetime of magnetite [3].

Materials and methods: Thus, the work aimed to develop advanced composites by coating magnetite with silane. The elaborated composites were characterized in terms of magnetic properties (VSM), chemical composition (FTIR), morphology (SEM), and crystallinity (XRD).

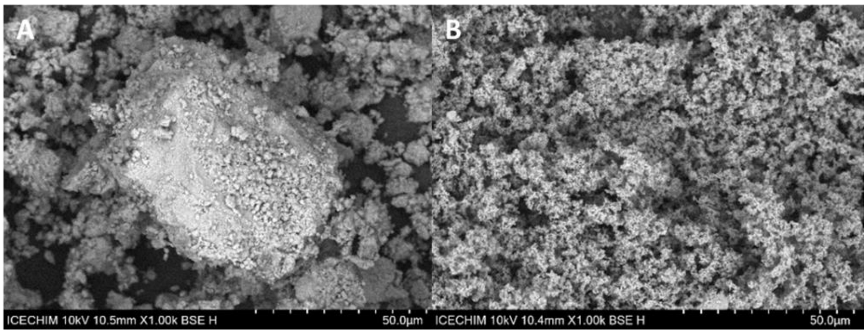

Figure 1. SEM images of magnetic particles before (A) and after (B) modification with silane moieties

Results: The hybrid samples exhibit magnetic features, despite a reduction in magnetization from the initial magnetite value (VSM). The hybrid samples show the characteristic XRD peaks and FTIR bands of both raw materials (magnetite and reference organosilane). SEM images show that the coating process leads to changes in structural order, which results in a lower agglomeration degree than for the unmodified magnetite.

Conclusions: The aim of the research was fully met, with the success of modifying magnetite with silane, being proven by studies of chemical composition (FTIR, XRD), morphology (SEM), and magnetic determinations (VSM). These composites showed improved properties, as a higher order degree was ensured (XRD), even though magnetic features are partly diminished upon modification.

***Acknowledgements**: This work was supported by a grant of the Ministry of Research, Innovation, and Digitization, CCCDI - UEFISCDI, project number PN-IV-P7-7.1-PED-2024-1069 (ctr. 18PED/2025, ZIRMAGSOLGEL) and by an inter-academic collaborative project RO-BG INNOMAG.*

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POLYMER MEMBRANES MODIFIED WITH SILANOL MOIETIES

Marinela Victoria (DUMITRU) IORDĂESCU [1], Tanța Verona IORDACHE [1], Ioana Cătălina GÎFU [1], Ana Mihaela GAVRILĂ [1], Anita Laura CHIRIAC [1], Anamaria ZAHARIA [1], Andrei SÂRBU [1], Sorin Viorel DOLANA [1], Iulia Elena NEBLEA [1], Teodor SANDU [1]*

[1]INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania

**Corresponding author: teodor.sandu@icechim.ro*

Keywords: water depollution, chitosan membranes, sol-gel

Introduction: Nowadays, water pollution attained alarming levels requiring pollution control measures. Therefore, polymer membranes emerged as a viable means to address this matter. The use of natural polymers instead of synthetic counterparts for membranes has recently gained interest as an eco- friendlier alternative [1]. The sol-gel process is a well-known method to produce solid materials with well-defined features [2]. Building on the features mentioned above, this work aimed at developing chitosan-based membranes with silanol groups rendered by approaching sol-gel, to combine individual benefits.

Materials and methods: Chitosan membranes were prepared in two stages: (1) a chitosan solution was prepared in acetic acid, and (2) coagulation of this solution in a sodium hydroxide solution. Silanol moieties were rendered using a mixture consisting of silanes in different ratios. Samples were prepared using different chitosan concentrations and different ratios between the two silanes and characterized by FTIR, TGA, and SEM.

Results: Thermal determinations (TGA/DTG) show an increase in thermal stability following the application of sol-gels. FTIR spectra prove the occurrence of a coordination phenomenon of the sol-gel to the chitosan membrane. The porosity of the membranes increases following modification with silanol groups.

Conclusions: The targeted membranes were successfully developed, and the basic pH at which the sol- gel process is performed does not affect the stability of the membrane. Chemical composition (FTIR), thermal stability (TGA), and morphology (SEM) studies prove the possibility of modifying chitosan membranes with silane groups, as well as the beneficial role of this modification on the final properties.

***Acknowledgements**: This work was supported by the Ministry of Research, Innovation and Digitalization, CCCDI-UEFISCDI through contract number 2N/03.01.2023 (PN 23.06.01.01. AQUAMAT)* project number PN-IV-P7-7.1-PED-2024-1069 (ctr. 18PED/2025, ZIRMAGSOLGEL).

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DEVELOPMENT OF TOPICAL FORMULATION CONTAINING LIPOSOMES LOADED WITH ECHINACEA PURPUREA: PHYSICOCHEMICAL PROPERTIES AND POLYPHENOL RELEASE DYNAMICS

Ramona-Daniela PAVALOIU [1], Corina BUBUEANU [1], Diana-Ioana CRISTEA [2], Teodor Mihai FLORESCU [2], Fawzia SHA'AT [1*]

[1]National Institute for Chemical-Pharmaceutical Research&Development—ICCF, 112, Vitan Av., 31299 Bucharest, Romania

[2]Faculty of Pharmacy, University of Medicine and Pharmacy "Carol Davila",
6 Traian Vuia Street, district 2, Bucharest, Romania

**Correspondingauthor:fawzya.shaat@gmail.com*

Keywords: hydrogel, Echinacea purpurea, liposomes, topical formulation

Introduction: *Echinacea purpurea* is a medicinal plant known for its rich content of polyphenols and its antioxidant and anti-inflammatory properties [1,2]. This study aimed to develop a topical hydrogel containing a 2 % liposomes loaded with *Echinacea purpurea*, evaluate its physical and sensory characteristics, and assess how effectively it releases polyphenols.

Materials and methods: The extract was prepared by ethanolic extraction of dried *Echinacea purpurea* leaves. The liposomes were added at 2% into a Carbopol-based hydrogel. The final product was evaluated for appearance, consistency, odor, pH, and texture (using a texture analyzer to measure firmness and spreadability). Polyphenol release was tested *in vitro* using a Franz diffusion cell setup with a synthetic membrane, and the released content was measured by UV-VIS spectrophotometry using the Folin–Ciocalteu method.

Results: The hydrogel had a uniform texture, visually transparent, and a aromatic odour. It showed good spreadability and suitable firmness for skin application. The pH was within the acceptable range for topical use (5.28 ± 0.03). *In vitro* tests showed a steady release of polyphenols over 72 hours, with about 82.7% of the total content being released. The release followed a diffusion-based mechanism.

Conclusions: The liposomes loaded with *Echinacea purpurea* extract were successfully incorporated into a stable and cosmetically acceptable hydrogel The formulation showed promising characteristics for topical use and effectively delivered polyphenols, suggesting potential for use in dermatological or skincare applications with antioxidant and anti-inflammatory benefits.

Acknowledgments: *This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CCCDI - UEFISCDI, project number PN-IV-P7-7.1-PTE-2024-0317, within PNCDI IV.*

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DEVELOPMENT AND CHARACTERIZATION OF SENOTHERAPEUTIC-LOADED LIPOSOMES AS AN ANTI-AGEING NANOCARRIER

Fawzia SHA'AT [1], Ramona-Daniela PAVALOIU [1*]
[1]National Institute for Chemical-Pharmaceutical Research&Development—ICCF, 112 Vitan Av., 31299 Bucharest, Romania
**Corresponding author: pavaloiu_daniella@yahoo.com*

Keywords: liposomes, senotherapeutic, anti-ageing, nanocarrier

Introduction: Cellular senescence contributes to the progression of aging and age-related diseases by promoting chronic inflammation and tissue dysfunction [1]. Recent studies have highlighted metformin's potential senotherapeutic effects, but its limited bioavailability restricts clinical applications [2,3]. The aim of this study was to develop and optimize a liposomal delivery system for metformin to improve its cellular uptake and enhance its senotherapeutic activity in vitro.

Materials and Methods: Liposomes were prepared using the thin-film hydration method followed by extrusion. Various formulation parameters were optimized, including lipid:metformin ratio, hydration conditions, and sonication time achieve high encapsulation efficiency and stable physicochemical properties. Particle size and polydispersity index (PDI) were measured using dynamic light scattering (DLS), while drug encapsulation was quantified by UV-Vis spectroscopy.

Results: The optimized metformin-loaded liposomes displayed nanosize, a narrow PDI indicating uniform nanoscale distribution and encapsulation efficiency reached about 80%. The liposomes loaded with metformi were stable for up to 3 months at 4°C, with no significant change in size or PDI.

Conclusion: Metformin-loaded liposomes offer a promising senotherapeutic strategy by improving drug delivery and therapeutic efficacy. These findings support further in vitro evaluation of this formulation for age-related pathologies associated with cellular senescence.

Acknowledgments: *This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CCCDI - UEFISCDI, project number PN-IV-P7-7.1-PTE-2024-0317, within PNCDI IV and through the "Nucleu" Program, Contract no. 1N/2023, Project code PN 23-28 carried out with the support of MCID, project no. PN 23-28 03 01*

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MICROPLASTIC GENERATION FROM ARTIFICIAL TURFS - A REVIEW

Florin Aurel DINCĂ [1], **Alexandra Gabriela STANCU** [1*], **Maria RÂPĂ** [2]
[1]*Faculty of Biotechnical Systems Engineering Corp D, University Politehnica of Bucharest, 313 Splaiul Independenței, district 6, 060042 Romania*
[2] *Faculty of Materials Science and Engineering, University Politehnica of Bucharest, 313 Splaiul Independenței, district 6, 060042 Romania*
**Corresponding author: stancualexandragabriela@gmail.com*

Keywords: microplastics, artificial turf, sport, analytical method, impact

Introduction: The worldwide use of artificial turf systems has grown substantially in recent decades, fueled by their durability, safety, low maintenance needs, and capacity to deliver consistent playing surfaces across different weather conditions [1]. Synthetic turfs in sport also are presented as an economical and eco-friendly alternative, offering advantages such as lower water usage, the elimination of fertilizers or pesticides, and the recycling of rubber from discarded tires. The Fédération Internationale de Football Association (FIFA) has established performance standards for synthetic pitches, with the goal of enhancing play quality and safeguarding athletes, clubs, and federations by endorsing products that comply with strict criteria. Artificial turfs comprise plastic grass, a granular infill made of crumb rubber, and support materials [2-4]. Environmental factors such as oxygen, water, heat, ultraviolet (UV) radiation, and abrasion contribute to the breakdown of artificial turf plastics, leading to microplastic generation (<5 mm in size), which present potential hazards to human health and the environment [1]. It was estimated that the crumb rubber from infill generate up to 16,000 tonnes of microplastics [3]. In September 2023, the European Commission declared a ban on the application of crumb rubber as infill in artificial turf pitches, granting an eight-year transition period to ensure that many existing synthetic sports grounds employing this material can complete their intended lifespan [5].

Materials and methods: Modern approaches for detecting and characterizing microplastics in artificial turfs, employ attenuated total reflectance Fourier-transform Infrared spectroscopy (ATR-FTIR), Raman spectroscopy, scanning electron microscopy (SEM), transmission electronic microscopy (TEM), and pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS).

Results: Artificial turf fibers are mainly composed of polyethylene (PE), polypropylene (PP), and polyamide (PA). Infill consist of ethylene propylene diene monomer rubber (EPDM), recycled styrene- butadiene rubber (SBR), and thermoplastic elastomer (TPE). Also, the EPDM nanoplastics were detected in the drainage water.

Conclusions: Microplastics associated with sports are a concern due to their sociocultural implications, possible effects on local biodiversity, the leaching of toxic substances, and their contribution to climate change. Alternative infill options include sand, cork, olive waste, and coconut fibers. Improving the collection, sorting, and recycling efficiency of artificial turf waste is recommended to enhancer plastic waste management within the framework of the circular economy.

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INTERACTION OF MULTIFUNCTIONAL POLYMERIC COMPOSITES BASED ON JELLYFISH POLYPEPTIDES, ALOE POLYPHENOLS AND SODIUM ALGINATE WITH SKIN CELLS

Laura Mihaela STEFAN [1]*, Ana-Maria SECIU-GRAMA [1], Andreea IOSAGEANU [1], Alexandra GASPAR-PINTILIESCU [1], Viorica COROIU [1], Oana CRACIUNESCU [1]

[1]National Institute of R&D for Biological Sciences, 296 Splaiul Independenței, 060031 Bucharest, Romania

**Corresponding author: laura.stefan@incdsb.ro*

Keywords: jellyfish, Aloe vera, cytocompatibility, intracellular ROS, anti-inflammatory activity, scratch assay

Introduction: Cell-material interactions are crucial for the development of new biomedical devices with upgraded biological properties for effective strategies in tissue engineering [1]. The aim of the present study was to evaluate the biological properties *in vitro* of bioactive polymeric composites based on jellyfish polypeptides, aloe polyphenols and sodium alginate, conditioned as films, for the optimization of multifunctional devices intended for wound healing.

Material and methods: Biopolymeric composites (var A and var B) were prepared by mixing the alcalase hydrolysate of *Rhizostoma pulmo* jellyfish, rich in polypeptides, with an ultrasound-assisted extract of *Aloe vera* epidermis, rich in phenolics, and sodium alginate, in proportions optimized *in silico* by Response Surface Methodology. Var A included higher content of jellyfish polypeptides and lower content of aloe phenolics than var B. *In vitro* cytocompatibility was evaluated on two cell lines, NCTC fibroblasts and HaCaT keratinocytes, using the MTT assay and cell morphology evaluation by fluorescence microscopy [2], while the anti-inflammatory activity was investigated on human monocyte leukemia THP-1 cells by ELISA quantification of specific cytokines (TNF-α, IL-8 și IL-1β) [3]. The intracellular reactive oxygen species (ROS) production was evaluated in tert-butyl hydroperoxide (t- BHP)-stressed NCTC and HaCaT cell cultures using fluorescent staining with *dichloro-dihydro- fluorescein diacetate* (DCFH-DA) followed by flow cytometry analysis [4]. The antioxidant activity of polymeric compositions was also investigated by spectrophotometric dosing of antioxidant enzymes, glutathione-S-transferase (GST) and catalase (CAT), secreted into the cell culture medium. The wound healing ability of polymeric composites was tested in a scratch assay model using HaCaT keratinocytes [2]. **Results**: *In vitro* tests showed a good cytocompatibility of both polymeric composites, after 24 h of treatment on both cell lines, with cell viability values higher than 70% (non-cytotoxic effect). ELISA quantification of pro-inflammatory cytokines indicated that both tested composites exhibited an anti- inflammatory activity, THP-1 cells secreting significantly ($p<0.05$) reduced levels of cytokines. Thus, var A reduced the production of TNF-α with 63%, while var B with 71%, compared to LPS inflamed control. Also, var A showed the highest inhibitory effect of IL-1β with 72%, while var B decreased the production of IL-1β with 47%. In case of IL-8, only var A decreased the production with 57%. Both t- BHP-stressed NCTC and HaCaT cells treated with var A exhibited a significant decrease ($p<0.05$) of the intracellular ROS production, indicating its antioxidant activity, whereas var B stimulated ROS production, reaching values of 145.1% in NCTC cells and 110% in HaCaT cells, compared to t-BHP- stressed control (100%). In addition, pre-treatment of both cell types with var A induced secretion levels of antioxidant enzymes (GST and CAT) similar to those of unstressed control, indicating its potential to protect cells from oxidative stress, while var B significantly ($p<0.05$) increased the levels of GST and CAT. Scratch assay showed that both polymeric composites induced cell migration and proliferation into the wounded area, indicating their potential to stimulate wound healing. Var A presented higher cell migration rate (62%), compared to the untreated control (56%), while var B-treated cells had lower migration rate (48%) than control.

Conclusions: Overall, our results showed that var A performed better than var B, exhibiting good cytocompatibility, anti-inflammatory and antioxidant activity, as well as regenerative potential, suggesting its use in novel protocols for wound healing stimulation.

Acknowledgements*: This work was supported by the Ministry of Education and Research, Program Nucleu, project no. 23020201.*

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STUDY OF THE INFLUENCE OF AQUEOUS MEDIA ON THE CHARACTERISTICS OF PLASTIC PACKAGING

Georgeta (DIACONESCU) TEODORESCU [1,2], Daniela SIMINA STEFAN [3], Alexia CROITORU [4,5]*

[1]INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania

[2]Doctoral School, Specialization of Environmental Engineering, Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA of Bucharest, 1-7 Polizu Street, 011061 Bucharest, Romania

[3]Department of Analytical Chemistry and Environmental Engineering, Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA of Bucharest 1-7 Polizu Street, 011061 Bucharest, Romania;

[4]Department of Science and Engineering of OxideMaterials and Nanomaterials, Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA of Bucharest, 1-7 Polizu Street, 011061 Bucharest, Romania

[5]National Centre for Micro- and Nanomaterials, National University of Science and Technology Politehnica of Bucharest, 313, Splaiul Independenței Steet, 060042 Bucharest, Romania

**Corresponding author: georgeta.teodorescu@upb.ro*

Keywords : ***Plastic packaging, Polyethylene terephthalate (PET) Polystyrene (PS), Aqueous media***

Introduction: Plastic materials such as polyethylene terephthalate (PET) and polystyrene (PS) are widely used in packaging due to their low cost and versatility. However, their stability may be affected by environmental and food contact conditions, which can lead to structural changes and migration of chemical compounds. The aim of this study was to evaluate the effects of aqueous media parameters— contact time, temperature, and pH—on the structural behavior of PET and PS packaging and to quantify the release of bisphenol A (BFA).

Materials and methods: PET and PS packaging samples were exposed to aqueous solutions with pH values between 1.5 and 9. The experiments were conducted at 20 °C and 30 °C for 50 days. Structural changes were analyzed using standard analytical methods, while the concentration of bisphenol A released into the contact solutions was determined spectrophotometrically.

Results: The investigated parameters—contact time, temperature, and pH—significantly influenced the properties of PET and PS packaging. Structural modifications were observed under both acidic and alkaline conditions, with more pronounced effects at longer exposure times and higher temperatures. Bisphenol A was detected in aqueous media at concentrations in the µg/L range, confirming its migration under the studied conditions.

Conclusions: Aqueous media, temperature, pH, and the 50-day contact period affect the structural integrity of PET and PS packaging and the release of bisphenol A. These findings highlight the importance of considering environmental conditions and contact duration when assessing the safety of plastic packaging. Further research may focus on mitigation strategies to reduce bisphenol migration.

Acknowledgements*:* Doctoral School, Specialization of Environmental Engineering, Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA of Bucharest

MXENE–POLYMER NANOCOMPOSITES AS VERSATILE PLATFORMS FOR ADVANCED FUNCTIONAL MATERIALS

Gabriela TOADER [1], Aurel DIACON [1*], Alexandra MOCANU [2], Livia A. DINU [2], Pericle VARASTEANU [2], Oana BRINCOVEANU [2], Cosmin ROMANITAN [2], Mioara ALEXANDRU [3], Florina L. ZORILA [3], Celina DAMIAN [4], Edina RUSEN [4], Raul A. MITRAN [5]

[1]Military Technical Academy "Ferdinand I", 39-49 G. Cosbuc Blvd., 050141 Bucharest, Romania
[2] National Institute for Research and Development in Microtechnologies - IMT Bucharest,
126A Erou Iancu Nicolae, 077190 Voluntari, Romania
[3] Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering (NIPNE), 30 Reactorului St., 077125 Magurele, Romania
[4] Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology
POLITEHNICA Bucharest, 1-7 Gheorghe Polizu St., district 1, 011061 Romania
[5]"Ilie Murgulescu" Institute of Physical Chemistry, Romanian Academy, 202 Splaiul Independenței, 060021 Romania
**Corresponding author: aurel_diacon@yahoo.com*

Keywords: temperature-responsive hydrogel, MXenes, polypyrrole, biomedical applications, actuation

Introduction: MXenes, a class of two-dimensional (2D) transition metal carbides and nitrides, have emerged as highly versatile materials due to their exceptional electrical conductivity, hydrophilicity, and tunable surface chemistry. Since their initial discovery, MXenes have been extensively investigated for applications in energy storage, sensing, catalysis, and electromagnetic interference (EMI) shielding. Their layered morphology and high aspect ratio make them particularly suitable for integration into polymer matrices, where they can impart multifunctional properties including mechanical reinforcement, electrical conductivity, and stimuli-responsive behavior. The increasing demand for lightweight, flexible, and multifunctional materials in electronics, soft robotics, and biomedical technologies has driven the exploration of MXene–polymer nanocomposites. These systems offer a compelling alternative to conventional metal-based EMI shielding materials, which are often limited by rigidity, weight, and corrosion susceptibility. By embedding MXenes into polymeric frameworks, it is possible to engineer composites with tailored mechanical, electrical, and biological properties. This study presents a comprehensive investigation into the synthesis and characterization of MXene-based polymer nanocomposites designed for EMI shielding, actuation, and biomedical applications. Pristine MXenes such as Nb_2AlC, $Mo_2Ti_2AlC_3$, and Ti_3AlCN were incorporated into various polymer matrices including polyurethane (PUR) foams and films, epoxy resins, and hydrogels. Sustainable synthesis approaches were employed, such as the use of recycled poly(ethylene terephthalate) for PUR foams and soap-free emulsion polymerization for colloidal dispersions. Microencapsulation techniques were utilized to enhance MXene stability within flexible matrices, while targeted chemical functionalization—introducing thiol (–SH), amine ($–NH_2$), and hydroxyl/oxyrane (–OH) groups—was applied to improve biocompatibility and antimicrobial performance.

By exploring the structure–property relationships across these diverse systems, this work highlights the adaptability of MXenes in engineering advanced polymer platforms. The resulting nanocomposites demonstrate tunable EMI shielding efficiency, mechanical robustness, and responsive behavior, positioning them as promising candidates for next-generation multifunctional materials.

Materials and methods: Pristine Nb_2AlC MXenes were incorporated into polyurethane (PUR) foams synthesized via the depolymerization of poly(ethylene terephthalate), yielding lightweight, porous structures with inherent EMI shielding capabilities. Flexible PUR films were subsequently fabricated using $Mo_2Ti_2AlC_3$ MXenes, enhancing both mechanical flexibility and shielding performance. To improve MXene stability and dispersion, poly(methyl methacrylate-co-hydroxypropyl methacrylate) microcapsules containing $Mo_2Ti_2AlC_3$ particles were embedded within the PUR matrix. Additionally, Nb_2AlC-MXene colloid nanocomposites were synthesized via soap-free emulsion polymerization, facilitating exfoliation and uniform distribution within an epoxy resin matrix. The influence of styrene- hydroxypropyl methacrylate-MXene colloid concentration on the electromagnetic properties of the epoxy films was systematically investigated. Further, $Mo_2Ti_2AlC_3$ MXenes were integrated into photopolymerized hydrogels containing polypyrrole (PPy), while Ti_3AlCN MXenes were embedded into thermoresponsive poly(N-isopropylacrylamide) (pNiPAM) hydrogels. HF etching was employed to chemically functionalize MXenes with –SH, $–NH_2$, and –OH/oxyrane groups, enhancing their compatibility with biological environments.

Results: The integration of MXenes into diverse polymer matrices yielded nanocomposites with enhanced multifunctional performance across electromagnetic shielding, mechanical flexibility, actuation, and biocompatibility domains. Nb_2AlC MXenes embedded in recycled polyurethane (PUR) foams demonstrated substantial EMI shielding effectiveness, attributed to their porous architecture and high electrical conductivity. These lightweight foams achieved attenuation levels suitable for protective applications in compact electronics, showcasing the potential of sustainable polymer platforms for shielding technologies. Flexible PUR films incorporating $Mo_2Ti_2AlC_3$ MXenes exhibited improved mechanical resilience and EMI shielding capacity. The incorporation of poly(methyl methacrylate-co- hydroxypropyl methacrylate) microcapsules containing $Mo_2Ti_2AlC_3$ particles further stabilized MXene dispersion, preserving structural integrity under mechanical stress and enhancing shielding performance. These results highlight the importance of encapsulation strategies in maintaining filler distribution and mechanical robustness. Epoxy-based nanocomposites synthesized via soap-free emulsion polymerization enabled efficient intercalation and exfoliation of Nb_2AlC MXenes, resulting in uniform dispersion within the matrix. The electromagnetic properties of these composites were tunable based on the concentration of styrene-hydroxypropyl methacrylate-MXene colloids. This allowed for controlled transparency or absorption in the X-band frequency range, offering customizable shielding profiles for specific application needs. Hydrogels incorporating $Mo_2Ti_2AlC_3$ MXenes and polypyrrole (PPy) particles demonstrated low swelling ratios and elevated electrical conductivity. These characteristics make them suitable for wearable electronics and soft interface technologies, where flexibility and conductivity are essential. The synergy between MXene dispersion and PPy integration contributed to enhanced mechanical strength and absorption-dominated EMI shielding mechanisms. Further, Ti_3AlCN MXenes were embedded into thermoresponsive poly(N-isopropylacrylamide) (pNiPAM) hydrogels, enabling reversible actuation under thermal or near-infrared (NIR) light stimuli. This expands the utility of MXene-based hydrogels into soft robotics and adaptive biomedical devices, where controlled deformation and responsiveness are critical. MXenes were chemically functionalized via HF etching to introduce thiol (–SH), amine ($–NH_2$), and hydroxyl/oxyrane (–OH) groups. These modifications significantly improved dispersion in aqueous media and enhanced biocompatibility, as confirmed by cell viability assays. Silver-decorated SH-functionalized MXene hydrogels were evaluated for antimicrobial activity against Staphylococcus aureus. After one hour of exposure, select formulations achieved a 4-log reduction in bacterial count. After 24 hours, nearly all samples exhibited consistent 5-log reductions, indicating strong bactericidal efficacy. The combined presence of silver and SH-functionalized MXenes, along with prolonged exposure, contributed to the observed antimicrobial performance. These findings collectively underscore the adaptability of MXenes in engineering polymer-based systems with tunable electrical, mechanical, and biological properties. Through strategic matrix selection, filler stabilization, and surface functionalization, MXene–polymer nanocomposites demonstrate significant promise for next-generation applications in electronics, soft robotics, and biomedicine.

Conclusions: This work demonstrates the versatility of MXene–polymer nanocomposites across multiple domains, including EMI shielding, soft actuation, and biomedicine. Through strategic matrix selection, filler encapsulation, and chemical functionalization, these materials achieve tunable performance characteristics. The findings underscore the potential of MXenes as key components in next-generation multifunctional platforms, capable of meeting the evolving demands of advanced electronic and biomedical technologies.

Acknowledgements*: This work was supported by a grant of the Ministry of Research, Innovation, and Digitization, CNCS UEFISCDI, project number PN-IV-P7-7.1-PTE-2024-0466 - ctr. no. 2PTE/2025, project number PN-IV-P7-7.1-PED2024- 0980 ctr. no. 69PED/2025, and project number PN-IV-P7-7.1-PTE-2024-0479 – ctr.no. 42PTE/2025.*

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VOLTAMMETRIC DETERMINATION OF DIAZEPAM

Adelaida-Sorana TRIFU [1,2*], **Iulia Gabriela DAVID** [1]

[1]*Department of Analytical Chemistry and Physical Chemistry, Faculty of Chemistry, University of Bucharest, Panduri Av. 90-92, district 5, 050663 Romania*

[2]*Department of General Medicine, University of Medicine and Pharmacy "Carol Davila",*
37 Dionisie Lupu Str., district 2, 020021 Romania

**Corresponding author: adelaida-sorana.trifu@s.unibuc.ro*

Keywords: diazepam, voltammetry, pencil graphite electrode, pharmaceuticals.

Introduction: Diazepam (DZ) is a well-known benzodiazepine drug, used for its anxiolytic, sedative and anticonvulsant effect [1]. DZ has an half-life ranging from 20 to 50 hours, while its primary active metabolite, nordazepam, can persist for up to 200 hours. This prolonged elimination indicates the drug's high toxicity risk in cases of overdose, which may result in symptoms such as dizziness, drowsiness, and diplopia [2]. The determination of DZ levels in biological fluids is essential in cases of misuse, such as drug facilitated sexual assaults, polydrug abuse and traffic collisions [3]. This work presents the development of a voltammetric method for DZ determination using a disposable pencil graphite electrode (PGE). The active surface of the PGE consists of a nanocomposite material composed of graphite powder, clay and a binder (commonly wax, resin or a high polymer) [4].

Materials and methods: An AUTOLAB PGSTAT 12 connected to a 3 electrodes cell was used for voltammetric measurements. The working electrode was a PGE coated *in situ* with a Hg film. The reference electrode was an Ag/AgCl/KCl (3 M) electrode and a Pt wire was used as an auxiliary electrode. The analytical instrument was connected to a PC running the GPES4.9 software. In order to eliminate dissolved oxygen, the voltammetric solution was deaerated.

Results: Using cyclic voltammetry (CV) and differential pulse voltammetry (DPV), the voltammetric response of DZ on PGE and on PGE coated *in situ* with a Hg film was studied. The best response was obtained using the latter electrode. The electroactivity of DZ is due to the presence of a 4,5-azomethine group in the structure of the benzodiazepine ring, which generates a cathodic signal at a potential ranging from -1.0 V to -1.2 V [5]. The effect of the supporting electrolyte on the electrode response was studied in solutions with different pHs: 0.1 M HCl, phosphate-buffer solution pH 7.00 and 0.2 M NaOH. The highest signal was obtained in 0.1 M HCl, so it was further used as the supporting electrolyte. The influence of DZ concentration on its cathodic signal amplitude was studied in the concentration range 2.50×10^{-5}-7.50×10^{-4} M. A linear dependence was observed between the peak current intensity and the DZ concentration over the entire concentration range studied. The limit of detection (LOD) and the limit of quantification (LOQ) were calculated, obtaining values of 8.35×10^{-6} M DZ and 2.53×10^{-5} M DZ, respectively. The practical applicability of the developed method was tested by voltammetric determination of the DZ content in pharmaceutical tablets with a content declared by the manufacturer of 10 mg of active substance per tablet. The multiple standard addition method was used.

Conclusions: A simple method for the quantification of diazepam was developed using a low-cost and easily available disposable electrode. Under optimized conditions the cathodic signal of diazepam varied linearly with concentration over a range of more than an order of magnitude. Although the LOD and LOQ are not very low, the developed voltammetric method using PGE is adequate for the rapid determination of the drug in pharmaceutical preparations.

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ALUMINA-BASED Ni-Fe CATALYST FOR CARBON DIOXIDE REFORMING: STRUCTURAL AND THERMODYNAMIC FEATURES, CATALYTIC PERFORMANCE

Aygun RUSTAMOVA[1*], Yegana HAMZAYEVA [2], Shahin ORUDJEV [1], Raksana AGAYEVA [1], Firuza PASHAYEVA [1], Rovshan MURADKHANOV [1], Etibar ISMAILOV [1]

[1]Institute of Catalysis and Inorganic Chemistry, 113, H.Javid ave., Baku, Azerbaijan
[2]Baku State University, 33, Z. Khalilov str., Baku, Azerbaijan
**Corresponding author: aygun.rustamova1601@gmail.com*

Keywords: Ni-Fe/alumina catalyst, CO_2 reforming, structural and thermodynamic characterization

Introduction: Methane reforming with carbon dioxide, commonly referred to as dry methane reforming (DRM), has attracted considerable attention as a promising method for simultaneously converting two major greenhouse gases into syngas, a mixture of H_2 and CO, which is then used to produce important industrial chemicals such as ammonia, methanol or hydrocarbon fuels via the Fischer-Tropsch process [1]. Compared with steam methane reforming (SRM), DRM is more susceptible to carbon (coke) deposition due to the lower H/C ratio in the feed mixture, which increases the likelihood of coke formation. Therefore, the development of coke-resistant catalysts is critical for the practical application of DRM. Among the DRM catalysts, nickel catalysts are particularly popular due to their low cost, high catalytic activity and wide availability. Therefore, research in this area is mainly focused on developing catalysts that are not only active and stable but also resistant to coke deposition, as well as on finding optimal operating conditions to ensure long-term process efficiency.

Materials and methods: Catalysts were synthesized by the impregnation method using nickelocene $Ni(C_5H_5)_2$, ferrocene $Fe(C_5H_5)_2$ as organometallic precursors and boehmite (γ-AlO(OH)) as the support material. After impregnation organometallic precursors from n-hexane solutions, the samples were dried in air at 60ºC for 4 hours and then the samples in closed quartz ampoules were heated in a muffle furnace by increasing the heating temperature from room temperature to 950 °C for 6 hours.

Results: Using scanning electron microscopy (SEM) in combination with energy-dispersive X-ray spectroscopy (EDS), X-ray diffraction (XRD) and ferromagnetic resonance (FMR) spectroscopy, it was found that the reaction gas mixture causes a change in the catalyst composition and redistribution of the catalyst components in its structure. These changes are associated with the aggregation of nickel and nickel-iron particles, the formation of nickel and iron carbides, oxides and the accumulation of carbon deposits. A thermodynamic stability analysis of iron-nickel catalysts based on alumina in the DRM reaction ($CH_4 + CO_2 \rightleftharpoons 2CO+2H_2$) was performed. The Uhlich method (first and second approximations taking into account $\Delta C_p(T)$) [2], the multireaction equilibrium model (DRM+RWGS+CH_4 cracking+Boudoir reaction) are used, and the oxidation limits of Ni/NiO and Fe/FeO/Fe_3O_4 are constructed through the pCO_2/pCO and pH_2O/pH_2 ratios using the Ellingham approximations. On this basis, the "Lyapunov function" formalism is developed for describing the stability of the size distribution of nanosized Ni–Fe particles in the Al_2O_3 structure at 873–1473 K and atmospheric pressure. The "attraction regions" of optimal sizes (6–10 nm) for CO_2/CH_4 fluxes ≥ 1 are shown, and the stability loss boundaries are identified (sintering via Ostwald ripening/migration–coalescence, carbon accumulation, particle overoxidation).

Conclusions: The results indicate the importance of controlling the physicochemical state of the catalyst composition and structural features to maintain catalytic performance and stability in DRM. The DRM reaction is thermodynamically favorable at $T \geq 950$ -1000 K. Excess CO_2 is critical for coking suppression (via carbon gasification). Ni–Fe alloy particles of 6 -10 nm on Al_2O_3 are the most stable according to the Lyapunov criterion. The oxidation limits (pCO_2/pCO, pH_2O/pH_2) determine the “stability range” and should be taken into account when choosing the regeneration mode. The proposed approach combines thermodynamics (Ulich 2nd approximation, multi-reaction equilibrium) and stability dynamics (Lyapunov method) to predict. A procedure is proposed that provides a physically interpretable extraction of the size distribution of nickel, nickel-iron nanoparticles from FMR, as well as particle size distribution functions with confidence intervals.

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BIOSENSING PLATFORMS WITH ADVANCED NANOCOMPOSITES FOR NON- INVASIVE MONITORING OF BIOMARKERS IN BIOLOGICAL FLUIDS

Lucian-Gabriel ZAMFIR [1*], Cătălina GÎFU [1], Saniye SOYLEMEZ [2], Dilek SOYLER [2], Petru EPURE [3], Iuliana RĂUT [1], Mariana CONSTANTIN [1], Cristina FIRINCĂ [1], Maria-Luiza JECU [1], Mihaela DONI [1], Ana-Maria GURBAN [1*]

[1] National Institute for Research and Development in Chemistry and Petrochemistry ICECHIM Bucharest
Department of Biotechnology, 202 Splaiul Independenței, district 6, 060021 Romania
[2]Necmettin Erbakan University, Faculty of Engineering-Architecture, Department of Biomedical Eng., Konya, Turkey
[3]Chimgrup SRL, 2 Crisana street, Suncuius, Bihor, Romania

**Corresponding author: lucian.zamfir@icechim.ro, ana-maria.gurban@icechim.ro*

Keywords: biomarkers, nanocomposites, health monitoring, sweat, saliva

Introduction: Rapid, sensitive and non-invasive detection of biomarkers of clinical interest is essential for both early diagnosis of diseases and real-time health monitoring. The use of advanced nanomaterials in the development of biosensing platforms has led to various applications in clinical settings, allowing miniaturization and integration into portable devices for point-of-care diagnostics [1]. Innovative Fullerenol and MXene nanomaterials have been used for the development of biosensors for the detection of clinical biomarkers in sweat (e.g. glucose, lactate and cortisol) as indicators of diabetes, inflammations and fatigue, and for the detection of biomarkers such as cell-surface proteins in saliva, carcinoembryonic antigen (CEA) and epidermal growth factor receptor (EGFR) for early detection of cancer. **Materials and methods**: The bionanomaterial-based sensors were designed and developed using polyhydroxylated fullerene derivative-Fullerenol (FL), titanium carbide ($Ti_3C_2T_x$) MXenes [2], platinum and gold metallic nanoparticles (PtNPs, AuNPs) and the redox mediator Prussian Blue (PB). Sensitive and selective electrochemical biosensors were obtained by functionalization of FL-PB and MXene composite nanomaterials with specific bioreceptors, meaning oxidases enzymes Glucose oxidase (GOx), Lactate oxidase (LOx), cortisol-specific aptamers and peptides.

Amperometric detection of glucose and lactate was performed using amperometric biosensors obtained by immobilizing the enzymatic receptors glucose (GOx) and lactate oxidase (LOx), in sol-gel (SG) and chitosan (CS)-based polymeric matrices on the FL-PB-modified sensors. Detection of cortisol was performed using electrochemical impedance spectroscopy (EIS) with the aptasensor based on the specific aptamer for cortisol covalently bound to the surface of the SPE functionalized with FL-glutamic acid. Biosensors specific for CEA and EGFR biomarkers were obtained by covalent immobilization of peptide receptors functionalizing on MXene.

Results: Electrochemical studies performed with sensors based on advanced nanomaterials demonstrated high electrocatalytic performances. The structural features and high electrical conductivity of the FL-PB nanomaterial led to improved analytical performances, allowing the selective and sensitive determination of glucose and lactate with specific sensitivities of 8.67 $mA\cdot M^{-1}cm^{-2}$ and 25.55 $mA\cdot M^{-1}cm^{-2}$, respectively. Cortisol detection was done with specific aptasensor by EIS measurements, demonstrating a sensitivity of 53 kΩ/nM. The sensors modified with $Ti_3C_2T_x$-MXenes were characterized by electrochemical studies of cyclic voltammetry and EIS, demonstrating improved electrocatalytic properties by using $[Fe(CN)_6]^{3-/4-}$. Subsequent functionalization of MXenes with amino groups allowed the covalent immobilization of CEA and EGFR-specific peptides functionalized with ferrocenyl groups, thus allowing the specific detection of CEA and EGFR biomarkers.

Conclusions: Electrochemical biosensors developed based on innovative nanomaterials were used for the sensitive and selective detection of glucose and lactate in sweat samples using amperometric enzymatic biosensors (e.g. GOx/FL-PB/SPE and LOx/FL-PB/SPE) and portable potentiostat, while cortisol detection was achieved by EIS using a specific aptasensor. Optimization of the electrochemical detection of CEA and EGFR biomarkers in saliva samples will still be performed, in order to improve the sensitivity and detection limit, as well as to limit cross-reactivity towards other interfering analytes.

***Acknowledgements**: This work was supported by the Ministry of Research, Innovation and Digitization, CNCS/CCCDI – UEFISCDI, through projects PN-IV-P2-2.1-TE-2023-1281, MXEPEPMIN within PNCDI IV, contract no. 58TE/2025, by M- ERANET-3-FULSENS-GEL, Contract no. 318/2022 and by Core Program PN 23.06.01.01. AQUAMAT.*

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BOSEAN: PURIFICATION OF WATER BODIES FROM OIL POLLUTION

Almir ABDULOV [1], Adilbek KENZHEBAI [1], Gulziya BEISENBEKOVA [1]*

[1]Nazarbayev Intellectual School of Science and Math in Atyrau, Kazakhstan

**Corresponding author:* baisenbekova_g@atr.nis.edu.kz

Keywords: plant waste, water purification, Reed, Filter.

Introduction: A reed-based biofilter has been created, installed in the prototype "Sea Urn" for cleaning water from solid particles (garbage) and oily products. Emissions of the oil refinery plant into the Ural River pollute it with various wastes, which negatively affects the surrounding ecosystem of the city and the residents of the city of Atyrau.

Carry out secondary processing of plant waste (reed parts) to obtain useful material and obtain a biofilter with improved adsorption properties for effective water purification.

Study the composition of natural waste (reed parts) and create a plant filter that is able to purify contaminated water from spills of petroleum products and other organic pollutants.

Material and method:

Stage A: 1) Creation of a prototype "Sea Urn" to place a plant filter in it.
2) Heat treatment (activation) in a muffle furnace to improve adsorption properties is carried out at a temperature of 300°C -600°C for 1-2 hours.
3) Chemical treatment. Extraction using hexane - as a non-polar, organic solvent for better separation of oil and water.
4) Laboratory experiment on the comparison of water purification from oil products with hexane and reeds.
5) Calculations of the mass concentration of petroleum products in hexane and reed extracts._

Stage B: 1) Study of drying, grinding, thermal and chemical processes.
2) Creating a filter prototype.
3) Calculations for the experiment.
4) Determination of the advantages and disadvantages of the resulting product.
5) Analysis of the collected material, comparison of the effect of organic solvent and plant material (part of the reed) on the purification of contaminated water with petroleum products.

Novelty of the study and degree of independence:

The resulting biofilter can be used in tanks contaminated with petroleum products. It is also possible to clean tanks of solid debris, thanks to the "Sea Urn" prototype.

Results: Plant waste after recycling is used to obtain an alternative application - a biofilter for adsorption of oil waste on the water surface.

Conclusions: The study confirmed that a reed-based biofilter can effectively purify water from petroleum products and solid waste. Thermal and chemical treatment improved its adsorption properties. The "Sea Urn" prototype offers an eco-friendly and low-cost solution for cleaning polluted water, especially in industrial areas like Atyrau.

Acknowledgements: *The authors gratefully acknowledge the support of Nazarbayev Intellectual School in Atyrau city, and the guidance of teachers and mentors throughout the research project.*

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DEVELOPMENT OF ANTIMICROBIAL CLAYS AS ADDITIVES FOR SPECIAL MATERIALS WITH POTENTIAL USE IN CULTURAL HERITAGE

Denisa FICAI [1,2,3,4*], Ludmila MOTELICA [2,3,4], Roxana Doina TRUSCA [3], Irina FIERASCU [5,6], Madalin Vasile COMAN [7], Radu Claudiu FIERASCU [1,4,5], Ovidiu Cristian OPREA [1,2,3,4], Anton FICAI [1,2,3,4], Ecaterina ANDRONESCU [1,2,3,4]

[1] Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA Bucharest, 1-7 Gh. Polizu, 011061 Bucharest, Romania
[2] Research Center for Advanced Materials, Products and Processes, National University of Science and Technology POLITEHNICA Bucharest, 060042 Bucharest, Romania
[3] National Center of Micro and Nanomaterials, National University of Science and Technology POLITEHNICA Bucharest, Splaiul Independentei 313, 060042 Bucharest, Romania
[4] Academy of Romanian Scientists (AOSR), Splaiul Independenței54, 050094 Bucharest
[5] National Institute for Research & Development in Chemistry and Petrochemistry—ICECHIM Bucharest, 202 Spl. Independentei, 060021 Bucharest, Romania
[6]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, 011464 Bucharest, Romania.
POP & ASOCIATII, Alea Barajului Cucuteni street, sector 3, Bucharest
**Corresponding author: denisaficai@yahoo.ro*

Keywords: *bentonite, biologically active substances, antimicrobial and antifungal activity*

Since ancient times, the obtaining, characterization and testing of biocides has gained momentum, as a result of the increasing resistance of pathogens to various antibiotics and biologically active agents, a direct effect of their long-term and misuse. Combating nosocomial infections, or hospital-acquired infections, has become a very serious objective in research, the discovery of new compounds with biocidal activity, which act both chemically and biologically on bacterial strains, gram negative or gram positive, but also on fungi, gaining primary attention in related research areas.

This paper addresses the development of systems that are intended for use in environmental applications, applications with potential for exploitation in the construction of foundations or buildings that are in contact with high humidity and proper temperature, the aim being to eliminate the risk of dampness.

A series of samples based on Montmorillonite (MMT) or Bentonite and biologically active substances (ampicillin, neomycin and erythromycin) were obtained by two similar methods, namely absorption from the aqueous solution of the antibiotic and respectively by vacuum absorption. By the method of absorption from aqueous solutions it is observed that the retention of antibiotic is moderate or even no adsorption was observed while in the vacuum absorption method allowed a practical loading equal to the amount of antibiotic taken into account which makes this method accessible with minimal losses.

The analyzed samples showed antimicrobial and antifungal activity on various strain lines, thus creating the premises for their use in various medical or environmental applications. Moreover, the obtained clays can be considered for the purpose of obtaining complex materials, with applications in construction, animal husbandry, etc. The inclusion of these clays loaded with antibiotics or other antimicrobial substances in binders/concretes can lead to the obtaining of special antimicrobial materials with exploitation potential for the purpose of constructing with the aim to eliminate/reduce the risk of microbial development in such humid environments.

Acknowledgements*: This work was supported by the Ministry of Education and Research (Ministry of Research, Innovation and Digitization), CCCDI - UEFISCDI, project number* ***PN-IV-P7-7.1-PTE-2024-0522,*** *47PTE/2025*

DIAZABICYCLO[2.2.2]OCTANE-DERIVED IONIC LIQUID AS A SUSTAINABLE CATALYST FOR THE SYNTHESIS OF HETEROCYCLES AND THEIR β-LACTAMASE INHIBITORY POTENTIAL

Maria Aqeel KHAN [1,2*], Marium ISHTIAQ [2]

[1] *Third World Center for Science and Technology, International Center for Chemical and Biological Sciences (ICCBS), University of Karachi, Karachi-75270, Pakistan*

[2] *H.E.J. Research Institute of Chemistry, International Center for Chemical and Biological Sciences (ICCBS), University of Karachi, Karachi-75270, Pakistan*

**Corresponding author: drmaria.aqeel@iccs.edu*

Keywords: Diazabicyclo[2.2.2]octane-based ionic liquid, Green chemistry, β-Lactamase inhibitors

Introduction: The use of ionic liquid as a green solvent has opened new prospects in the sustainable chemistry. They are getting tremendous attention due to their robust and environmental friendly nature [1] as well as they offer a range of applications in fields such as electrochemistry, green chemistry, and materials science. In this light, 1,4-Diazabicyclo[2.2.2]octane is developed as new ionic liquid owing to the cage-like structure facilitating it to behave as an organocatalyst in numerous transformations.

Materials and methods: Herein, diazabicyclo[2.2.2]octane upon quaternization and halogen displacement reactions afford desired ionic liquid [1]. The ionic liquid was used as reaction-cum- catalyst to study its scope of its utlilty. It was used to prepared a number of heterocycles, including Schiff bases, indoles, dihydropyrimidines [1,2], isoxazoles, triazoles, *etc*. Synthesized compounds were explored for biological activities.

Results: The prepared ionic liquid was utilized as reaction media as well as catalyst for the syntheses of multiple types of heterocyclic scaffolds. Results revealed that the synthesized ionic liquid was found non-cytotoxic against normal cell line. Other attributes include recyclability and reusability; atom economic; cost effective; gave higher yields; catalyzed reaction in a short period of time; and widely applicable for multiple kinds of heterocycles and different reaction types [1,2]. Synthesized compounds were also explored for their biological potential, such as β-lactamase inhibition, which offers a better treatment option for controlling multidrug-resistance, a global health challenge caused by Gram- negative bacteria. Compounds were found to be significant inhibitors of β-lactamase enzyme, and non- cytotoxic against human 3T3 cell line.

Conclusions: The current study revealed that sustainable approach for the synthesis of heterocycles utilizing non-toxic ionic liquid as an alternative green solvent. Also, synthesized heterocycles were safe and effective inhibitors targeting CTX-M-14 type of β-lactamase enzyme (from *K. pneumonia*), which opens a window for the drug and discovery process.

***Acknowledgements**: The author (MAK) would like to acknowledge the Third World Center for Science and Technology, International Center for Chemical and Biological Sciences (ICCBS), University of Karachi, Karachi-75270, Pakistan for providing financial support.*

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SECTION 2 - Bioresources, biotechnologies and biorefining

(Oral presentations)

AI-OPTIMIZED ALGAE CULTIVATION FOR SUSTAINABLE BIODIESEL PRODUCTION

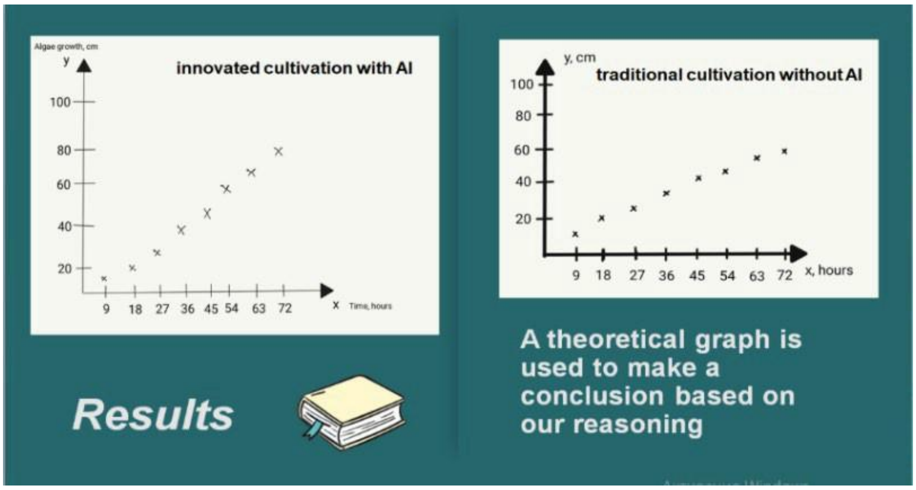
Adina SAILAU [1], Mauitova AIBIBI [1], Asif ABBAS SYED [1*]
[1] Nazarbayev Intellectual School of Science and Math in Atyrau, Kazakhstan
**Corresponding author: asifchem143@gmail.com*

Keywords: algae, biodiesel, AI, IoT,sustainability

Introduction: The increasing concern regarding the environmental degradation caused by fossil fuels and their role in global air pollution is fuelling the demand for more renewable and cleaner energy sources. Microalgae biodiesel offers one such cleaner fuel alternative due to the organism's rapid growth, high lipid content, and negligible competition with food crops. Still, conventional methods face difficulties toward efficiency and scalability in production. In this regard, the current research intends to show how Artificial Intelligence and the Internet of Things can maximally capture this potential and optimize the cultivation of algae, leading toward improved biodiesel yield with greatersustainability.

Materials and method: Microalgae were cultivated in a controlled laboratory setting. A monitoring system based on AI and IoT controlled the most important environmental factors such as light intensity, carbon dioxide concentration, and temperature. Four major steps were involved in the cultivation: (1) artificial cultivation of algae, (2) drying, compressing, and oil and biomass extraction, (3) oil extraction through transesterification with methanol, and (4) purification of biodiesel. AI-optimized cultivation was compared to traditional methods.

Results: AI-assisted cultivation was found to have a greater lipid yield than traditional practice, due to constant monitoring and control of growing conditions. Theoretical modeling suggested that the adjustment of such environmental factors maximizes scalability and efficiency in terms of biodiesel output. Relative yield patterns for AI-optimized versus traditional cultivation systems are illustrated in Figure 1.



A theoretical graph is used to make a conclusion based on our reasoning

Conclusions: The application of AI and IoT in algae cultivation processes enhances biodiesel production and scalability significantly. It reduces the consumption of fossil fuel, offers a sustainable source of energy environmentally, and is not a competitor to food crops. Future studies of mass adoption will tend to improve cost-effectiveness and industrial acceptance.

***Acknowledgements**: The authors gratefully acknowledge the support of Nazarbayev Intellectual School in Atyrau city, and the guidance of teachers and mentors throughout the research project.*

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COMPARATIVE STUDY OF BANANA AND ORANGE PEEL-DERIVED BIO-CHAR FOR EFFICIENT WATER PURIFICATION

Ramina DOSZHAN [1], Akbota YERSULTAN [1*]
[1]Nazarbayev Intellectual School of Science and Math in Atyrau, Kazakhstan
**Corresponding author: ersultan_a@atr.nis.edu.kz*

Keywords: Biochar, fruit peel waste, water purification, synthetic dye removal, and sustainable sorbents

Introduction:The growing demand for sustainable water purification technologies highlights the need for low-cost, bio-based materials capable of removing pollutants effectively. Agricultural waste such as banana and orange peels represents a promising low-cost feedstock for biochar production. Both residues are rich in biopolymers such as cellulose, hemicellulose, lignin, and pectin, which undergo thermal decomposition during pyrolysis to generate porous carbonaceous structures. The objective of this study was to compare the water purification capacity of biochar derived from banana and orange peels, with a focus on their ability to remove synthetic dyes from aqueous solutions. The study emphasizes both the valorization of biowaste and the development of multifunctional sorbents for environmental applications. This comparative approach provides new insights into how the intrinsic composition of fruit wastes influences the performance of the resulting biochar in watertreatment.

Materials and methods: Fruit peels were washed, sun-dried for 1.5 hours, cut into 1–2 cm pieces, wrapped in aluminum foil, subjected to low-temperature slow pyrolysis in an oven at 250 °C for 1.5 hours, cooled inside the oven, crushed, and sieved through a 0.5 mm mesh.

Results: The orange peel–derived biochar demonstrated higher dye adsorption efficiency compared to banana peel biochar. This effect can be attributed to the higher initial content of pectin, essential oils, and phenolic compounds in orange peels, which generate a more heterogeneous surface chemistry with abundant functional groups (–OH, –COOH) after pyrolysis. In contrast, banana peels, richer in starch and hemicellulose, produced biochar with a simpler carbon matrix and lower adsorption affinity. Both materials, however, showed significant porosity development and capacity to reduce dye coloration in water.

Conclusions: This study demonstrated the potential of fruit peel-derived biochars as low-cost adsorbents for water purification. Among the tested materials, orange peel-derived biochar exhibited superior dye removal efficiency compared to banana peel-derived biochar, likely due to its higher content of pectin, essential oils, and phenolic compounds, which resulted in a more heterogeneous surface chemistry and abundant functional groups after pyrolysis. Despite the lower adsorption capacity, banana peel biochar also showed considerable porosity and contributed significantly to reducing dye coloration in water. These findings highlight the value of agricultural waste valorization and suggest that fruit peel biochars can serve as sustainable, eco-friendly materials for wastewater treatment applications.

***Acknowledgements**: The authors gratefully acknowledge the support of Nazarbayev Intellectual School in Atyrau city, and the guidance of teachers and mentors throughout the research project.*

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ECO-FRIENDLY DISHWASHING LIQUID FROM ORANGE AND BANANA PEELS: A SUSTAINABLE SOLUTION TO CHEMICAL POLLUTION

Elina KAIRATOVA[1*], Asif ABBAS SYED [1]
[1]Department of Chemistry, Nazarbayev Intellectual School, Atyrau, Kazakhstan
**Corresponding author: elinakadyrgazieva@gmail.com*

Keywords: biodegradable cleaners, waste valorization, natural surfactants, sustainable chemistry, antimicrobial activity

Introduction: The rising demand for sustainable consumer products has made it an urgent need and biodegradable options that are non-toxic alternatives to conventional cleaning agents. As synthetic detergents cause water pollution and skin irritation, by millions of tons of fruit peels discarded as waste worldwide, this study aims to develop a multifunctional, biodegradable cleaning product that performs efficiently in the cleaning process. Besides the cleaning action, it also moisturizes and protects the skin. Banana and orange peels, rich in cellulose, hemicellulose, pectin, lignin, and phenolic compounds, are excellent candidates as green and renewable bioresources [4,5]. According to previous studies, these peels possess antioxidant, antimicrobial, and surfactant properties [1,4,5]; hence, they would be good vegetable agents while cleansing. To impregnate safety and acceptance, moisturizing agents such as glycerin (3%) and panthenol (1%) are incorporated into the composition [2,3]. This work proposes the novel integration of fruit peel surfactants with clinically tested moisturizers, thus providing a modern biotech solution of value.

Materials and methods: Banana peel (*Musa x paradisiaca*) and orange peel (*Citrus sinensis*) were purchased from local markets, washed, dried at 60 °C and ground into powder. Water and ethanol extraction were performed to extract the bioactive compounds. The extracts were characterized by FTIR and UV–Vis to confirm the presence of tannins, saponins, and polyphenols [4,5]. The cleaning formulation was prepared by mixing the fruit peel extract (10% w/v) with glycerin (3%) and panthenol (1%) [2,3]. The antibacterial activity was measured by the disk diffusion method against *E. coli* and *S. aureus* [1]. The surfactants were tested for their ability to reduce surface tension and produce foam. The biodegradability study was conducted according to OECD guidelines (28-day CO_2 evolution). Sensory tests were performed with volunteers upon foam stability, smell, and texture. The cleaning ability was compared with that of a commercial detergent.

Results:*E. coli* and *S. aureus* were inhibited and kept at a radius of 12 mm and 15 mm, respectively, by the banana peel [1,4], while the orange peels displayed similar antibacterial activities and higher antioxidant potential (>70% DPPH scavenging) [5]. Due to the surface tension being reduced from 72 mN/m to 34 mN/m, it could be seen as an effective surfactant [1]. Biodegradability was 82% after 28 days, which is greater than the 60% threshold given by OECD. Application of glycerin and panthenol greatly improved the formulation in terms of user acceptance: the volunteers reported smoother skin and less dryness as side effects [2,3]. Good foam was produced from the formulation with a nice citrus fragrance, and grease removal was about 75%–85%, which is slightly less than commercialproducts.

Conclusion: Fruit peel waste was successfully upcycled to a biodegradable detergent with both environmental and skin benefits [4,5]. The addition of glycerin and panthenol to the product renders it safer for use [2,3], and the antimicrobial and surfactant properties provide the product with its desired cleaning action [1]. It is highly biodegradable and has tremendous potential for further development and establishment as a green alternative to synthetic detergents.

***Acknowledgements**: The authors thanks to Nazarbayev Intellectual School, Atyrau, for research support*

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ALFAPURE: A BIOFILTER BASED ON FOOD WASTE AND ALFALFA FOR THE REMOVAL OF HEAVY METALS AND PETROLEUM PRODUCTS FROM WATER BODIES

Balnur DIDARKYZY [1], Amirzhan Madina BEYBITKYZY [1], Gulziya BEISENBEKOVA [1*]
[1]*Nazarbayev Intellectual School of Science and Mathematics, Atyrau, Kazakhstan*
**Corresponding author: baisenbekova_g@atr.nis.edu.kz*

Keywords: alfaalfa, food waste, heavy matals, water purification, petroleum products

Introduction: Heavy metals and petroleum products are among the most common industrial pollutants, entering water bodies through wastewater discharges [2,3,4]. In Kazakhstan, particularly in the Atyrau region (the Ural River), this problem is acute, negatively affecting both the ecosystem and public health [1]. According to studies conducted with the participation of the Ministry of Ecology, the river shows exceedances of class I quality standards for COD, total iron, petroleum products, magnesium, nitrite anion, and BOD_5 [1].
Objective: The aim of the project is to create, develop and implement a biofilter based on food waste and alfalfa for the effective purification of water bodies from heavy metals and petroleum products (UN Sustainable Development Goals (SDGs): 6. Clean Water and Sanitation, 14. Life Below Water).

Materials and methods: The study consisted of several stages. First, a literature review and analysis were conducted [2,3,4,5], followed by the investigation of the adsorption properties of food waste and alfalfa. Next, methods for producing a biofilter from these materials were examined. The final stage involved the analysis and synthesis of the collected data.
In the practical part, alfalfa was first grown, reaching the required biomass in approximately two weeks. After that, all materials — alfalfa and food waste (orange peel, kiwi peel, banana peel, and coffee grounds) — were dried and subjected to carbonization in a vertical furnace at 500–600 °C. The resulting charcoal was then ground into a fine powder.
To form the biofilter, 0.20 g of each material was taken, mixed, and assembled into a single filtering mechanism. The efficiency of the biofilter was tested for the adsorption of heavy metals and petroleum products [3,4]. To assess lead adsorption, 1.5 ml of $Pb(NO_3)_2$ solution was mixed with 40 ml of tap water, resulting in a cloudy white mixture, which became clear after passing through the filter. To test petroleum adsorption, 3 ml of gasoline and 10 drops of oil were added to 100 ml of distilled water and thoroughly mixed; the solution was then passed through the biofilter twice, resulting in a significant reduction of contamination.

Results: Three tests were conducted on the solution with the addition of KI to determine the presence of lead ions. During the experiments, the yellow precipitate PbI_2 gradually decolorized, and by the third test the mixture became completely colorless. This indicates that the lead ions were effectively absorbed by the biofilter [3].
Next, a flammability test of the mixture was performed. No ignition occurred during the experiment, indicating the absence of petroleum products in the sample [4].

Conclusions: In conclusion, an effective biofilter based on alfalfa and food waste was developed. The ALFAPURE project is an innovative, cost-effective, and environmentally safe solution for water purification, suitable for both industrial areas and small communities [5]. The biofilter reduces water pollution, improves environmental conditions, and promotes sustainable development. Future plans include further development of the project and improvement of the filter mechanism.

***Acknowledgements**: We would like to express our sincere gratitude to our research supervisor, Chemistry teacher Gulziya Saparbekovna, for her guidance and support throughout the course of this project.*

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SUSTAINABLE HYDROGEN PRODUCTION FROM END-OF-LIFE VEHICLE PLASTICS USING MICROWAVE-ASSISTED PYROLYSIS

Grigore PȘENOVSCHI[1,2*], **Ioan CĂLINESCU** [2], **Ciprian-Gabriel CHISEGA-NEGRILĂ** [2]
[1]INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania
[2]Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA of Bucharest, 011061 Romania
**Corresponding author: grigore.psenovschi@icechim.ro*

Keywords: catalytic pyrolysis, polypropylene recycling, end-of-life vehicles (ELVs), activated carbon, waste-to- energy, environmental impact

Introduction: Plastic waste has become a pressing issue in Romania, driven by the continuous growth in volumes from industrial sources, particularly end-of-life vehicles (ELVs), and by the urgent need to mitigate environmental impacts [1, 2]. This work explores microwave-assisted pyrolysis as an alternative valorization strategy for polypropylene (PP) and polyethylene (PE) waste, with a focus on maximizing gaseous product generation, especially hydrogen-rich fractions. Experiments were carried out in a monomode microwave reactor, where the feedstock was arranged in layers together with silicon carbide, acting as a microwave susceptor, and activated carbon as a catalyst. The study systematically examined the effects of catalyst dosage, reactor setup, and polymer type. Across all tested plastics, the produced gases demonstrated high heating values (46,941–55,087 kJ/kg) alongside low specific CO_2 emissions (4.4–6.1 × 10^{-5} kg CO_2/kJ), indicating both strong energy potential and a reduced carbon footprint. Overall, the findings confirm that microwave-assisted pyrolysis provides an effective pathway for converting ELV-derived plastic waste into valuable energy carriers.

Materials and methods: Silicon carbide (SiC) (Green Silicon Carbide, 2–4 mm, Sinabuddy Mineral, Zhengzhou, China), activated carbon (AC) (Coconut Shell activated carbon 6 × 12 mesh, Legend Inc. SUA, Sparks, NV, USA), polypropylene (PP) granules, and polyethylene granules purchased from Romcolor, Copăceni, Romania. Additionally, polypropylene obtained from automotive dismantling , and two types of mixed polyolefin waste—composed of polypropylene and polyethylene - collected from car components obtained from SC Pieseauto Dez SRL, Constanta, Romania.

Results: The best results are obtained when the hydrogen concentration is high for the PP (54,320.32 kJ/kg) and PP+PE samples (55,087.35 kJ/kg). In all other cases, Gross Heating Value (GHV) are obtained for the gas mixture higher than the corresponding values for conventional fuels such as kerosene or diesel. From an environmental standpoint, specific CO_2 emissions from the pyrolysis gases were generally lower or comparable to commercial fossil fuels.

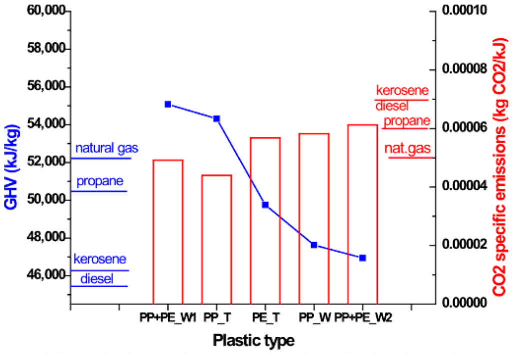

Figure 1. Calorific value (GHV) and CO2 specific emissions of gaseous fraction obtained at microwave assisted pyrolysis of plastic vs. conventional fuels

Conclusions: Microwave-assisted pyrolysis shows considerable promise in producing cleaner gas compositions with very good value for GHV. The use of microwaves enhances selectivity towards lighter hydrocarbons, which are highly valuable for fuel refining, thus offering a potential route for producing more refined fuels.

Acknowledgements: *PN 23.06 Core Program—ChemNewDeal within the National Plan for Research, Development and Innovation 2022–2027, developed with the support of the Ministry of Research, Innovation, and Digitalization, project no. PN 23.06.01.01, AQUAMAT; and the Competitiveness Operational Program 2014–2020, Action 1.1.4: Attracting high-level personnel from abroad to enhance the RD capacity, project: P_37_471, "Ultrasonic/Microwave Nonconventional Techniques as new tools for nonchemical and chemical processes", financed by contract: 47/05.09.2016.*

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YEAST SURFACE DISPLAY OF FUNGAL CYSTEINE-RICH PROTEINS FOR BIOGENIC SELENIUM NANOPARTICLES PRODUCTION

Livia-Teodora CIOBANU[1,2], Diana CONSTANTINESCU-ARUXANDEI [1], Florin OANCEA [1], Ileana Cornelia FARCASANU [2*]

[1]National Institute for Research & Development in Chemistry and Petrochemistry ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania [2]Interdisciplinary School of Doctoral Studies, University of Bucharest, 36-46 Mihail Kogalniceanu Bd, 050107 Bucharest, Romania.

**Corresponding author: ileana.farcasanu@chimie.unibuc.ro*

Keywords: hydrophobins, cerato-platanins, yeast recombinant protein, biocorona

Introduction: The narrow physiologic margins of selenium impose toxicological challenges, restricting the biological applications of this essential element. Zero-valent selenium in its nanoparticulate form (selenium nanoparticles – SeNPs) have been reported as the safest selenium formulation. Microorganism mediated synthesis of SeNPs stands out as a highly sustainable method, yielding biogenic SeNPs with superior stability, bioactivity, and biocompatibility. Microbial host biomolecules act as natural reducers and stabilizers, capping SeNPs in the form of a *biocorona*, which further modulates the biological interactions and functional behavior of these nanostructures [1]. Due to their ease of genetic manipulation and model microorganism attributes, yeast cells can be recombinantly designed as *nano factories* for production of SeNPs with elevated biological activity [2]. This study aimed to display cysteine-rich selenite-processing polypeptides with putative biostimulant activity, at the surface of *Saccharomyces cerevisiae* yeast cells for customized biogenic SeNP production.

Materials and methods: Cysteine-rich sequences with SeNP-stabilizing potential, specifically hydrophobins and cerato-platanins, were isolated by reverse-transcription polymerase chain reaction (RT-PCR) using cDNA synthetized from *Trichoderma reesei* QM6a RNA template. To achieve surface display of recombinant proteins, the genes were cloned into the pYD1 plasmid, a yeast display vector specifically constructed for external cell wall protein expression. The recombinant plasmid DNA was cleaved using the restriction enzymes employed during cloning, for further electrophoretic detection of the released gene insert. The recombinant constructs were subsequently transformed into *S. cerevisiae* yeast cells. The modified yeast strains were cultured in media supplemented with sodium selenite (Na_2SeO_3) serving as a SeNPs precursor, to investigate its effects on cell growth and nanoparticle synthesis.

Results: RT-PCR products resulted in distinct products of ~0.5 kb for hydrophobins and ~0.5–0.8 kb for cerato-platanins, confirming the specificity of the amplification process. Electrophoretic analysis of the digested recombinant DNA fragments was consistent with successful gene cloning. Mutant strains transformed with hydrophobin recombinant constructs exhibited higher tolerance to Na_2SeO_3, in comparison to cerato-platanin-expressing strains. One of the hydrophobin-expressing *S. cerevisiae* strains showed earlier onset of red coloration, which is an indicative of SeNP formation.

Conclusions: Genes encoding for fungal hydrophobins and cerato-platanins – functional peptides with SeNP stabilizing and bioactivity enhancement potential– were successfully cloned into the pYD1 surface display vector. Biogenic SeNP synthesis mediated by *S. cerevisiae* transformants was preliminary confirmed. Future research perspectives will focus on the isolation and characterization of both the recombinant proteins and the synthesized SeNPs.

***Acknowledgements**: This research was funded by the Ministry of Education and Research, project PN 23.06.02.01 InteGral, Nucleu Program and grant CNCS/CCCDI—UEFISCDI, contract number 55PTE/2025, within PNCDI IV.*

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THERMO-CATALYTIC VALORIZATION OF WASTE PLASTICS INTO FUELS OVER BIMETALLIC NICKEL AND COBALT OXIDES ON ALUMINA

Aminu Bayawa MUHAMMAD [1*], Aliyu Muhammad SOKOTO [2], Nura Bala MANGA [1], Suleiman Abubakar ZAURO [1]

[1]*Department of Energy and Applied Chemistry, Usmanu Danfodiyo University, PMB 2346, Sokoto, Nigeria*
[2]*Department of Pure and Environmental Chemistry, Usmanu Danfodiyo University, PMB 2346, Sokoto, Nigeria*

**Corresponding author: muhammad.aminu@udusok.edu.ng*

Keywords: Catalytic pyrolysis, waste plastics, diesel-range hydrocarbons, NiO-Co_3O_4/Al_2O_3 catalyst, sustainable fuel

Introduction: The growing challenge of plastic waste management and the demand for sustainable energy solutions necessitate innovative approaches. This study explores the catalytic pyrolysis of waste plastics using a $NiO.Co_3O_4/Al_2O_3$ catalyst to produce diesel-range hydrocarbons, offering a dual solution for waste valorization and fuel production.

Materials and methods: Waste plastics (packaging materials and carrier bags) were pyrolyzed in a tubular reactor at 350–450°C under nitrogen, with and without the $NiO.Co_3O_4/Al_2O_3$ catalyst (5 wt%). The catalyst was characterized by XRF, FTIR, and SEM. Product yields (liquid oil, gas, residue) were measured, and the oil was analyzed via GC-MS.

Results: Catalyzed pyrolysis significantly increased liquid yield (31–36%) compared to uncatalyzed pyrolysis (14–18%) and reduced residue formation. GC-MS analysis revealed a high proportion of aliphatic hydrocarbons, particularly alkenes, within the diesel range. The catalyst demonstrated enhanced activity, achieving >70% fuel conversion at 450°C.

Conclusions: The $NiO.Co_3O_4/Al_2O_3$ catalyst effectively improves plastic waste conversion into valuable hydrocarbons, aligning with sustainable fuel production goals. This approach presents a promising strategy for addressing plastic pollution and energy needs in Nigeria.

Acknowledgements: *This research was supported by the Tertiary Education Trust Fund (TETFund), Nigeria.*

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ESTIMATION AND HEALTH RISK ASSESSMENT OF POLYCYCLIC AROMATIC HYDROCARBONS IN LOCALLY-ROASTED MEATS MARKETED IN ZARIA, NIGERIA

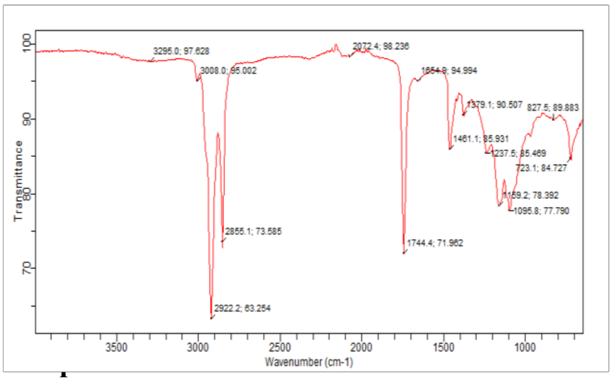
Salihu Abdullahi KIYAWA [1*], Musa Muhammed IBRAHIM[2], Mohammed Mu'azu[3]
[1]Northwest University, PMB 3220, Kano, Kano state, Nigeria
[2]Bayero University, PMB 3011, Kano, Kano state, Nigeria
[3]Ahmadu Bello University, Samaru, Zaria, Kaduna state, Nigeria

**Corresponding author: salihkiyawiy@gmail.com*

Keywords: Health risk, polycyclic aromatic hydrocarbons, roasted meat, Zaria, Nigeria.

Abstract

Locally-roasted meat sellers use woods, plastics and charcoal to make their in processing, packaging, drying, smoking, baking, roasting, grilling and frying. Such materials used as fuels contain Polycyclic Aromatic Hydrocarbons (PAHs).[1]. At high temperature, PAHs produce free radicals that are harmful to human health. PAHs have been reported to be carcinogenic [2]. Zaria, lies on 11° 5' 7.9476" N and 7° 43' 11.8020" E, 686 m above sea level covering 45,567 km^2 and a population of 6,066,562 [3]. The study investigates the concentrations PAHs in meats traditionally prepared by different methods. Six markets including Amaru Market (AM), Zaria Market (ZM), Danmagaji Market (DM), Tudunwada Market (TM), Samaru Market (SM) and Sabon Gari Market (SBM) in Kaduna state, Nigeria were used as the sample location. GC-MS and FT-IR were used for the analysis. Anthracene (Ant) was found to have the highest mean concentration in AM (15.86 µg/kg), exceeding the standard ($P < 0.05$). This suggests combustion-related PAHs, as anthracene pyrogenic. Also, benzo[a]anthracene levels were high in AM and SM, indicating exposure to combustion by-products [4]. PAHs, benzo[a]pyrene with the highest mean concentration in AM (0.048 µg/kg) is below the USEPA guideline of 0.2 µg/kg for food. Flt and Pyridine (Pyr) in TM and SM point towards combustion or grilling activities common in these areas. Naphthalene in SM (62.04 µg/kg) is associated with petroleum residues and indoor combustion. Significant differences ($P < 0.05$) among the markets for **Ant**, **BbF**, and **Fle** is due to differences in vehicular emissions, open burning, and food preparation methods High levels of PAHs in certain markets, especially AM and SM, pose potential health risks. Long-term exposure to PAHs is carcinogenic, mutagenic and teratogen. The concentrations observed in some markets exceed recommended limits have public health concerns [5]. The FT-IR spectrum of the roasted meats in Zaria metropolis are similar meaning that PAHs have similar patterns in FT-IR analysis but differs in transmittance for complementing the presence of PAHs in the samples. The FT-IR functional groups of aliphatic C-H stretching occurred at 2922 and 2855cm^{-1}, showing the presence of aliphatic chains, typical in lipids and fatty acids common in meat samples. Methylene bending/aromatic C-C vibrations occurred at 1461cm^{-1}, methyl bending at 1379cm^{-1}, C-O and C-N stretching at 1237, 1159 and 1095cm^{-1}, aromatic Out-of-Plane C-H bending occurred at 827 and 723cm^{-1}



The findings showed that DM and SM have PAH levels with health risks. The high presence of carcinogenic BaP and the detection of aromatic compounds associated with high-temperature cooking underscore the need for regular monitoring and implementation of safety standards. The FTIR analysis supports the chemical evidence of PAHs and lipid oxidation products in roasted meats, highlighting the impact of cooking methods on food safety.

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PHARMACOGNOSTIC ASPECTS AND PHYTOTHERAPEUTIC APPLICATIONS OF *MATRICARIA CHAMOMILLA*, *MELISSA OFFICINALIS* AND *HYPERICUM PERFORATUM*

Anca Andreea ZOE [1], Nicoleta MORARU [2], Cătălina Cristina (STANICA) TEODORESCU[2], Anca-Daniela RAICIU[1,2,3*]
[1]Hofigal Export-Import S.A.; Intrarea Serelor Street no.2; district 4 Bucharest, 042124 Romania
[2]"TITU MAIORESCU" University, Faculty of Pharmacy, Department of Pharmacognosy, Phytochemistry, Phytoterapy, Gh. Sincai Street, no.16, 4 district Bucharest, 040315 Romania
[3]PLANTA ROMANICA Association, George Enescu street, no.27-29; district 1 Bucharest, 010303 Romania
**Corresponding author: daniela_raiciu@yahoo.com*

Keywords: Matricaria chamomilla, Melissa officinalis, Hypericum perforatum, pharmacognosy, phytotherapy

Introduction: Phytotherapy employs bioactive compounds from medicinal plants in the prevention and treatment of various conditions. Pharmacognostic analysis allows the correlation of morpho- anatomical and phytochemical characteristics with therapeutic value. In this context, *Matricaria chamomilla, Melissa officinalis*, and *Hypericum perforatum* represent three species of major interest in complementary medical practice.

Materials and methods: A synthesis of pharmacognostic data and current clinical evidence regarding the chemical constituents and therapeutic applicability of these three species was performed [1,2].

Results:*Matricaria chamomilla* (chamomile) contains volatile oil rich in α-bisabolol and chamazulene, flavonoids, and coumarins, exhibiting anti-inflammatory, spasmolytic, and wound- healing properties. Its phytotherapeutic applications include functional digestive disorders and cutaneous or mucosal inflammations.

Melissa officinalis (lemon balm) is characterized by volatile oils (citral, citronellal), phenolic acids, and flavonoids. It is used as a mild sedative, anxiolytic, antispasmodic, and antiviral, being indicated in neurovegetative and dyspeptic disorders, as well as in cutaneous viral infections.

Hypericum perforatum (St. John's wort) contains naphthodianthrones (hypericin), hyperforin, and flavonoids, with antidepressant and anti-inflammatory activity [3]. It is clinically validated in mild to moderate depression but presents significant drug interactions through hepatic enzyme induction.

Conclusions:The three analyzed species highlight the importance of correlating pharmacognostic data with clinical experience. *Matricaria chamomilla* [6,8] is relevant for its anti-inflammatory and digestive effects, *Melissa officinalis* [4,7] for its sedative and antiviral activity, and *Hypericum perforatum* for its antidepressant value [5]. These plants confirm the role of phytotherapy as a valuable adjuvant in integrative medical practice.

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SECTION 2 - Bioresources, biotechnologies and biorefining

(Poster presentations)

1. *DIAZONIUM SALTS ELECTROCHEMICAL SENSOR FOR HEAVY METALS DETECTION IN TOMATO SAMPLES*

2. *DEVELOPMENT OF BIOACTIVE EDIBLE COATINGS FOR EXTENDED SHELF- LIFE OF FRUITS*

3. *HYDROGEN-BONDING NETWORKS IN NATURAL DEEP EUTECTIC SYSTEMS MODULATE THE FUNCTIONAL BEHAVIOR OF POLYPHENOLS*

4. *CHARACTERIZATION OF MICROBIAL INTERACTIONS IN THE SPONTANEOUS*

5. *SYNERGISTIC FUNGAL–PLANT SYSTEMS INTEGRATED WITH ELECTROCHEMICAL MONITORING FOR SUSTAINABLE HEAVY METAL REMEDIATION IN SOIL*

6. *COMPARATIVE ANTIMICROBIAL EFFICACY OF KOMBUCHA-DERIVED VINEGAR AND CONVENTIONAL VINEGAR SOLUTIONS FOR REDUCING POST-HARVEST MICROBIAL CONTAMINATION ON FRESH MARKET APPLES: AN ECO-FRIENDLY DECONTAMINATION APPROACH*

7. *WORMWOOD HYDROLATE UP-REGULATED VEGF SYNTHESIS AND PROTECTED MOUSE ENDOTHELIAL CELLS AGAINST LIPOPOLYSACCHARIDE-INDUCED OXIDATIVE DAMAGE*

8. *“GREEN SOLUTIONS” FOR CULTURAL HERITAGE PROTECTION: A SUSTAINABLE APPROACH THROUGH INTERDISCIPLINARY INNOVATION*

9. *VALIDATION OF THE METHOD FOR DETERMINATION OF ZINC, ALUMINUM AND TITANIUM IN POLYOLEFINS PACKAGING BY ICP-OES*

10. *ORGANOSOLV EXTRACTION OF LIGNIN FROM SAWDUST AND SPENT MUSHROOM SUBSTRATE*

11. *ANTIOXIDANT PEPTIDES FROM RHIZOSTOMA PULMO JELLYFISH FOR BIOMEDICAL APPLICATIONS*

12. *APPLICATIONS OF LIPOSOMES IN THE FOOD INDUSTRY*

13. *ADVANCED ULTRASOUND-ASSISTED EXTRACTION OF BIOACTIVE COMPOUNDS FROM BEE PRODUCTS*

14. *ENHANCED GROWTH OF CHLORELLA SOROKINIANA BY LIGNOSULFONATE SUPPLEMENTATION*

15. *CAN THE MICROORGANISMS USED IN SUSTAINABLE AGRICULTURE ENSURE THE BIOREMEDIATION OF HEAVY METAL EFFLUENTS?*

16. *FROM WASTE TO PROTECTION: CIRCULAR STRATEGIES FOR SUSTAINABLE MAP CULTIVATION*

17. *EXPLORING MICROBIAL STRATEGIES FOR PHENOL BIODEGRADATION IN CONTAMINATED ENVIRONMENTS*

18. *EVALUATION OF THE ANTIMICROBIAL POTENTIAL OF BIOSURFACTANT PRODUCED BY PSEUDOMONAS PUTIDA STRAIN*

19. *EVALUATION OF PHYTOCHEMICAL COMPOUNDS AND ANTIOXIDANT ACTIVITY OF ALOE ARBORESCENS*

20. *CLEAN & GREEN: INNOVATIVE SOLUTIONS FOR FRESH PRODUCE IN A SUSTAINABLE FOOD CHAIN*

21. *MUCOADHESIVE HYDROGELS BASED ON BACTERIAL CELLULOSE FROM KOMBUCHA FERMENTATION AND VEGETAL CELLULOSE FROM BREWER'S SPENT GRAIN*

DIAZONIUM SALTS ELECTROCHEMICAL SENSOR FOR HEAVY METALS DETECTION IN TOMATO SAMPLES

Maria-Cristina RADULESCU [1*], Madalina-Petruta BUCUR [1], Bogdan BUCUR [1], Simona Carmen LITESCU FILIPESCU [1], Lucian Gabriel RADU [1]

[1]INCDSB Bucharest, 296 Splaiul Independenței, district 6, 060021 Romania

**Corresponding author: cristina.radulescu@incdsb.ro*

Keywords: 4-phenyl isothiocyanate diazonium salts, electrochemical sensor, heavy metals detection, tomato samples

Introduction: Tomatoes are a very important food source which contains nutrients, antioxidants, proteins, carbohydrates, as well as other secondary metabolites (e.g. vitamins C and E, b-carotene, flavonoids, lycopene, etc.) necessary for human nutrition. In the same time, tomatoes consumption represents a major source of heavy metals contamination, because they cannot be degraded or destroyed [1]. In this work is presented an analytical system for the detection of heavy metals obtained by developing electrodes functionalized with isothiocyanate fragments [2]. The procedure for electrode surface modification consists in three steps carried out in the same solution: (1) the reduction of nitro groups to amino moieties by chronoamperometry, (2) transformation of amino to diazonium with nitrous acid and (3) the electrografting of diazonium salts by chronopotentiometry at constant current.

Materials and methods: A PGSTAT302N potentiostat/galvanostat (Metrohm-Autolab, Netherlands) equipped with a 3-electrode glass cell (Metrohm) controlled with Nova 1.11 was used for the electrochemical measurements. A 3 mm diameter glassy carbon rod electrode (GCE) (Metrohm) was used as the working electrode, an Ag/AgCl//3M KCl electrode (Metrohm) as the reference electrode and a Pt wire electrode as the auxiliary electrode. Chronopotentiometry at constant current was used for the heavy metal accumulation on the electrode surface. The stripping process was performed by differential pulse voltammetry (DPV) from -0.8 V to -0.4 V for Pb(II) and, respectively, between -0.1 V and 0.4 V for Fe(II).

Results: In Figure 1 are presented the DPV signals (A) and the calibration plot (B) recorded for Fe(II) ions analysis in the optimum conditions. The detection limit was of 2.0 µg L^{-1} and the relative standard error for a concentration of 100 µg L^{-1} Fe(II) was 4.5% (n = 10 measurements) for the same electrode, respectively 5.2% between different electrodes (n = 6). The sensor was suitable to use for the Pb(II) and Fe(II) ions detection in tomato after the sample pretreatment by using open vessel acid mineralization. A quantity of 1.525 mg Fe(II)/kg was found in dried tomato sample, respectively of 6.862 mg Fe(II)/kg in raw tomato sample.

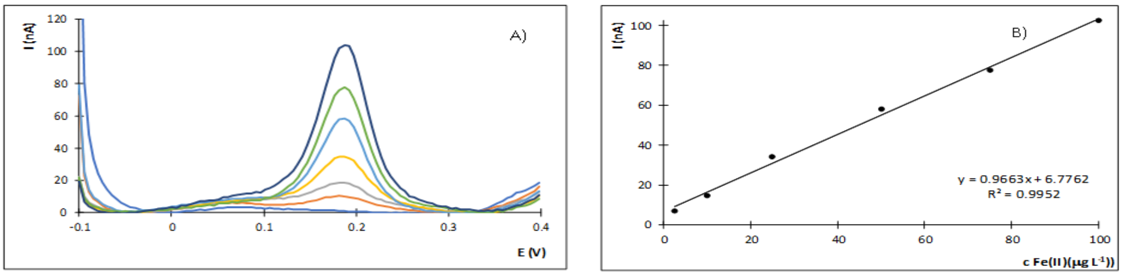

Figure 1. A) DPV signals recorded with a 4-phenyl isothiocyanate modified glassy carbon electrode for different Fe(II) ions concentrations in the range of 2.5 - 100 µg L^{-1} and B) the corresponding calibration graph. Optimal conditions: 0.5 mM 4-nitrophenyl isothiocyanate, -0.9 V accumulation potential, 360 s accumulation time, acetate buffer pH 4.5.

Conclusions: A stable thin organic layer of 4-phenyl isothiocyanate with minimal surface passivation was obtained. The developed sensor presented excellent electronalytical performances and it was successfully applied for the detection of Pb(II) and Fe(II) ions in tomato samples.

***Acknowledgements**: This work was performed with the support of MRID through the Core Program within the National Research, Development and Innovation Plan 2022–2027 project no. 23020101(SIA-PRO), contract no 7N/2022 and project PNRR-III-C9-2022 – I5 cod 18/16.11.2022 (ResPonSE).*

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DEVELOPMENT OF BIOACTIVE EDIBLE COATINGS FOR EXTENDED SHELF- LIFE OF FRUITS

Alina ORTAN [1], Simona MARCU SPINU [1*], Mihaela DRAGOI CUDALBEANU [1],
Daniela IONESCU [2], Justinian-Andrei TOMESCU [2], Carmen CIMPEANU [1]
[1]Faculty of Land Reclamation and Environmental Engineering, University of Agronomic Sciences and
Veterinary Medicine of Bucharest, 59 Mărăști Boulevard, 011464 Bucharest, Romania
[2] HOFIGAL Export Import SA București, 2 Intrarea Serelor, district 4 Bucharest, Romania
**Corresponding author: simona.spinu@fifim.ro*

Keywords: edible coatings, natural extracts, NADES, post-harvest preservation, sustainable technology

Introduction: Reducing post-harvest fruit losses represents one of the most pressing challenges in modern food systems. Fruits, characterized by high moisture and nutrient content, are prone to microbial contamination and oxidative deterioration. In recent years, bioactive edible coatings have emerged as an eco-friendly strategy to preserve fruit quality, reduce waste, and replace synthetic packaging [1]. These coatings, typically based on biopolymers such as chitosan or alginate, can be enhanced with natural antioxidants and antimicrobials obtained from plant sources, offering both protection and nutritional value

Approach: This review summarizes recent advances in the development and application of bioactive edible coatings for post-harvest fruit preservation. A particular focus is placed on green extraction techniques—especially the use of Natural Deep Eutectic Solvents (NADES)—which have been recognized as efficient and sustainable alternatives to conventional organic solvents for extracting plant- derived phenolic compounds [2]. The review also discusses how the structural and mechanical characteristics of polysaccharide-based coatings influence their functionality as moisture and gas barriers and their interaction with fruit surfaces

Recent advances: Recent studies report that edible coatings enriched with phenolic and flavonoid compounds exhibit enhanced antimicrobial and antioxidant activity, contributing to improved firmness, color retention, and nutritional quality during storage [2]. The use of NADES has proven particularly efficient for extracting bioactive compounds with minimal environmental impact [3]. Furthermore, synergistic interactions between plant-derived bioactives and polymer matrices enhance the functional performance of coatings, supporting their use as a sustainable alternative to synthetic packaging.

Conclusions: Bioactive edible coatings formulated with natural polysaccharides and enriched with plant extracts represent an effective, safe, and environmentally friendly technology for prolonging the shelf- life of fruits. Integrating green extraction technologies and biodegradable coating materials supports the transition toward sustainable food systems. Future research should prioritize scaling-up production, evaluating biodegradability under real storage conditions, and assessing consumer acceptance of coated fruits.

Acknowledgements*: This work was supported by a grant of the Romanian Ministry of Education and Research, CCCDI- UEFISCDI, project number PN-IV-P7-7.1-PED-2024-2366, contract 123PED/2025 within PNCDI IV.*

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HYDROGEN-BONDING NETWORKS IN NATURAL DEEP EUTECTIC SYSTEMS MODULATE THE FUNCTIONAL BEHAVIOR OF POLYPHENOLS

Luminita DIMITRIU [1,2], Diana CONSTANTINESCU-ARUXANDEI [1*], Daniel PREDA[1,3], Cristian- Andi NICOLAE [1], Mihaela GANCIAROV [1], Marius GHIUREA [1], Florin OANCEA [1,2*]

[1]INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania
[2]Faculty of Biotechnologies, University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăști Blv., district 1, 011464 Bucharest, Romania
[3]University Politehnica Bucharest, Str. Gheorghe Polizu nr. 1-7, Sector 1, 011061 Bucharest, Romania

**Corresponding author: diana.constantinescu@icechim.ro, florin.oancea@icechim.ro*

Keywords: honey, antioxidant activity, caffeic acid, epicatechin, Loewe additivity model, synergy score

Introduction: Honey can be regarded as a natural deep eutectic system (NaDES) formed through hydrogen bonding among its major components - glucose, fructose, sucrose, and water. These hydrogen- bond networks generate unique physicochemical properties that can modulate the behavior of bioactive molecules. This study aimed to explore how the supramolecular organization of honey and a biomimetic NaDES influences the functional properties of polyphenols, in particular their antioxidant activity (AOA)**.**

Materials and methods: Honey (H) and a honey-like NaDES (glucose–fructose–sucrose–water, GFSw) were characterized by FTIR, DSC/TGA, X-ray Diffraction, density, surface tension, and water activity measurements. Selected polyphenols (caffeic acid - CA, epicatechin - EP) were incorporated in H and GFSw, and AOA was evaluated by DPPH and FRAP assays. The combination index (CI), isobolomic analysis, and Loewe Synergy Score generated by SynergyFinder R package were used to study synergism/antagonism behavior.

Results: FTIR spectra and DSC analysis confirmed the presence of extensive hydrogen bonding and a characteristic glass transition, indicating eutectic-like behavior.

Honey and GFSw showed similar density and low water activity, supporting their structural analogy. The incorporation of polyphenols enhanced antioxidant performance, particularly in FRAP assays, where synergistic effects were observed through the CI and isobolographic analysis for the mixtures containing CA. In DPPH assays, the same combination showed synergism as evaluated by the Loewe Synergy Score. In contrast, systems containing EP exhibited antagonistic interactions in both honey and GFSw matrices.

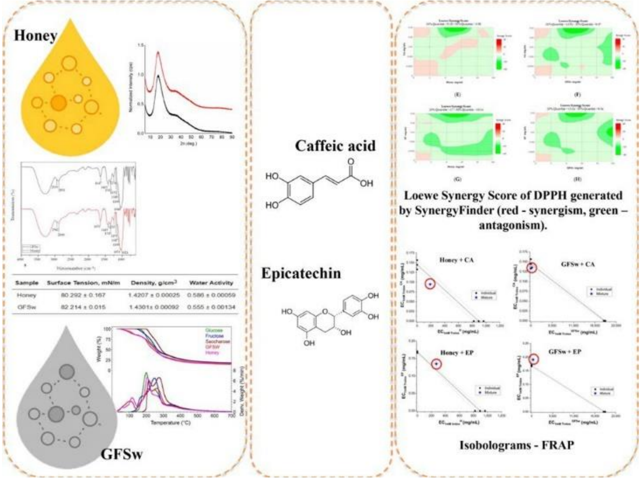

Figure 1. Schematic overview of the experimental workflow for the study of polyphenols in honey and biomimetic GFSw systems.

The differences between the CA–honey and CA–GFSw mixtures were not statistically significant, as both systems displayed comparable AOA responses

Conclusions: The hydrogen-bonding network in H, acting as a natural eutectic system, governs the physicochemical environment of polyphenols and could play a role in their redox efficiency. Understanding these interactions provides a basis for designing biomimetic eutectic systems as functional carriers for natural antioxidants. GFSw exhibited AOA behavior similar to H when mixed with polyphenols; however, H appeared to possess additional properties that increased synergism or reduced antagonism in some cases. The AOA behavior of H–polyphenol mixtures can be influenced by the AOA method, the type and concentration of polyphenol, and the complex nature of honey

Acknowledgements*: This work was supported by the Romanian Ministry of Agriculture and Rural Development, project ADER 17.1.2 / 2023 and by project POC-A1-A1.2.3-G-2015-P_40_352-SECVENT, contract 81/2016, SMIS 105684, funded by cohesion funds of the European Union, subsidiary projects 2236/2018 and 5544/2020.*

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CHARACTERIZATION OF MICROBIAL INTERACTIONS IN THE SPONTANEOUS FERMENTATION OF A TRADITIONAL ROMANIAN PRODUCT, BORȘ

Ecaterina-Andreea CONSTANTIN[1,2], Camelia DIGUȚĂ [2], Florentina MATEI [2],
Diana CONSTANTINESC-ARUXANDEI [1*], Florin OANCEA [1*]
[1]INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, 6th district, 060021 Romania
[2] Faculty of Biotechnologies, University of Agronomic Sciences and Veterinary Medicine of Bucharest,
54 Mărăști Bd, district 1, Romania
**Corresponding author: diana.constantinescu@icechim.ro, florin.oancea@icechim.ro*

Keywords: borș, lactic acid bacteria, carbon source, product functionality, enzyme activity

Introduction: Borș is a Romanian fermented drink made from wheat bran and corn flour, obtained through the action of lactic acid bacteria (*Lactobacillus*, *Pediococcus*, *Weissella*) and yeasts (*Saccharomyces)*, which produce organic acids, ethanol, and bioactive compounds with nutritional and antioxidant properties [1, 2]. The purpose of this paper is to investigate the interactions between microorganisms involved in the spontaneous fermentation of traditional beverages (such as borș) and their impact on product functionality, with the aim of developing functional foods and the biotechnological exploitation of these products.

Materials and methods: Lactic acid bacteria involved in the spontaneous fermentation of borș were isolated on MRS selective medium supplemented with 0.1 g/L cycloheximide and characterized microscopically using Gram staining. Genomic DNA was extracted using the ZR Fungal/Bacterial DNA MiniPrep kit (Zymo Research), and the V3–V4 regions of the 16S rRNA gene were amplified by PCR using the primers 341F and 785R. After identification, the isolated strains were evaluated for growth on media containing different carbon sources and for tolerance to abiotic stress factors, including high salinity. Additionally, the capacity of lactic acid bacteria to produce extracellular enzymes (amylases, cellulases, xylanases), relevant for the degradation of complex substrates, wasassessed.

Results: Four lactic acid bacterial strains were isolated from borș — *Lactobacillus plantarum* (T1), *Pediococcus pentosaceus* (T2), *Companilactobacillus crustorum* (T3), and *Latilactobacillus curvatus* (T4) — and exhibited distinct metabolic and adaptive profiles. *L. plantarum* showed uniform growth across all tested carbon sources, stabilizing after 24 hours, and demonstrated medium salt tolerance, maintaining growth up to 5% NaCl. *P. pentosaceus* preferentially utilized maltose and mannose, reaching maximum optical densities (~2.7–2.8) between 24 and 72 hours, but was sensitive to salt stress above 2% NaCl. *C. crustorum* exhibited consistently high growth across multiple carbon sources, indicating good metabolic adaptability, yet showed only moderate salt tolerance, with growth decreasing notably above 5% NaCl. *L. curvatus* was distinguished by efficient mannose utilization and rapid growth in the presence of glucose and fructose, but exhibited high sensitivity to salt stress, with growth reduction observed even at 0.5% NaCl. The analysis of enzymatic assays revealed significant differences between strains. *L. curvatus* recorded the highest xylanase activity (22.63 ± 1.28 mM xylose) and cellulase activity (6.2 ± 0.88 mM glucose), along with the lowest amylase activity (5.24 ± 0.55 mM maltose). *L. plantarum* exhibited the highest amylase activity (10.35 ± 0.083 mM maltose*)*, and *C. crustorum* showed the lowest values for xylanase activity (3.72 ± 1.08 mM xylose) and cellulase activity (1.92 ± 0.97 mM glucose).

Conclusions: The four strains of lactic acid bacteria isolated from borș exhibited complementary metabolic and adaptive traits. *L. plantarum* and *L. curvatus* play a predominant role in the degradation of complex carbohydrates, whereas *P. pentosaceus* and *C. crustorum* confer metabolic versatility, collectively contributing to the stability of spontaneous fermentation.

***Acknowledgements**: This work was supported by the Romanian Ministry of Agriculture and Rural Development, project "Research regarding development of sustainable technologies for obtaining and valorizing innovative ingredients and foods, for nutritional equilibration of modern consumer's diet" - ADER 17.1.2. and by the Ministry of Education and Research, project PN 23.06.02.01 InteGral, Nucleu Program.*

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SYNERGISTIC FUNGAL–PLANT SYSTEMS INTEGRATED WITH ELECTROCHEMICAL MONITORING FOR SUSTAINABLE HEAVY METAL REMEDIATION IN SOIL

Cristina FIRINÇĂ [1,2*], Lucian-Gabriel ZAMFIR [1], Iuliana RĂUT [1], Mariana CONSTANTIN [1], Radu FIERĂSCU [1], Luiza CAPRĂ [1], Mihaela DONI [1], Luiza JECU [1], Ana-Maria GURBAN [1*], Tatiana ȘESAN [2]

[1]INCDCP ICECHIM Bucharest, Department of Biotechnology, 202 Splaiul Independenței, 060021 Romania [2]Faculty of Biology, University of Bucharest, Splaiul Independenței 91-95, 050095 Bucharest,Romania

**Corresponding authors: cristina.firinca@icechim.ro, ana-maria.gurban@icechim.ro*

Keywords: heavy metals, bioleaching, remediation, biosensors, hyperaccumulator plants

Introduction: Heavy metal contamination and bioaccumulation are ongoing issues for which biological remediation methods offer a sustainable, inexpensive and effective solution, ensuring the metabolization of pollutants into less toxic forms and their uptake from the contaminated sites[1]. The efficiency of the bioremediation process requires sensitive real-time monitoring in order to assess long-term applicability. For this reason, the aim of this work is to integrate fungal bioremediation using a novel metallotolerant consortium and ornamental plant cultivation to assess their combined potential for remediating chromium-contaminated soil, coupled with in-situ monitoring using portable electrochemical tools.

Materials and methods: For this study, soil samples were collected from three areas in Bucharest with different levels of chromium contamination and treated by a two-step bioremediation protocol, employing fungal treatment followed by planting hyperaccumulator plants. Filamentous fungi were isolated from the soil with the highest concentrations of chromium. They were evaluated for metal tolerance, total Cr removal, plant-growth promotion potential and mutual compatibility in order to form a robust consortium [2]. Assessment of Cr^{6+} reduction to the less toxic form, Cr^{3+}, was performed by determination of chromate reductase activity using 1,5-diphenylcarbazide. The most suitable strains were combined (1:1 volumetric ratio of spore suspension) and applied on the contaminated soils at the beginning of the experiment, as well as before planting. The monitorization of bioremediation efficiency was carried out over 8 weeks using a portable electrochemical tool integrating a miniaturized sensor directly immersed in the soil solution extracted with a lysimeter. After fungal remediation, seed germination and development of *Tagetes erecta* were monitored as a potential Crhyperaccumulator.

Results: A novel consortium of *Trichoderma* and *Clonostachys* strains was successfully obtained, demonstrating high Cr tolerance, with efficiency in removing over 70% of chromium from the solution at all tested concentrations. All plant-growth promoting attributes were confirmed, except nitrogen fixation. In addition, bioleaching of chromium from soil particles was confirmed after 8 weeks of mycoremediation, along with the complete reduction of Cr^{6+} in the soil, confirmed by electrochemical detection of chromium concentrations using the developed sensors based on Prussian blue redox mediator (figure 1).

Fig. 1. Integrated bioremediation system with real-time monitoring of chromium concentration.

A combination of fungal consortium and vermicompost proved to be the most effective method in promoting germination, root development and biomass accumulation in *Tagetes erecta* grown in chromium-contamination conditions.

Conclusions: Our work introduces a dual strategy that integrates a novel chromium-bioremediating consortium with a miniaturized and portable electrochemical tool, for the synergistic reduction of Cr^{6+} contamination with real-time monitoring, while simultaneously supporting the establishment of a hyperaccumulator plant for subsequent phytoextraction and eco-restoration of contaminated soil.

Acknowledgements: *This work was carried out through the PN 23.06 Core Program - ChemNewDeal within the National Plan for Research, Development and Innovation 2022-2027, developed with the support of Ministry of Research, Innovation, and Digitization, project no. PN 23.06.01.01-AQUAMAT.*

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COMPARATIVE ANTIMICROBIAL EFFICACY OF KOMBUCHA-DERIVED VINEGAR AND CONVENTIONAL VINEGAR SOLUTIONS FOR REDUCING POST-HARVEST MICROBIAL CONTAMINATION ON FRESH MARKET APPLES: AN ECO-FRIENDLY DECONTAMINATION APPROACH

Alexandra ENE-MANEA [1,2], Andrei Theodor BELEA [2], Alina ORTAN [1], Irina Elena CHICAN [3],
Daniela IONESCU [2], Mihaela AVRAM [2], Cristina Mihaela LUNTRARU [2],
Justinian-Andrei TOMESCU [2,4*]

[1] *University of Agronomic Sciences and Veterinary Medicine of Bucharest, Bucharest, Romania*

[2]*S.C. Hofigal Import Export S.A., 2 Intrarea Serelor Street, District 4, 042124 Bucharest, Romania*

[3]*INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania*

[4] *Faculty of Chemical Engineering and Biotechnologies, University Politehnica of Bucharest, Romania*

**Corresponding author: andrei.tomescu@hofigal.eu*

Keywords: Food safety, Kombucha, Vinegar, post-harvest decontamination

Introduction: Fresh apples are among the most consumed fruits worldwide due to their nutritional benefits and ease of consumption. Traditional approaches to reduce microbial contamination rely on washing with water, which is the most common household method [1]. Scientific literature highlights kombucha's ability to decontaminate the surface of fruit by significantly reducing microbial load, owing to its robust antimicrobial properties. These properties arise from its complex composition, including organic acids (such as acetic and lactic acid), polyphenols, and enzymes generated during the fermentation process. Studies indicate that these compounds work synergistically, enhancing their effectiveness against harmful bacteria and pathogens. The acidic environment disrupts microbial cell integrity, while polyphenols contribute additional antibacterial and antifungal effects. Consequently, kombucha serves as a natural and efficient agent for surface decontamination, as supported by research [2-3].

Materials and methods: Apples purchased from a local market in Bucharest, Romania, were evaluated for microbial load to assess the decontamination efficacy of kombucha and classic vinegar treatments. The study determined: (1) total aerobic microbial counts, total yeast and mold counts, and bile salt- tolerant bacteria; (2) the presence of selected pathogens, including *Staphylococcus aureus*, *Salmonella* spp., and *Escherichia coli*; and (3) microbial load differences between unwashed apples and those treated with kombucha, classic vinegar, or water washing. Standard microbiological methods were employed for microbial enumeration and pathogen identification. For both kombucha and classic vinegar, pH measurements, total polyphenol content, and antioxidant activity were determined to correlate their chemical properties with antimicrobial efficacy.

Results: The results showed that washing and treatments with kombucha and classic vinegar significantly reduced the microbial load on apples. In contrast, untreated apples exhibited higher total aerobic microbial counts, total yeast and mold counts, and the presence of bile salt-tolerant bacteria, indicating a higher microbial contamination level.

Fig.1. Microbial Load of Apples (TAMC) after 48h **A.** Water-washed apple samples showing reduced total aerobic microbial counts compared to **B.** Unwashed apple samples

Conclusions: In conclusion, apples from the Bucharest market may pose health concerns due to their microbial load, including bile salt-tolerant bacteria. While washing with water reduces microbial contamination, it is not fully effective. Eco-friendly and safe methods may offer a sustainable approach to ensure safer consumption.

Acknowledgements*: This work was financially supported by a grant of the Ministry of Research, Innovation and Digitization – UEFISCDI, project number PN-IV-P7-7.1-PTE-2024-0607.*

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WORMWOOD HYDROLATE UP-REGULATED VEGF SYNTHESIS AND PROTECTED MOUSE ENDOTHELIAL CELLS AGAINST LIPOPOLYSACCHARIDE-INDUCED OXIDATIVE DAMAGE

Alexandra GASPAR-PINTILIESCU [1*], Ana-Maria SECIU-GRAMA [1], Andreea IOSAGEANU [1], Ana-Maria PRELIPCEAN [1], Justinian TOMESCU [2], Viorica COROIU [1], Oana CRACIUNESCU [1]
[1]National Institute of R&D for Biological Sciences, 296, Splaiul Independenței, 060031, Bucharest, Romania
[2]HOFIGAL Export-Import S.A, Bucharest, Romania
**Corresponding author: alexandra.gaspar@incdsb.ro*

Keywords: wormwood polyphenols, cell proliferation, VEGF synthesis, intracellular ROS

Introduction: Hydrolates or hydrosols are underutilized aqueous by-products obtained during the process of extracting essential oils. It has been reported that these distillates contain residual volatiles, such as monoterpene alcohols, aldehydes, ketones, and sesquiterpene alcohols, as well as polyphenols, thus demonstrating potential as sustainable ingredients in cosmetic, food, health or agriculture applications [1,2]. The aim of the present study was to analyze the phenolics composition of *Artemisia absinthium* (wormwood) hydrolate and to investigate its *in vitro* cytocompatibility and biological activity in mouse bEnd.3 endothelial cell culture.

Material and methods: Wormwood hydrolate was obtained through hydrodistillation of wormwood aerial parts and separation from the essential oil (kindly provided by Hofigal Import Export SA). Phenolics composition was assessed by reversed-phase high performance liquid chromatography (RP- HPLC) [3], while volatiles were analyzed by gas-cromatography coupled with mass spectrometry (GC- MS) [2]. *In vitro* cytocompatibility of wormwood hydrolate was evaluated in mouse bEnd.3 endothelial cell line by Neutral Red test [4], while its effect on the vascular endothelial growth factor (VEGF) production was determined in the culture medium using a specific ELISA kit. The intracellular reactive oxygen species (ROS) production was evaluated in a lipopolysaccharide (LPS)-stressed bEnd.3 experimental model using *dichloro-dihydro-fluorescein diacetate* (DCFH-DA), a cell permeant fluorogenic dye, followed by flow cytometry analysis[4].

Results: RP-HPLC analysis showed that wormwood hydrolate contained rosmarinic acid (10.07 mg/g dry weight) and myricetin (7.02 mg/g dry weight) as main polyphenolic compounds. Traces of isoquercetin, p-coumaric acid and kaempferol 7-O-glucoside were also detected and quantified in wormwood hydrolate. GC-MS analysis showed that β-pinene (56.86%) and β-phellandrene (11.69%) belonging to monoterpene hydrocarbons group were the most abundant volatiles. *In vitro* cell culture studies in mouse bEnd.3 endothelial cells showed that wormwood hydrolate increased cell proliferation, reaching values between 109.57% and 122.99%, in the range of concentrations between 25-250 μg/mL. VEGF secretion in the culture medium also increased in a dose-dependent manner and the values were correlated with the cell viability, indicating its angiogenic potential. LPS-stressed cells treated with 50- 250 μg/mL wormwood hydrolate exhibited a significant decrease of the intracellular ROS production, indicating its antioxidant capacity.

Conclusions: The obtained results showed that wormwood hydrolate stimulated the synthesis of the pro-angiogenic factor VEGF and protected bEnd.3 cells against oxidative damage induced by LPS, in relation to its phenolic and volatile contents, suggesting potential uses in health-related applications.

***Acknowledgements**: This work was supported by a grant of the Ministry of Education and Research, CNCS - UEFISCDI, project number PN-III-P1-1.1-PD-2021-0114, within PNCDI 2022-2027 and funded by Program Nucleu, project no. 23020201.*

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"GREEN SOLUTIONS" FOR CULTURAL HERITAGE PROTECTION: A SUSTAINABLE APPROACH THROUGH INTERDISCIPLINARY INNOVATION

Irina FIERASCU [1,2], Anda Maria BAROI [1], Roxana Ioana MATEI [1], Toma FISTOS [1],
Ioana Silvia HOSU [1], Irina Elena CHICAN [1], Cristina ENASCUTA [1], Adriana MOANȚĂ[3],
Radu Claudiu FIERASCU [1,4,5]*

[1]INCDCP-ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania
[2] University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăști Blvd,Romania
[3] CEPROCIM S.A., 6 Preciziei Str., Bucharest, Romania
[4] National University of Science and Technology Politehnica Bucharest, 1-7 Gh. Polizu Str.,Romania
[5] Academy of Romanian Scientists, Ilfov Street 3, Bucharest, Romania
**Corresponding author: fierascu.radu@icechim.ro*

Keywords: "green chemistry", cultural heritage, nanoparticles, metallic oxides, coatings

Introduction: Recent progress in materials science is playing a crucial role in the sustainable preservation of cultural heritage structures by promoting multifunctional and eco-conscious solutions. In recent years, there was a noticeable interest in the search for novel biocidal agents, with most efforts directed toward enhancing human health through new compounds, while comparatively less attention has been given to the protection of culturally significant structures and artifacts. To ensure the continuity of human progress and the authenticity of artifacts and monuments, the preservation and conservation of historic heritage buildings are essential. Structures—especially those exposed directly to the elements—undergo significant weathering, a process now accelerated by rising levels of air pollution. Globally, cultural heritage faces increasing pressure from both environmental factors and tourism, raising critical questions about the most effective strategies for managing and protecting these irreplaceable monuments and archaeological sites from further degradation.

Materials and methods: This paper aims to be a critical review that covers aspects of using new non-conventional solutions (with antibacterial and photocatalytic effect) for cultural heritage protection. Plant extracts, phytosinthesized materials, metallic oxides are some of the topics of this review [1-3]. Also, are presented advantages and limitations of these solutions.

Conclusions: Interdisciplinary studies can play a very important role in protecting and preserving the cultural heritage for future generations. They play a vital role in cultural heritage protection by integrating scientific, environmental, and conservation expertise, where the application of green chemistry principles fosters the development of sustainable, low-toxicity solutions for preserving historic materials and environments.

***Acknowledgements**: This work was supported by the Ministry of Education and Research (Ministry of Research, Innovation and Digitization), CCCDI—UEFISCDI, project number PN-IV-P7-7.1-PED-2024-0286, contract 77 PED/2025, within PNCDI IV and Ministry of Education and Research (Ministry of Research, Innovation and Digitization) through INCDCP-ICECHIM Core program PN 23.06.01.01 (AQUAMAT).*

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VALIDATION OF THE METHOD FOR DETERMINATION OF ZINC, ALUMINUM AND TITANIUM IN POLYOLEFINS PACKAGING BY ICP-OES

Georgeta-Ramona IVAN [1*], Luiza CAPRA [1], Mihaela GANCIAROV [1], Rusandica STOICA [1]
[1]INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania
**Corresponding author:* georgeta.ivan@gmail.com

Keywords: polyolefin, packangings, zinc, aluminium, titanium

Introduction: Polyolefins are materials obtained by the polymerization of ethylene or propylene or by the copolymerization of these substances with up to 25% higher homologues (C4 to C10) or carboxylic acids or esters [1]. Depending on the field of use, these polymers may contain additives to optimize their physical, chemical, and mechanical properties. Polyolefins may contain antioxidants, lubricants, and titanium dioxide as an opacifying agent for light protection [1].

To determine the extractable elements (Al, Zn, and Ti) from polyolefin packaging using inductively coupled plasma optical emission spectrometry (ICP-OES), a validation study was conducted in which the following performance parameters were determined: linearity, detection limit (LD), quantification limit (LQ), repeatability (precision), recovery rate (accuracy), and expanded standard uncertainty, U (k=2).

Materials and methods: In this study, the following were used: Argon 5.0 with a purity of 99,999% (purchased from Messer Romania), standard solution multielement CPA21-100 mg/L (CPAchem Ltd., Bulgary), standard solution multielement CP IV-1000 mg/L (Merck, Germania) and standard solution multielement CP XVI-1000 mg/L (Merck, Germania).

Results: A validation study was conducted for three types of polyolefin packaging: low-density polyethylene (LDPE) bags, bioriented polypropylene (BOPP) bags, and LDPE polyethylene bags with bioriented polypropylene and an aluminum layer, (LDPE+BOPP). The elements were extracted in a 0.1N HCl solution by boiling under reflux for 1 h with continuous stirring. The performance parameter values obtained in the validation study and the proposed acceptance criteria are presented in Table 1.

Table 1. Performance parameters of the method for determining extractable elements (Zn, Al, and Ti)

Performance parameter	**Acceptance criteria**	**Determined values**		
		Zn	Al	Ti
Linearity [2]	r ≥ 0,997	> 0,999	> 0,999	> 0,999
Detection limit, mg/kg	LD ≤ 0,017 mg/kg (Zn, Al) LD ≤ 0,0075 mg/kg (Ti)	0,0029	0,0034	0,0015
Quantification limit, mg/kg	LQ ≤ 0,050 mg/kg (Zn, Al) LQ ≤ 0,025 mg/kg (Ti)	0,0087	0,0103	0,0044
Concentration, mg/kg	-	0,128 – 0,961	0,296 – 142,1	< LQ
Repeatability (precision) [3]	repeatability limit, r (Horwitz)	0,00046 – 0,51	0,00065 – 0,32	0,00048 – 0,26
Recovery rate (accuracy) [3]	80 ≤ R ≤ 110 for C > 0,1 mg/kg	99,92	99,93	100,13
Expanded standard uncertainty (k=2), % [3]	U ≤ 10%	5,9 – 9,4	6,0 – 9,9	5,8
	U ≤ 20% for LC	14,7	19,9	19,7

Conclusions: The method for determining extractable elements (Al, Zn, and Ti) from polyolefin packaging using ICP-OES meets the proposed performance criteria, according to the data presented in Table 1. The studied method can be successfully applied for the quality control of polyolefins packaging.

***Acknowledgements**: "This work was carried out through the PN 23.06 Core Program - ChemNewDeal within the National Plan for Research, Development and Innovation 2022-2027, developed with the support of Ministry of Research, Innovation, and Digitization"*

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ORGANOSOLV EXTRACTION OF LIGNIN FROM SAWDUST AND SPENT MUSHROOM SUBSTRATE

Maria-Antonia TĂNASE [1], Ștefan-Ovidiu DIMA [1], Mălina DESLIU-AVRAM [1], Mihaela GANCIAROV[1], Cristian-Andi NICOLAE [1], Bogdan TRICĂ [1], Victor Alexandru FARAON [1], Diana CONSTANTINESCU-ARUXANDEI [1], Florin OANCEA [1*]

[1]INCDCP-ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania

**Corresponding author: florin.oancea@icechim.ro*

Keywords: FTIR, XRD, SEM, TGA, antioxidant activity

Introduction: Lignin, one of the main components of lignocellulosic biomass, is the largest natural source of aromatic compounds and plays an important part in the transition towards sustainable biorefineries [1]. Despite its abundance, lignin is still undervalued, often regarded as waste. Efficient recovery of lignin is therefore essential to confront its potential use as a renewable feedstock for high- value applications. Organosolv treatment has arose as a promising approach, offering selective lignin extraction with high purity, while supporting the valorization of biomass in an economically viable way [2]. The aim of this study was to extract and characterize lignin from spent *Pleurotus ostreatus* substrate (SPS) in comparison with the lignin extracted from the sawdust used as the substrate for *Pleurotus* growth, using an organosolv approach, after pre-recovery of proteins.

Materials and methods: Sawdust and spent *Pleurotus ostreatus* substrate were treated to extract lignin from biomass. The treatment consisted of three steps: protein extraction (hydrothermally in 0.1 M NaCl), extractible content removal (Soxhlet extraction, toluene: ethanol 2:1 v/v) and lignin extraction (organosolv treatment, 80% ethanol, 5% HCl v/v as catalyst, at 120°C, for one or two hours). Lignin samples were analyzed using infrared spectroscopy (FTIR), elemental analysis, thermogravimetry (TGA/DTA), X-Ray diffraction (XRD) and scanning electron microscopy (SEM). Their antioxidant activity was evaluated using total phenolic content and DPPH assays.

Results: Overall, the results showed that the lignin extraction yields were higher for sawdust samples compared to SPS. FTIR analysis confirmed the presence of characteristic lignin vibrational bands, including C=O stretching at 1720 cm^{-1}, attributed to β-O-4 linkages, and bands in the 1595–1425 cm^{-1} range, common for aromatic units within the lignin structure [3]. A comparison of FTIR spectra before and after organosolv treatment revealed a decrease in lignin-associated bands and an increase in cellulose-associated bands, indicating lignin removal. Elemental analysis further demonstrated the absence of nitrogen pollutants in all samples, while the estimated degree of unsaturation greater than 4 confirmed the presence of aromatic units and unsaturated substituents [4]. Thermal stability tests showed that the samples remained stable at moderate temperatures, with the main degradation occurring above 300 °C. XRD analysis is consistent to those found in literature [5]. SEM micrographs demonstrated irregular shapes and a polydisperse size distribution. The highest phenolic content was obtained from lignin extracted from sawdust using a 2-hour hydroalcoholic treatment, whereas the highest antioxidant activity, as measured by the DPPH assay, was observed in lignin from sawdust subjected to a 1-hour treatment.

Conclusions: In conclusion, organosolv treatment enabled the recovery of lignin from both sawdust and SPS, all lignin samples showing characteristic aromatic structures, good thermal stability, and absence of nitrogen pollutants, having iregular shapes and a polydisperse size distribution. Although yields were lower than for sawdust, SPS lignin remains a valuable product from an undervalued by-product, supporting its potential in sustainable applications.

Acknowledgements*: This research was funded by the Ministry of Education and Research, project PN 23.06.02.01 InteGral, Nucleu Program.*

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ANTIOXIDANT PEPTIDES FROM RHIZOSTOMA PULMO JELLYFISH FOR BIOMEDICAL APPLICATIONS

Elena MIHAI [1*], Alexandra GASPAR-PINTILIESCU [1], Bogdan NEGREANU-PIRJOL [2], Rodica TATIA [1], Ticuta NEGREANU-PIRJOL [2,3], Oana CRACIUNESCU [1]

[1] National Institute of R&D for Biological Sciences, 296 Splaiul Independenței, Bucharest 060031, Romania

[2] University 'Ovidius' of Constanta, Faculty of Pharmacy, 6 Cpt. Av. Al. Serbanescu Str., Constanta, Romania

[3] Academy of Romanian Scientists, 3 Ilfov Str., Bucharest, Romania

**Corresponding author: elena.mihai@incdsb.ro*

Keywords: bioactive peptides, marine compounds, jellyfish, electrophoresis, antioxidant activity, cytotoxicity

Introduction: *R. pulmo* jellyfish represents an underutilized source of marine invertebrates that can be sustainable exploited for the development of blue economy and control of Black Sea ecosystem, as it is an invasive species [1]. The aim of this study was to obtain and preliminary characterize novel bioactive peptides from the mesoglea of *R. pulmo* jellyfish of interest as valuable ingredients for biomedical applications.

Material and methods: The mesoglea of *R. pulmo* from Black Sea was washed, minced and subjected to ultrasound-assisted extraction in alkaline buffer, enzymatic hydrolysis in the presence of alcalase and papain, respectively, followed by centrifugal ultrafiltration to separate 3 peptide fractions with MW>10 kDa, MW between 3-10 kDa and MW<3 kDa. Electrophoresis of enzymatic extracts and peptide fractions was carried out in vertical gradient tricine-SDS gel of 10–20% by Schagger method [2], in the presence of a MW standard of 14-212 kDa. Their antioxidant activity was determined using TEAC, DPPH and FRAP methods [3]. *In vitro* cytocompatibility was evaluated in L929 fibroblast cell line using direct contact method [4], according to the international standard ISO 10993-5/2009 for medical devices.

Results: The electrophoretic migration pattern showed that the protein bands of the retentate obtained through MW cutoff of 10 kDa from alcalase hydrolysate were in the range of 12-20 kDa, while the permeate with MW between 3-10 kDa and peptide fraction with MW<3 kDa did not show visible bands within the standard MW range, indicating efficient hydrolysis and centrifugal ultrafiltration process. In turn, the retentate obtained through MW cutoff of 10 kDa from papain hydrolysate presented large polypeptides in the range of 16-100 kDa, while the bands of permeate were in the range of 10-30 kDa with an intense band at 22 kDa, indicating lower proteolytic capacity of papain on jellyfish mesoglea. The alcalase hydrolysate had moderate antioxidant activity defined by the following values: 2.84 mM Trolox equiv/g, DPPH IC_{50} of 1.84 mg/mL, and FRAP of 0.94 mM/g. However, these values were superior to those recorded for papain hydrolysate. Among the separated peptide fractions, alcalase- treated fraction with MW<3 kDa showed the highest antioxidant activity (10.73 mM TE/g). In terms of *in vitro* biocompatibility, both alcalase and papain jellyfish hydrolysates presented good cytocompatibility in L929 fibroblasts within a wide range of concentrations 0.047 – 3 mg/mL (Fig. 1). In addition, alcalase hydrolysate significantly ($p<0.05$) stimulated cell proliferation up to 105-135% at 0.047-1.5 mg/mL, while papain hydrolysate induced a significant increase ($p<0.05$) up to 120-160% at 0.047 – 0.187 mg/mL, after 24 h of cultivation.

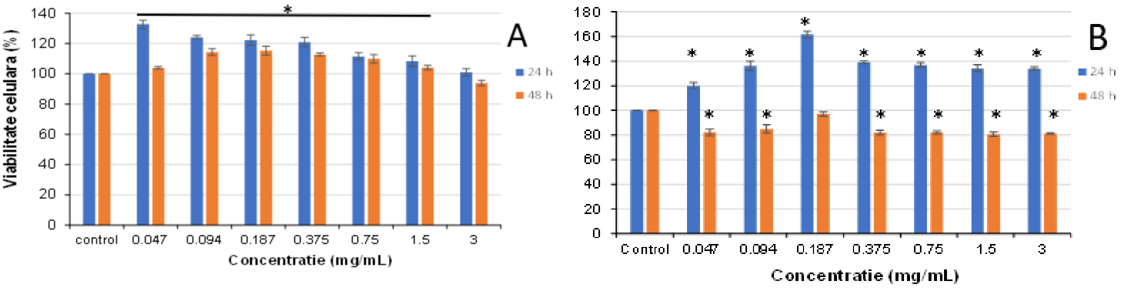

Fig. 1. Cell viability of L929 fibroblasts cultivated in the presence of *R. pulmo* jellyfish extracts for 24 h. *$p<0.05$

Conclusions: All these results indicated the bioactivity of *R. pulmo* jellyfish protein hydrolysates, their potential to scavenge free radicals, to stimulate fibroblast metabolism and extracellular matrix synthesis for accelerating the wound healing process. Future studies will establish structure-activity correlations by peptide sequence analysis, in view of novel and optimized antioxidant compounds for skin photoprotection and repair.

***Acknowledgements**: This work was supported by the Ministry of Education and Research, Program Nucleu, project no. 23020201.*

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APPLICATIONS OF LIPOSOMES IN THE FOOD INDUSTRY

Diana PASARIN [1*], Catalin BILBIE [2], Luciana PALADA-PARASCHIV [2],
Cristina Emanuela ENASCUTA [1], Catalin-Bogdan MATEI [1], Andra-Ionela GHIZDAREANU [1]
[1]INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania
[2]Expergo Business Network SRL, 256G Bulevardul Basarabia, district 3, Romania
**Corresponding author: diana.pasarin@icechim.ro*

Keywords: bioactive compounds, liposomes, food industry

Introduction:Liposomes, versatile nanometric structures composed of phospholipid bilayers, represent efficient vehicles for the encapsulation, protection, and controlled release of sensitive bioactive compounds. Within the EUREKA project no. FI 14299 (contract 252/2021), the research focused on the development of functional food products with superior organoleptic properties, which integrate extracts from germinated seeds encapsulated in liposomal systems, microencapsulated grape seed oil, and grape seed flour.

Materials and methods:The elaborated technological process involves the preparation of liposomes by homogenizing the phases at 5000-12000 rpm for 10-30 minutes, followed by ultrasound treatment, the addition of the cryoprotectant trehalose (7-8%), and lyophilization of the final solution. The obtained lyophilized powder remains stable for 18 months when stored at -20°C in vacuum-sealed bags. The advantages of the developed technology are significant: improved intestinal absorption, increased bioavailability of the encapsulated bioactive substances, protection and controlled release of the sensitive active ingredients, as well as extending the shelf life of the extracts. The resulting liposomal composition can be incorporated into both dry or liquid food matrices, meeting the nutritional and energy requirements of modern consumers concerned with healthy eating.

Conclusions: The research results led to the filing of a patent application with the registration number A00078/15.02.2023, which protects both the liposomal composition containing extracts from germinated seeds rich in biologically active compounds, as well as its preparation process.

The technology of encapsulating extracts from germinated seeds of red clover and amaranth in liposomes represents a promising solution for the food industry, offering an efficient method of valorizing bioactive compounds from plant sources. Through the improved stability and increased bioavailability of the functional ingredients, this approach meets the increasingly demanding requirements of consumers for foods that combine nutritional qualities with sensory ones.

***Acknowledgements**: This work was supported by a grant of the Romanian Ministry of Research and Innovation, CCCDI- UEFISCDI, project number PN-III-P3-3.5-EUK-2019-0169, within PNCDI III. This work was carried out through the PN 23.06 Core Program - ChemNewDeal within the National Plan for Research, Development, and Innovation 2022-2027, developed with the support of Ministry of Research, Innovation, and Digitization, project no. PN 23.06.01.01", AQUAMAT.*

ADVANCED ULTRASOUND-ASSISTED EXTRACTION OF BIOACTIVE COMPOUNDS FROM BEE PRODUCTS

Cristina Emanuela ENASCUTA [1], Elena-Emilia SIRBU [1,2*], Irina FIERASCU [1], Diana PASARIN [1], Raluca SENIN [1], Ioana Raluca SUICA-BUNGHEZ [1], Grigore PSENOVSCHI [1], Manuel DRUGULESCU [3], Radu Claudiu FIERASCU [1], Vasile LAVRIC [4]

[1] INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania
[2] Chemistry Department, Petroleum-Gas University of Ploiesti, Bucharest Blvd. 39, 100680 Ploiesti, Romania
[3] ACTIV CPC&I SRL, 116 Calea 13 Septembrie, District 5, Bucharest, Romania
[4] Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA Bucharest, Romania

**Corresponding author: oprescuemilia@gmail.com*

Keywords: bee products, bioactive compounds, ultrasound-assisted extraction

Introduction: Bee products such as propolis, beeswax, royal jelly, and bee pollen are rich sources of bioactive compounds with antioxidant, antimicrobial, and anti-inflammatory properties. Efficient extraction of these compounds is essential for their application in food, pharmaceutical, and cosmetic industries. Ultrasound-assisted extraction (UAE) is an advanced, green technology that enhances yield, reduces extraction time, and preserves the integrity of thermolabile compounds. The aim of this paper is to explore the optimization and advantages of UAE in extracting valuable bioactives from bee-derived materials, highlighting its potential as a sustainable alternative to conventional methods.

Materials and methods Beeswax, honeycomb, and bee pollen were obtained from a local beekeeper in Bacău, Romania. Ethanol (98%) and ethyl acetate (99.5%) were purchased from Chimreactiv, Romania. Hexane (purity 98%) was purchased from Scharlau, Germany. All reagents used, such as 2,2-diphenyl-1- picrylhydrazyl (DPPH), Folin-Ciocalteu reagent, gallic acid, and sodium carbonate, were purchased from Sigma-Aldrich, Germany. UAE was performed using a high-power ultrasonic bath with 160W nominal power and 35 kHz frequency (Sonorex DigiPlus DL 255 H, Bandelin Electronic GmbH & Co. KG, Berlin, Germany) coupled with a compact recirculating cooler (IKA RC 2 lite, IKAWorks GmbH & Co, Staufen, Germany). The collected solvents fractions were evaporated on a rotary vacuum evaporator (DLAB RE100-Pro, Amex, Romania). The distribution of fatty acid ethyl esters (FAEEs), essential oils was found using a GC–MS system (CLARUS 500, Perkin Elmer, Shelton, WA, USA), the total phenolic and flavonoid content were determined using the spectrophotometric method (Ultra 3600 Rigol).

Conclusions: This study demonstrated that beeswax, pollen and honeycomb are a good source of antioxidants, as proven by its high antioxidant activity. Regarding antioxidant activity, the best results were obtained in the case of pollen using 98% ethanol as the extraction solvent and the ultrasound field as the extraction method.

Experimental results showed that total polyphenolic compounds were extracted very well at room temperature, at an ultrasound power of 100%, extraction time of 30 minutes. In contrast, classical extraction (maceration), is more suitable for obtaining flavonoids but requires a much longer extraction time (24 hours at least). Ethanol seems to be the best extraction solvent for both phenolic compounds and flavonoids while hexane is suitable for obtaining fatty acids, essential oils or fatty alcohols. Also, bioactive compounds in pollen have a strong potential to be commercialized in the form of microcapsules in both the food and pharmaceutical industries due to its potential health benefits.

***Acknowledgements**: This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CCCDI - UEFISCDI, project number PN-IV-P7-7.1-PED-2024-0973, within PNCDI IV. Also, this work was carried out through the PN 23.06 Core Program - ChemNewDeal within the National Plan for Research, Development and Innovation 2022-2027, developed with the support of Ministry of Research, Innovation, and Digitization, project no. PN 23.06.01.01", AQUAMAT.*

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ENHANCED GROWTH OF CHLORELLA SOROKINIANA BY LIGNOSULFONATE SUPPLEMENTATION

Daria Gabriela POPA[1,2], Oana Andreea CHEOAFĂ [1], Diana CONSTANTINESCU-ARUXANDEI [1], Florin OANCEA [1,2*]
[1]INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, 1st district, Romania
**Corresponding author: florin.oancea@icechim.ro*

Keywords: microalgae biostimulant, biomass, optical density, cell density, pigments

Introduction: Lignosulfonates are by-products of the sulfite pulping process, known for their binding and chelating properties, being utilized in various industrial applications, including agriculture [1]. Lignosulfonates have recently gained interest for their potential to stimulate the microalgae growth [2-4], and biomass yield. These substances can improve nutrient uptake, enhance photosynthetic efficiency, and increase microalgae cultures biomass production. There is not much available information about the effect of lignosulfonates on *Chlorella sorokiniana*, which represents the scope of this study.

Materials and methods: A fresh culture of *C. sorokiniana (*NIVA-CHL 176*)* was grown in Z8 media in the presence of four concentrations of lignosulfonate, 1 mg/L (Lc1), 10 mg/L (Lc2), 50 mg/L (Lc3), and 500 mg/L (Lc4), respectively. The microalgae cultures were kept under controlled conditions of temperature (25 ± 1°C) and light (130 µmol/m^2 ·s white light). The microalgae growth was determined by measuring the main growth parameters: optical densities, biomass quantities and pigment concentrations (Chlorophyll A, Chlorophyll B, carotenoids), during a 12 day cultivation period.

Results: On day 12, the biomass accumulation (Fig.1) was higher in all treatments compared to control. The highest increase was observed for Lc3, which exceeded the control by 21%, followed closely by Lc2 with 20% and Lc4 with 14% enhancement. The optical density was higher under the treatments, e.g., for variant Lc3 16% higher than control, for Lc2 an increase of 13% compared with control. Extracted pigments like carotenoids increased by 41% in Lc3 and by 30% in Lc2.

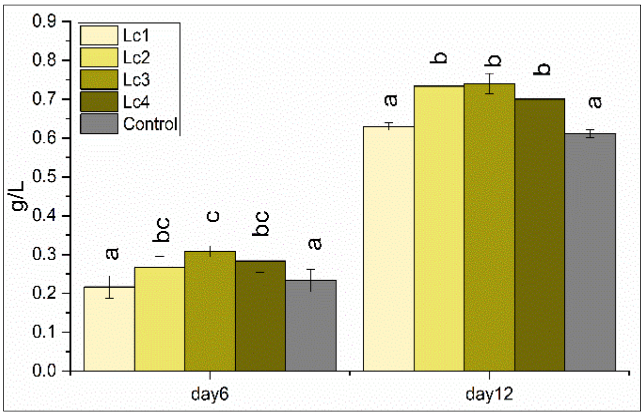

Fig. 1 Biomass production of *C. sorokiniana* cultures. Lc1 – 1 mg/L, Lc2 – 10 mg/L, Lc3 – 50 mg/L, Lc4 – 500 mg/L, Control – Z8

Conclusions: The treatments with lignosulfonate improved *C. sorokiniana* cultures in biomass production, culture density, and pigment accumulation compared with control, with the strongest and most consistent effects observed at 50 mg/L lignosulfonate concentration.

Acknowledgements*: This research was funded by the Ministry of Education and Research, project PN 23.06.02.01 InteGral, Nucleu Program.*

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CAN THE MICROORGANISMS USED IN SUSTAINABLE AGRICULTURE ENSURE THE BIOREMEDIATION OF HEAVY METAL EFFLUENTS?

Nicoleta RADU[1,2*], Mihaela BOTEA[2,3], Mariana CONSTANTIN [1], Iuliana RAUT [1]
[1]*INCDCP-ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania*
[2]*USAMV Bucharest, 59 Marasti Boulevard, district 1, Romania*
[3]*ICDPP Bucharest, 9 Ion Ionescu de la Brad Bulevard, district 1, Romania*
**Corresponding author:* nicolbiotec@yahoo.com

Keywords: bioremediation, heavy metals, microorganisms

Introduction: Effluents containing heavy metals, generated from industrial activities and intended for discharge into natural water bodies, must comply with specific quality standards. Quality standards imposed by the World Health Organization (WHO), the Environmental Protection Agency (EPA), or Romanian regulations (NTPA001) establish strict limits regarding the maximum permissible concentrations of heavy metal cations. In this context, bioremediation processes carried out using microorganisms can ensure compliance with quality parameters for certain species of metallic cations present in aqueous systems [1-5].

Materials and Methods: Multicomponent aqueous systems, named AS1 and AS2 which contain metal cations Fe, Ni, Cd, Pb, Mn, and Zn in concentrations situated below 50 mg/L, were employed in bioremediation processes performed in batch, under normal conditions for 670 hours. Two *Trichoderma* species, designated *Trichoderma sp. 1* and *Trichoderma sp. 2,* isolated from heavy metal-contaminated sites, were used in the bioremediation studies. The aqueous solutions containing heavy metal cations were inoculated with one species of Trichoderma each. After 670 hours, samples were collected and analysed by ICP-AES methodology.

Results: The results obtained after measurements showed that *Trichoderma sp*. 1 was capable of removing cadmium and lead ions from the aqueous systems, up to the concentrations below 0.02 mg/L and 0.24 mg/L, respectively. Regarding zinc and nickel ions, these were efficiently removed from the aqueous systems by *Trichoderma* sp. 2, up to the concentrations of 0.46 mg/L and 0.45 mg/L, respectively.

Conclusions: The results obtained from the studies performed in studies on multicomponent aqueous systems and two species *Trichoderma* genus, isolated from polluted sites, indicate that these species can be used to treat aqueous effluents containing heavy metal ions such as Cd, Pb, Ni, and Zn. Specifically, cadmium and lead ions are efficiently removed from aqueous systems by *Trichoderma sp. 1*, whereas zinc and nickel ions are effectively removed by *Trichoderma sp. 2.* The resulting effluents comply with the quality standards set by NTPA 001 regarding the maximum allowable concentrations of Cd, Zn, Ni, and Pb ions for discharging in natural receptors.

***Acknowledgements**:* This work was carried out through the PN 23.06 Core Program-ChemNewDeal within the National Plan for Research, Development and Innovation 2022–2027, developed with the support of the Ministry of Research, Innovation, and Digitization, project no. PN 23.06.01.01 (AQUAMAT). Also, this research was funded by ADER project no 5.1.6/17.07.2023.

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FROM WASTE TO PROTECTION: CIRCULAR STRATEGIES FOR SUSTAINABLE MAP CULTIVATION

Anda Maria BAROI [1], Daniela IONESCU [2], Irina FIERASCU [1,3], Cristina Emanuela ENASCUTA [1], Justinian-Andrei TOMESCU [2], Stefan BUHAEV [2], Cristina Mihaela LUNTRARU [2], Roxana Ioana MATEI [1], Toma FISTOS [1], Ioana Silvia HOSU [1], Irina Elena CHICAN [1], Radu Claudiu FIERASCU [1,4,5*]

[1]INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania
[2] HOFIGAL EXPORT IMPORT S.A. 2 Intr. Serelor, Bucharest, Romania
[3] University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăști Blvd, Romania
[4] National University of Science and Technology POLITEHNICA Bucharest, 1-7 Gh. Polizu Str., Romania
[5] Academy of Romanian Scientists, Ilfov Street 3, Bucharest, Romania
**Corresponding author: fierascu.radu@icechim.ro*

Keywords: medicinal and aromatic plant, agriculture, nanoparticles, crop protection, waste

Introduction: The sustainable cultivation of medicinal and aromatic plants (MAPs) faces growing challenges due to environmental stressors, pests, and the need for eco-friendly agricultural practices. Medicinal and aromatic plants (MAPs) are valued not only for their therapeutic and aromatic properties, but also for their significant economic and ecological roles in sustainableagriculture.

Materials and methods: This study is a critical review regarding circular approach to MAP crop protection by valorizing plant waste—often considered an underutilized by-product—into bioactive tools that enhance the resilience of the same crop. Specifically, post-harvest residues such as leaves, stems, or spent biomass from essential oil extraction are processed to extract phytochemicals with antimicrobial and biostimulant properties. These natural compounds are then formulated into green protective agents (e.g., biopesticides, foliar sprays, or soil amendments) and re-applied to the crop, contributing to reduced chemical input and improved plant health. This integrated model not only supports crop protection in a closed-loop system, but also aligns with circular economy and green chemistry principles by minimizing waste and maximizing resource efficiency. The findings demonstrate the potential of intra-crop recycling strategies to foster sustainable MAP production, reduce environmental impact, and add economic value to agricultural residues[1-3]. Also, are presented advantages and limitations of these solutions.

Conclusions: The study highlights the promising potential of a circular approach in the sustainable management of medicinal and aromatic plant (MAP) crops by transforming plant waste into protective tools for the same crop system. The valorization of post-harvest residues—rich in bioactive compounds—into biopesticides, biostimulants, or soil enhancers demonstrates a dual benefit: reducing reliance on synthetic agrochemicals and minimizing biomass waste. Such an intra-crop recycling strategy contributes not only to enhanced plant health and productivity but also to improved environmental outcomes through reduced inputs, emissions, and soil contamination. Moreover, this closed-loop model supports the core principles of green chemistry and circular economy by promoting the full utilization of natural resources within agricultural systems. As global interest grows in sustainable and regenerative farming, the integration of crop-specific waste valorization into protection practices represents a scalable and eco-innovative pathway for the future of MAP cultivation. Continued research and optimization—particularly in standardizing extraction, formulation, and application—will be essential for broad adoption and commercial viability.

***Acknowledgements**: This work was supported by the Ministry of Research, Innovation and Digitization (Ministry of Education and Research, National Authority for Research), CCCDI—UEFISCDI, project number PN-IV-P7-7.1-PED-2024-0318, contract 85PED/2025, within PNCDI IV and Ministry of Research, Innovation and Digitization (Ministry of Education and Research, National Authority for Research) through INCDCP-ICECHIM Core program PN 23.06.01.01 (AQUAMAT).*

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EXPLORING MICROBIAL STRATEGIES FOR PHENOL BIODEGRADATION IN CONTAMINATED ENVIRONMENTS

Iuliana RĂUT [1*], Lucian-Gabriel ZAMFIR [1], Cristina FIRINCĂ [1,2], Mariana CONSTANTIN [1,3], Luiza JECU [1], Ana-Maria GURBAN [1]
[1]INCDCP-ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania
[2]University of Bucharest, Faculty of Biology, Bucharest, Romania
[3]Faculty of Pharmacy, Titu Maiorescu University, Bucharest, Romania
**Corresponding author: raut.iuliana@icechim.ro*

Keywords: phenol, biodegradation, emerging contaminants, microorganisms

Introduction: Urbanization and industrialization have significantly contributed to the degradation of water quality, with domestic, industrial, and agricultural discharges introducing pollutants such as phenolic compounds, pharmaceuticals, and pesticides into surface and groundwater. Phenol, widely used in various industries, poses serious risks to human health and ecosystems even at low concentrations. While several remediation methods exist, biological treatments—particularly microbial degradation—are among the most effective, eco-friendly, and practical solutions, especially for low phenol levels in water, as certain bacterial strains can efficiently utilize volatile organic compounds (VOCs) as substrates [1–3].

Materials and methods: Given the toxic potential of phenol and its negative environmental impact, this study focused on selecting a bacterial strain capable of growing and utilizing phenol as the sole source of carbon and energy. Six bacterial strains (e.g. *Bacillus subtilis, Bacillus amyloliquefaciens, Bacillus licheniformis, Bacillus megaterium, Bacillus pumilus, Pseudomonas putida)* from the Microbiology Laboratory's Microorganism Collection at the ICECHIM Research Institute were tested. The following aspects were considered: (a) ability of the microbial strains to utilize phenolic compounds from solid culture medium [1]; (b) microbial growth kinetics in liquid medium supplemented with phenol [1,4]; and (c) assessment of the phenol degradation by using 4-aminoantipyrine (4 APP) based spectrophotometric method [4].

Results: (a) All bacterial strains showed good growth on solid minimal medium supplemented with phenol as the sole source of carbon and energy. The lowest bacterial growth was observed in *B. pumilus* at a phenol concentration of 200 mg/L. (b) The bacteria cultivated in liquid minimal medium containing phenol exhibited growth comparable to that of the control group (bacteria grown in phenol-free medium), demonstrating that the strains were capable of growing and developing by utilizing phenol as the sole source of carbon and energy. During the logarithmic phase, bacterial growth was at its highest rate. (c) The most significant decrease in phenol concentration was recorded for the *B. licheniformis* strain, with a reduction of 28.17%, followed by *B. pumilus*, *B. subtilis*, *B. amyloliquefaciens*, and *B. megaterium*.

Conclusions: Among the strains analyzed in this study, *B. licheniformis* proved to be the most efficient in phenol degradation. Furthermore, additional research is needed to optimize the 4 APP method, as certain interferences were observed that may have affected the accuracy of the obtained values. This is consistent with the literature, which also reports that this technique may be susceptible to such interferences.

Acknowledgements: The work was supported by a grant of the Ministry of Research, Innovation and Digitization, CCCDI - UEFISCDI, through projects number PN23.06.01.01-AQUAMAT and within PN-IV-P7-7.1-PED-2024-1277-SafeBioChain.

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EVALUATION OF THE ANTIMICROBIAL POTENTIAL OF BIOSURFACTANT PRODUCED BY *PSEUDOMONAS PUTIDA* STRAIN

Roxana-Mădălina STOICA [1*], Nicoleta ENE [1]

[1]*National Institute for Chemical-Pharmaceutical Research and Development-ICCF, 112 Vitan Avenue, Bucharest, Romania*

**Corresponding author: roxym_stoica@yahoo.com*

Keywords: biosurfactant, Pseudomonas putida, antibacterial activity, Bacillus cereus strain

Introduction: Biosurfactants represent an important class of surface-active agents synthesized by microorganisms, with multiple industrial applications. Among their most valuable properties, the antimicrobial activity has gained increasing interest due to the potential role of biosurfactants as natural alternatives to synthetic antimicrobial agents [1,2]. In this context, the antibacterial activity of the biosurfactant produced by *Pseudomonas putida* strain against *Bacillus cereus* wasevaluated.

Materials and methods: Biological material - *Pseudomonas putida* ICCF 391. Culture media: the strain was grown on liquid medium with the following composition % (v/v): glycerol 3.0 and waste cooking oil 2.0 as carbon sources; yeast extract 1.0 and bacto-peptone 1.0 as nitrogen sources, and KH_2PO_4 0.2 as mineral salts. Bioprocess conditions: 30ºC, initial pH 6.5-7.0, 72 h, 220 rpm, and inoculation volume 10%. The biosurfactant obtained was tested for antibacterial activity using the wells method against *Bacillus cereus* strain. Experiments were performed in triplicate.

Results: The biosurfactant produced by *Pseudomonas putida* displayed significant antibacterial activity against *Bacillus cereus*, with an inhibition zone of 29 mm. These results highlight its strong antimicrobial potential and suggest possible applications in the pharmaceutical and food industries as a natural antimicrobial agent.

Conclusions: The biosurfactant synthesized by *Pseudomonas putida* showed strong antibacterial effect against the test pathogen, supporting its potential as an efficient bioactive compound for industrial and biomedical applications.

Acknowledgments*: This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CCCDI- UEFISCDI, project number PN-III-P2-2.1-PED-2021-3528/731PED-2022 within PNCDI III.*

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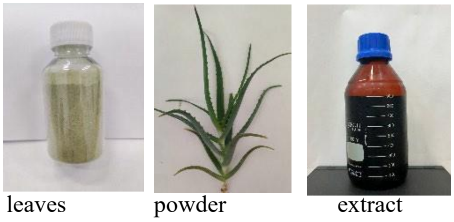
EVALUATION OF PHYTOCHEMICAL COMPOUNDS AND ANTIOXIDANT ACTIVITY OF ALOE ARBORESCENS

Cătălina ȘTEFAN [1], Raluca ȘUICĂ-BUNGHEZ [1*], Mihaela GANCIAROV [1], Raluca SENIN [1],
Luiza CAPRA [1], Georgeta IVAN [1], Rusăndica STOICA [1*]
[1]National Institute for Research & Development in Chemistry and Petrochemistry ICECHIM Bucharest,
202 Splaiul Independenței, 6th district, 060021 Romania
**Corresponding author: raluca.bunghez@icechim.ro; rusandica.stoica@icechim.ro*

Keywords: Aloe arborescens, antioxidant activity, phytochemical properties, UV-VIS, GC-MS

Introduction: *Aloe Arborescens* species is used for medicinal and ornamental purposes. The phytochemical profile could be assigned to various bioactive compounds such as polysaccharides, proteins, water and fat-soluble vitamins, fatty acids, phenolic compounds, organic acids and minerals[1], which are being used in the cosmetic and pharmaceutical industries. The composition of *Aloe Arborescens* (Figure 1) was analyzed and described in the present study.



leaves powder extract

Fig. 1. *Aloe Arborescens* plant

Materials and methods: *Aloe Arborescens* lyophilized powder was characterized by FTIR, TGA, elemental analysis (C, H, N, O). The aloe powder was extracted using 40-60 % (v/v) ethanolic solvent (Merck) by the ultrasound-assisted extraction (UAE) method at room temperature. The GC-MS method was used for fatty acid identification. The UV–VIS technique was applied to determine the total polyphenols content (λ=765 nm), total flavonoids content (λ=510 nm) and antioxidant activity (λ=517 nm, DPPH method) of the obtained extracts.

Results: Moisture, crude protein and ash content were determined from aloe powder. The compounds identified by FTIR were: phenolic compounds (phenolic acids, flavonoids and anthraquinones)[2]. The extracts were evaluated through total phenolic content — TPC with values between 9.9-14.7 mg/g gallic acid equivalent and total flavonoid content — TFC between 2.6-5.9 mg/g catechin equivalent. The antioxidant activity of *Aloe Arborescens* leaves extracts varied from 3.4 to 6.9 mg/g Trolox equivalent, demonstrating a good scavenging capacity for free radicals[3]. The results obtained were comparable with those mentioned in the various studies[4,5]. The best extraction system was obtained for 40 % (v/v) ethanolic extract in the presence of citric acid, which is now the subject of a stability study.

Conclusions: The results of this study indicate that *Aloe Arborescens* leaves are an important source of bioactive compounds with good antioxidant activity and high values of total polyphenols and flavonoids content.

Acknowledgements*: This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CCCDI - UEFISCDI, project number PN-IV-P7-7.1-PTE-2024-0749, within PNCDI IV and by Nucleu Program, project PN 23.06 Core Program - ChemNewDeal within the National Plan for Research, Development and Innovation 2022-2027, developed with the support of Ministry of Research, Innovation, and Digitization, project no. PN 23.06.01.01 AQUAMAT and PN 23.06.02.01 InteGral.*

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CLEAN & GREEN: INNOVATIVE SOLUTIONS FOR FRESH PRODUCE IN A SUSTAINABLE FOOD CHAIN

Anda Maria BAROI [1], Irina Elena CHICAN[1], Daniela IONESCU[2], Alina Ruxandra Eugenia ORŢAN[3], Radu Claudiu FIERĂSCU [1,4,5*], Justinian – Andrei TOMESCU[2], Carmen Laura CÎMPEANU[3]

[1]INCDCP-ICECHIM Bucharest, 202 Spl. Independentei, 6th district, Romania
[2]HOFIGAL EXPORT IMPORT SA
[3] University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, Romania
[4] National University of Science and Technology Politehnica Bucharest, 1-7 Gh. Polizu Str., Romania
[5] Academy of Romanian Scientists, Ilfov Street 3, Bucharest, Romania
**Corresponding author: irina-elena.chican@icechim.ro*

Keywords: "green chemistry"; ecological solutions; fruits; vegetables; surfactants

Introduction: Consumers increasingly demand fresh produce that is free from harmful pesticide residues, while also expecting methods of cleaning that are safe, environmentally sustainable, and non-toxic. Traditional washing agents and disinfectants often rely on synthetic chemicals, which may leave residues, damage produce tissues, or have negative environmental impacts. Recent research has focused on the development of green formulations that use biodegradable, low-toxicity surfactants, natural antimicrobial agents, and responsive ("smart") behaviors—to more effectively and safely remove contaminants from fruits and vegetables.

Materials and methods: This paper aims to be a critical review that covers aspects regarding reducing microbial load and pesticide residue, while preserving quality during postharvest handling using different innovative approaches [1-2]. Also, are presented advantages and limitations of these solutions.

Conclusions: The development of green formulations for cleaning fruits and vegetables represents a significant step toward safer food practices and more sustainable postharvest handling. Research from recent studies highlights the potential of biodegradable surfactants, plant-based antimicrobials, and innovative solvents, to effectively reduce pesticide residues and microbial contamination without harming produce quality or the environment. These eco-friendly alternatives align closely with the principles of green chemistry, promoting human health, environmental safety, and resource efficiency. Continued interdisciplinary research and standardization of testing methods will be essential to support their broader adoption in both household and industrial applications.

***Acknowledgements**: This work was supported by the Ministry of Education and Research (Ministry of Research, Innovation and Digitization), CCCDI—UEFISCDI, project number PN-IV-P7-7.1-PTE-2024-0607, contract 57 PTE/2025, within PNCDI IV and Ministry of Education and Research (Ministry of Research, Innovation and Digitization) through INCDCP-ICECHIM Core program PN 23.06.01.01 (AQUAMAT).*

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MUCOADHESIVE HYDROGELS BASED ON BACTERIAL CELLULOSE FROM KOMBUCHA FERMENTATION AND VEGETAL CELLULOSE FROM BREWER'S SPENT GRAINS

Naomi TRITEAN [1,2#], Ioana POPA-TUDOR [1#], Ștefan-Ovidiu DIMA [1], Bogdan TRICĂ [1], Marius GHIUREA [1], Anisoara CIMPEAN [2], Florin OANCEA [1*], Diana CONSTANTINESCU-ARUXANDEI [1*]

[1]INCDCP ICECHIM Bucharest, 202 Splaiul Independenței, district 6, 060021 Romania
[2]Faculty of Biology, University of Bucharest, 91-95 Splaiul Independenței, R-050095 Bucharest, Romania
**Corresponding author: florin.oancea@icechim.ro, diana.constantinescu@icechim.ro;*
[#] These authors contributed equally to this work.

Keywords: nanoformulation, nanocellulose, cytocompatible, antioxidant, human gingival fibroblast

Introduction: Cellulose nanofibers represent a promising biomaterial for several applications due to their remarkable physico-chemical and biological properties. Bacterial (nano)cellulose produced through Kombucha fermentation, i.e., using a symbiotic culture of bacteria and yeast (SCOBY), has a higher purity and water holding capacity compared to plant (nano)cellulose, as well as increased mechanical and chemical stability [1, 2]. On the other hand, plant (nano)cellulose has been shown to be more active against several pathogenic bacteria and to have higher antioxidant activity [2, 3]. The aim of this study was to compare bacterial with vegetal nanocellulose-based hydrogels in order to select the nanoformulation with the highest bioactive potential for different biomedical applications [4].

Materials and methods: Bacterial cellulose was obtained from Kombucha fermentation, and vegetal cellulose was synthesized from brewer's spent grains (BSG). Bacterial and vegetal nanocellulose were produced through chemical and mechanical purification processes. In order to obtain the hydrogel nanoformulations based on bacterial (BNC) and vegetal (VNC) nanocellulose, the nanocellulose suspensions were concentrated up to a concentration of 0.4% dry weight (w/v). The hydrogel nanoformulations were characterized by Transmission- and Scanning Electron Microscopy (TEM, SEM), X-Ray Diffraction (XRD), Fourier-Transform Infrared Spectroscopy (FTIR), rheology. The mucin binding efficiency was assessed using the periodic acid-Schiff (PAS) method. The surface tension and the contact angle were also investigated. The antioxidant activity was determined by DPPH and Potassium Ferricyanide Reducing Power (PFRAP) assays. The cytocompatibility was investigated using human gingival fibroblasts (HGF-1, ATCC CRL-2014) by combining Cell Counting Kit-8 (CCK-8) and LIVE/DEAD assays. The cell morphology was analyzed by fluorescent labeling of cytoskeletal actin and nuclei. The diffusimetric method was used in order to assess the antibacterial activity using the following bacterial strains: *Bacillus cereus* NCTC 10320, *Enterococcus faecalis* ATCC 29212, *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922, and *Serratia marcescens* NCTC 10211.

Results: TEM and SEM analyses indicated that BNC hydrogel has a mesh-like structure, with longer cellulose fibers in comparison with VNC. The crystallinity of BNC was higher (54% for BNC, 35% for VNC). The BNC hydrogel had increased surface tension and hydrophilicity compared to VNC hydrogel. The mucin binding efficiency of BNC was about 2× higher compared to VNC according to the PAS assay. The rheological measurements in axial mode indicated that the BNC-mucin system (BNCMu) had a higher adhesion force (0.154 N) in comparison with the VNCMu (0.128 N). Only the VNC hydrogel showed antioxidant activity by DPPH and PFRAP assays. The dose of 0.025% (w/v) BNC presented the highest potential to increase the number of metabolically active viable cells (107.60 ± 0.98% of cytotoxicity negative control), whereas the same dose of VNC hydrogel was the most effective for reducing the amount of reactive oxygen species (ROS), i.e., about 23%. The semi-quantitative screening of the antibacterial activity of the two hydrogels indicated that BNC and VNC did not inhibit the growth of the pathogenic bacteria.

Conclusions: The data suggest that BNC from Kombucha fermentation could be a better candidate for the development of different bioactive mucoadhesive nanoformulations than VNC from brewer’s spent grains. The antioxidant and antibacterial properties of the two (nano)formulations should be further improved.

Acknowledgements: *This research was funded by project PN 23.06.02.01 InteGral, Nucleu Programme, funded by Ministry of Research, Innovation and Digitalization and project POC-A1-A1.2.3-G-2015-P_40_352-SECVENT, Sequential processes to close bioeconomy side stream and innovative bioproducts resulted from these, contract 81/2016, SMIS 105684, funded by Cohesion Funds of the European Union, subsidiary project 1392/2022 NutriCel.*

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ASSOCIATED EVENTS

1. *Partnerships, Synergies and Tools for Innovation and Development!*

2. *Research and Innovation - societal impact*

3. *Integrated approach to environmental protection – AquaMat*

4. *Innovative approach for the protection of medicinal and aromatic plant crops – between circular bioeconomy and nanotechnology*

5. *Transdisciplinary approach for the modern formulation of construction materials, a paradigm shift in the protection of immovable cultural heritage*

6. *Advanced ecological solutions to increase the food safety of vegetables and fruits, from producer to consumer*

7. *Next generation method for studying redox signalling in plants and screening biostimulant potential formulations applied to plants: bimodal sensors*

PARTNERSHIPS, SYNERGIES AND TOOLS FOR INNOVATION AND DEVELOPMENT!

An event dedicated to those who shape the future through science, technology and collaboration!

What happens when scientific research meets entrepreneurship? When innovative ideas from laboratories are taken up by courageous companies and transformed into real solutions for people, communities and the environment? The answer is simple: **world-changing projects emerge**. It is precisely this type of collaboration that is at the heart of the “Partnerships, Synergies and Tools for Innovation and Development” initiative — a dynamic platform for dialogue, learning and future-building between academia, research centres and small and medium-sized enterprises. Held under the aegis of PRIOCHEM XXI, the workshop is co-organized by the Bucharest-Ilfov Regional Development Agency, Măgurele Science Park, Inpulse Partners, members of Enterprise Europe Network, and ICECHIM Bucharest, on October 14, 2025, 10:00 am at ICECHIM headquarters (Splaiul Independenței 202, sector 6 Bucharest), 3rd floor, *in a hybrid format (participation is possible both physically and via the Zoom platform)*.

The event aims to bring to the forefront the European funding opportunities available for innovation projects, making them easier to understand and more accessible for all those who want to transform a valuable idea into a concrete result. It is a real opportunity to discover which programs support initiatives in areas such as green technology, digitalization, health or creative industries and how these funds can be accessed efficiently.

Moreover, participants will have the chance to meet potential partners for future projects, learn from the experiences of those who have already managed to implement such initiatives and understand how to avoid common bottlenecks in the process of transnational collaboration. Through success stories, case studies and interactive discussions, we will explore together what an effective partnership between a university or research institute and an innovative company means.

We address those who believe that change begins with cooperation: researchers, academics, entrepreneurs, representatives of SMEs and clusters, members of NGOs involved in the field of innovation or sustainable development, but also consultants and experts who provide technical support in building European projects.

Whether you are just starting out or already have experience in international projects, the event offers you an open framework for connecting, learning and developing. Innovation needs united communities – and we invite you to be part of one.

RESEARCH AND INNOVATION - SOCIETAL IMPACT

Nicolae VARACHIU[1*]

[1] INCDCP-ICECHIM Bucharest, 202 Spl. Independentei, 6 th district, Romania
**Correspondence: nicolae.varachiu@icechim.ro*

The round table aimed to present concrete research results that have successfully undergone innovation processes and are already applied or ready for immediate implementation in society. The event encouraged the exchange of best practices, lessons learned, and open discussion on what has worked well in innovation and technology transfer and what challenges persist.

Nineteen participants took part in the session—sixteen in person and three online—including representatives from companies, research institutes, universities, and organizations, alongside researchers from ICECHIM. Among the external participants were representatives from ROADIX Group, INTER-BIO Association, Kema Tronic, SIMAVI, the Institute of Space Science, Măgurele Science Park, HOFIGAL, ServProiect Concept, and the National University of Science and Technology Politehnica Bucharest.

The session opened with an overview of key concepts related to innovation and technology transfer, followed by short presentations supported by slides and interactive discussions. The debates were highly engaging, focusing on practical experiences, effective models of collaboration, and the creation of synergies between research and industry. Participants appreciated the event as a valuable platform for knowledge sharing and partnership development.

As a concrete outcome, new connections were established, paving the way for future collaborations and joint participation in European funding competitions. Notably, following the round table, an initial meeting was held—facilitated by Dr. habil. Radu Fierăscu, ICECHIM's Technical Director—between HOFIGAL, ServProiect Concept, Kema Tronic, and ICECHIM, to explore the creation of a regional hub for applied research, technology transfer, and innovation in Southern Muntenia (Slobozia, Ialomița County). The SIMAVI company, which participated online, also expressed interest in joining this initiative.

The presentations and extended materials will be made available on the ICECHIM PRIOCHEM website to further disseminate the outcomes of this fruitful exchange.

INTEGRATED APPROACH TO ENVIRONMENTAL PROTECTION – AQUAMAT

Radu Claudiu FIERĂSCU[*], Ana Maria GURBAN, Irina FIERĂSCU, Teodor SANDU, Valentin RĂDIȚOIU, Cristina Emanuela ENĂȘCUȚĂ

INCDCP-ICECHIM Bucharest, 202 Spl. Independentei, 6 th district, Romania
**Correspondence: fierascu.radu@icechim.ro*

The AquaMat session focuses on a system-level perspective for water-resource protection, emphasising that contemporary challenges such as pollution, resource scarcity, and ecosystem degradation demand integrated solutions rather than isolated interventions.

Within this framework, the project PN 23.06.01.01 seeks to bring together advanced sensor technologies, novel material platforms and data-driven decision support to deliver environmental protection solutions that are both technically robust and socio-economically viable. During the workshop, attendees will review the main pathways of the project in 2025, including the development of monitoring matrices, advanced remediation materials and initial field-deployed pilot instruments.

The discussion will examine key thematic lessons such as: how to ensure interoperability of sensor-material solutions in real-world contexts; how to move from laboratory materials to scalable remediation modules; and how to integrate stakeholder input and regulatory constraints into the design of systems. The session invites researchers, engineers, policy makers and practitioners to explore collaboration across disciplines (chemistry, materials science, environmental engineering, data analytics) and sectors (public, private, academia). From the dialogue, participants will chart potential next-steps: demonstration sites, cross-national collaboration, standardisation of modules and a strategic roadmap for turning AquaMat's core outputs into fully fledged environmental-management services. Ultimately, the workshop frames the protection of water resources as not just a technical challenge but a societal one—requiring transdisciplinary engagement, resilience thinking and a transition from research innovation to operational deployment.

Acknowledgements: *This work was supported by the Ministry of Research, Innovation and Digitization (Ministry of Education and Research, National Authority for Research) through INCDCP-ICECHIM Core program PN 23.06.01.01 (AQUAMAT).*

INNOVATIVE APPROACH FOR THE PROTECTION OF MEDICINAL AND AROMATIC PLANT CROPS – BETWEEN CIRCULAR BIOECONOMY AND NANOTECHNOLOGY

Radu Claudiu FIERĂSCU [1*], Daniela IONESCU [2]

[1] INCDCP-ICECHIM Bucharest, 202 Spl. Independentei, 6 th district, Romania
[2] HOFIGAL Export Import SA București, 2 Intrarea Serelor, district 4 Bucharest, Romania
**Correspondence: fierascu.radu@icechim.ro*

This workshop presents the BioEcoNan project (85PED/2025) and invites participants into a forward-looking conversation about how agriculture, materials science and sustainability can intersect to serve the cultivation of medicinal and aromatic plants (MAP). The core idea is to harness vegetal wastes from MAP cultivation—traditionally seen as residual or low-value material—and convert them via green-nanotechnology routes into advanced protective agents that serve a dual function: crop protection from biotic stress (fungal, bacterial pathogens) and biostimulation of plant growth and health.

The session will outline the conceptual framework: extracts rich in active phytoconstituents obtained from MAP wastes are used as precursors to phytosynthesise nanoparticles whose combined properties yield synergy. Rather than dwell on the fine details of synthesis protocols, the workshop will emphasise the strategic opportunities: how circular-economy thinking can reshape value chains in MAP cultivation; how synergies between biological extracts and nano-carriers can enhance stability, bioavailability and targeted delivery; how the integration of protection and stimulation can improve yield, quality and resource-efficiency.

The discussion will also reflect on practical challenges: aligning laboratory innovations with agronomic reality, ensuring scalability and cost-effectiveness, navigating regulatory frameworks for nano-bio formulations, and creating demonstration farms or pilot facilities.

By bringing together agronomists, botanists, nanotechnologists, agro-chemical developers and policy stakeholders, the session seeks to identify joint research paths, potential partnerships and demonstration frameworks that can carry the BioEcoNan vision into practice. In this way, the workshop emphasises that sustainable agriculture is not simply about replacing inputs, but about re-imagining the entire system of value—closing loops, adding value to reserve streams and innovating in crop protection beyond legacy chemistry.

Acknowledgements*: his work was supported by the Ministry of Research, Innovation and Digitization (Ministry of Education and Research, National Authority for Research), CCCDI—UEFISCDI, project number PN-IV-P7-7.1-PED-2024-0318, contract 85PED/2025, within PNCDI IV.*

TRANSDISCIPLINARY APPROACH FOR THE MODERN FORMULATION OF CONSTRUCTION MATERIALS, A PARADIGM SHIFT IN THE PROTECTION OF IMMOVABLE CULTURAL HERITAGE

Irina FIERĂSCU [1*], Adriana MOANȚĂ [2]

[1] INCDCP-ICECHIM Bucharest, 202 Spl. Independentei, 6 th district, Romania
[2] CEPROCIM S.A., 6 Preciziei Str., Bucharest, Romania
**Correspondence: irina.fierascu @icechim.ro*

The ConstructHer workshop addresses an important intersection of materials science, green chemistry and heritage conservation, framed within the context of project 77PED/2025.

The event presents the main challenge: how to formulate construction materials (mortars, plasters, gypsum, cement) that are not only compatible with the requirements of immovable cultural heritage (historic buildings, monuments) but also meet contemporary expectations of environmental sustainability and multifunctional performance (e.g., biocidal, photocatalytic, disturbance-resistant).

The narrative of the workshop will trace how the project seeks to develop “green” metallic nanoparticles synthesised via plant-extract routes, and integrate them into formulations to achieve antibacterial and photocatalytic behavior, while maintaining mechanical, aesthetic and durability properties required for heritage substrates.

Rather than presenting full technical data, the discussion will highlight the strategic questions: what does it mean to shift the paradigm in heritage-construction materials? How can dispersion, morphology control and functional loading of nanoparticles be balanced with structural integrity and compatibility? What are the life-cycle, maintenance and regulatory implications of using such advanced materials in historic structures or special-use civil construction (hospitals, critical facilities)? How can interdisciplinary teams (materials scientists, conservation engineers, architects, heritage managers, industrial partners) co-operate to bring formulations into pilot zones, validate under real-life conditions and advance toward commercialisation or restoration practice?

The session aims to identify pilot implementation scenarios, stakeholder networks, scalability pathways and documentation frameworks (technical dossiers, performance metrics, standards) needed for next steps. In doing so, it emphasises the broader shift: heritage protection is moving beyond mere preservation into proactive performance-enhancement, sustainability and functional integration—and materials innovation is central to that transition.

Acknowledgements*: This work was supported by the Ministry of Research, Innovation and Digitization (Ministry of Education and Research – National Authority for Research), CCCDI—UEFISCDI, project number PN-IV-P7-7.1-PED-2024-0286, contract 77 PED/2025, within PNCDI IV.*

ADVANCED ECOLOGICAL SOLUTIONS TO INCREASE THE FOOD SAFETY OF VEGETABLES AND FRUITS, FROM PRODUCER TO CONSUMER

Irina Elena CHICAN [1*], Daniela IONESCU [2], Alina Ruxandra Eugenia ORȚAN [3]

[1] INCDCP-ICECHIM Bucharest, 202 Spl. Independentei, 6 th district, Romania
[2] HOFIGAL Export Import SA București, 2 Intrarea Serelor, district 4 Bucharest, Romania
[3]Faculty of Land Reclamation and Environmental Engineering, University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăști Boulevard, 011464 Bucharest, Romania
**Correspondence: irina-elena.chican@icechim.ro*

The SIGUR workshop (57PED/2025) addresses the full value chain of fruits and vegetables—from field production through post-harvest handling, processing, distribution and consumption—with a focus on ecological, safe and resilient solutions. The event frames the global context: increasing consumer demand for safe and sustainable produce, rising regulatory and market pressures, climate-induced stresses on crops and supply chains, and the need for integrated innovation across production systems, processing technologies and monitoring/tracing frameworks.

The workshop will introduce the project's vision: developing ecological interventions (such as alternative plant-protection materials, benign processing and packaging routes, enhanced traceability, consumer-oriented safety assurance) that reduce reliance on synthetic inputs, minimise contamination risk and ensure food-safety integrity. Without detailing specific experiments, the discussion will emphasise the value-chain perspective: how can research deliver practical tools for growers, processors and regulators? How can ecological solutions be validated, scaled, adopted in commercial settings and embedded into existing infrastructure? What are the barriers—economic, regulatory, behavioural—to realising food-safety innovations?

The session invites participants—from agronomy, food-technology, supply-chain management, quality assurance and regulatory bodies—to explore collaborative pathways: pilot programs, demonstration networks, stakeholder platforms, co-design of monitoring/traceability systems and communication models for consumers. The intended outcome is a shared agenda of research-action themes, multi-actor partnerships and value-chain integration models that will help translate the SIGUR project's objectives into measurable impact.

Ultimately, the workshop emphasises that assuring food safety is not just a matter of downstream controls, but of system-wide ecological change, stakeholder alignment and innovation across the full supply chain.

Acknowledgements*: This work was supported by the Ministry of Research, Innovation and Digitization (Ministry of Education and Research – National Authority for Research), CCCDI—UEFISCDI, project number PN-IV-P7-7.1-PTE-2024-0607, contract 57 PTE/2025, within PNCDI IV.*

NEXT GENERATION METHOD FOR STUDYING REDOX SIGNALLING IN PLANTS AND SCREENING BIOSTIMULANT POTENTIAL FORMULATIONS APPLIED TO PLANTS: BIMODAL SENSORS

Ioana Silvia HOSU*

INCDCP-ICECHIM Bucharest, 202 Spl. Independentei, 6 th district, Romania
**Correspondence: Ioana.shosu@yahoo.com*

The workshop "Next generation method for studying redox signalling in plants and screening biostimulant potential formulations applied to plants: bimodal sensors" presents the connection between the plant monitoring directly in the greenhouse with the oxidative stress study methods (and other analytical methods) developed and performed in the laboratory. This is a part of the project with the same name (PN-IV-P7-7.1-PED-2024-1966, 66PED/2025), managed by the Project Director Dr. Chem. Ioana Silvia Hosu. The project is funded by UEFISCDI through PNCDI IV - Program 5.7, Subprogram, 5.7.1, Experimental Demonstrative Project.

The project aims to develop a bimodal sensor to be used for oxidative stress determination for plants/plant extracts, in the laboratory. Nevertheless, the validation of the sensor is to be performed using plant characteristics (different phenotyping characteristics) measured and observed directly in the greenhouse.

The main points of the workshop are:

- Discussing which are the **phenotyping characteristics** to be explored in the greenhouse, in real-time and the timeline of their observation/measurement.
- Discussing which are the **analytical methods to be used for correlation of oxidative stress** with the phenotyping characteristics.
- Discussing other **approaches for future perspectives**.

The workshop is an opportunity for the involved stakeholders (researchers, farmers, agrochemical producers etc.) to understand better how the subject of plant health monitoring can be addressed in the future. Attendees assist to disclosures of the project's findings, which will help them understand how the innovation in plant health monitoring can appear.

***Acknowledgements**: This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CCCDI - UEFISCDI, project number PN-IV-P7-7.1-PED-2024-1966, within PNCDI IV.*

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NANOTEAM

PHANOS

Metrohm
Romania

Metrohm Analytics Romania SRL

Metrohm is a worldwide leading manufacturer of precision instruments for chemical analysis. In the field of electrochemical ion analysis, we have been the world number one unchallenged for many years. But we offer much more than just instruments. In our laboratories we develop tailor-made applications that help our customers to safeguard the quality of their products, to comply with regulations and to optimize processes.

Well-known companies from all industrial sectors prefer our instruments and can rely worldwide on local after-sales service and support. Our customers come from the chemical, petrochemical and pharmaceutical industries, as well as from the automotive and food sectors. The metal and electronics industries, water and environmental analysis and research and training are further fields in which our analytical instruments provide highly accurate results.

The history of our company starts in 1943. That was when the engineer Bertold Sühner started constructing technical apparatus in Herisau, Switzerland. Bertold Sühner was a brilliant inventor. Among other things he constructed radios, oscilloscopes and teraohmmeters, i.e. instruments with which extremely high electrical resistances can be measured. Bertold Sühner ‘s philosophy still guides us today. Independence plays the central role in this philosophy. We have always grown from our own strength and have never surrendered our independence to banks or the stock market. This gives us the freedom to make long-term plans and decisions – in the interest of our customers, our employees and our region.

Since our foundation more than 70 years ago, we have been manufacturing exclusively at our headquarters in Herisau. In times in which whole industries are shifting production to supposedly cheaper locations abroad, we are still producing here with a unique manufacturing depth: We turn and mill all the components for our instruments ourselves. We manufacture our own print ed circuit boards for the control electronics, the columns for our ion chromatographs, and the glass membranes for our electrodes. We even have our own state-of-the-art printing facility where the technical documentation for our instruments is printed. Of course, the entire assembly operation is also located in Herisau.

In a competition driven solely by price, quality will inevitably suffer. Therefore, we don’t even get involved in this type of competition. However, our products and services are the first choice for all those who demand uncompromising quality at a reasonable price. It starts with the fact that we have not outsourced our production but keep it at our headquarters in Herisau. On top of this comes our manufacturing depth. Our customers can rely on the fact that virtually 100 percent of the components of a Metrohm instrument have been developed and manufactured in Herisau. Ultimately, it is our employees who make the crucial difference. Responsibility for quality is not delegated at Metrohm but is regarded as personal responsibility of each individual throughout each production step. This culture of care and selfresponsibility pays for itself. An ever-increasing number of customers rely on Swiss quality from Herisau and many have been loyal to our brand for decades.

We do not just attempt to be as independent as possible in the development and production of our instruments – we also keep sales and distribution in our own hands. Metrohm is exclusively represented in more than 80 countries, of which more than 40 we have our own subsidiaries. This guarantees a close network for sales and service. A total of 1900 employees are working for us outside Switzerland and achieve more than 90 percent of our turnover there.

“When in Rome, do as the Romans do”. Good advice, particularly in sales. We follow the consequences of this proverb with our own logic – and use local employees in our subsidiaries right from the start. They know their markets and are perfectly familiar with the culture of their country.

We don't follow the trends – we make them!

A pioneer in scholarly, open access publishing, MDPI has supported academic communities since 1996. Based in Basel, Switzerland, MDPI has the mission to foster open scientific exchange in all forms, across all disciplines.

Our 488 diverse and open access journals, including 479 peer-reviewed journals and 9 conference journals, are supported by more than 295,000 academic experts who share our mission, values, and commitment to providing high-quality service for our authors. We serve scholars from around the world to ensure the latest research is freely available and all content is distributed under a ***Creative Commons Attribution License (CC BY)****.*

MDPI's portfolio comprises at least 298 journals with impact factors, 64% of which are ranked in the top 2 quartiles of their respective fields. To view the current impact factors for MDPI journals (according to the ***Journal Citation Reports****), please visit our yearly announcement page* ***here****.*

With additional offices in Beijing, Wuhan, Tianjin and Nanjing (China), Barcelona (Spain), Belgrade and Novi Sad (Serbia), Manchester (UK), Tokyo (Japan), Cluj and Bucharest (Romania), Toronto (Canada), Kraków (Poland), Singapore (Singapore), Bangkok (Thailand) and Seoul (Republic of Korea), MDPI has published the research of more than 330,000 individual authors and our journals receive more than 25 million monthly webpage views.

NEW PROTOCOL GROUP
DESIGNING AND BUILDING FUTURE ENERGY SYSTEMS

Designing & Building Future Energy Systems

Integrating engineering, innovation, and sustainability — everything under one protocol.

www.newprotocol.ro

Full-cycle partner, not just EPC.

About the Group

New Protocol Group (NPG) is an integrated energy and innovation company built to meet the growing demand for **sustainable infrastructure** across Europe.

We are more than an **EPC contractor**. We are a **full-cycle energy partner**, capable of developing, executing, and maintaining **renewable assets** at scale — ensuring long-term performance, transparency, and value creation. **Our group combines specialized entities under one cohesive umbrella.**

SmartEcoPV

Proprietary nanoparticle coating and drone-based cleaning technology for PV efficiency optimization.

NPG EPC & Project Management

Technical design, budgeting, legislation, financing frameworks, construction, commissioning.

O&M Division

Advanced maintenance, monitoring, and predictive analytics for high-performance energy assets.

Brandaware

Strategic design and digital communications for the energy and technology ecosystem.

Driving the next generation of clean energy projects

Our Services

At New Protocol Group, we bring together a complete ecosystem of expertise across the renewable energy value chain. From concept to commissioning, we deliver integrated solutions that accelerate the transition to clean, efficient, and sustainable power.

EPC & Project Management.

Turnkey delivery from feasibility and permitting to COD; bankable design, clear budgets, tight schedules.

SmartEcoPV.

Developed in collaboration with top research institutions, our proprietary technology increases PV performance by reducing dust, snow, and pollutant buildup while minimizing operational costs.

BESS & Hybrid Systems.

We design and implement battery storage and hybrid (PV + wind + storage) systems that enhance grid stability and open new trading opportunities.

EV Charging Infrastructure

We develop fast-charging networks powered by renewable sources, enabling sustainable mobility for communities and businesses.

Engineering, Design & Data.

We deliver data-driven design, UI/UX, and analytics solutions for energy operations and digital platforms.

O&M Services

We provide long-term operational and maintenance support, including remote monitoring, predictive maintenance, and on-site interventions.

☎ +40 763 356 950 ✉ office@newprotocol.ro 🌐 www.newprotocol.ro

NANOTEAM

***NanoTeam** is a Romanian company specialized in providing advanced laboratory instruments for research, development, and industrial applications, as well as for biodiversity, environmental studies, universities, and scientific centers.*

Its website highlights a diverse portfolio that includes:

- *Hitachi electron microscopes (SEM, TEM) and sample preparation systems,*
- *confocal Raman spectroscopy,*
- *atomic force microscopes (AFM),*
- *thermal analysis systems (DSC, STA/TGA, TMA, DMA),*
- *high-resolution IR spectroscopy (e.g., Molecular Vista),*
- *XPS, Auger, and ToF-SIMS systems,*
- *multi-nuclear NMR spectroscopy (Oxford Instruments),*
- *flow chemistry systems (Vapourtec), and others.*

The company presents itself as a reliable technical partner with strong technical and scientific expertise, offering solutions tailored to customer needs, post-sale support, and consultancy for equipment integration.

*Based in **Cluj-Napoca, Romania**, NanoTeam places emphasis on innovation, performance, and quality in delivering high-level scientific instruments.*

PHANOS

About us

- **Young and enthusiastic team, we've started to operate in 2024**
- **The company was founded by a team with over 14 years of extensive experience in research and industrial sales, significantly contributing to the design, implementation, and commercialization of a wide range of innovative products.**
- **Phanos Technology SRL is ISO 9001 and ISO 14001 certified, demonstrating the company's commitment to consistently meeting customer requirements and exceeding their expectations while adhering to high standards of quality and environmental management.**
- **Our mission is to support technological progress and deliver value to our customers through innovation and high-quality services. Our vision is to become a recognized leader at both the national and European levels.**
- **CEO – Nicu Becherescu, PhD in Physics, with a specialization in Condensed Matter Physics and Quantum Mechanics**
- **COO- Surupaceanu Ionut, MS Physics, with a specialization in Laser Physics.**

Company profile

Marketing & Business Development: The company began its activity by providing specialized marketing services for companies in the technical field, playing a crucial role in online promotion, developing growth strategies, and managing investor relations. Additionally, the company actively participated in the design and implementation of research and development projects, further establishing its reputation as a trusted partner for its clients.

Sales: In the next stage of its development, the company leveraged its accumulated experience towards the commercialization of scientific and industrial equipment, supplied by external partners. By continuing to support our partners, we have developed a complementary portfolio of products and services, allowing us to offer additional solutions to the same customer profile. Thus, we were able to better meet their needs and consolidate our position in the market.

Research projects: We are actively involved in research projects where we assist research centers in advancing and maturing their developed technologies. These projects are supported by both national and European funding, enabling us to innovate and deliver competitive products

Publication partners:

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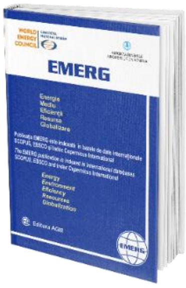

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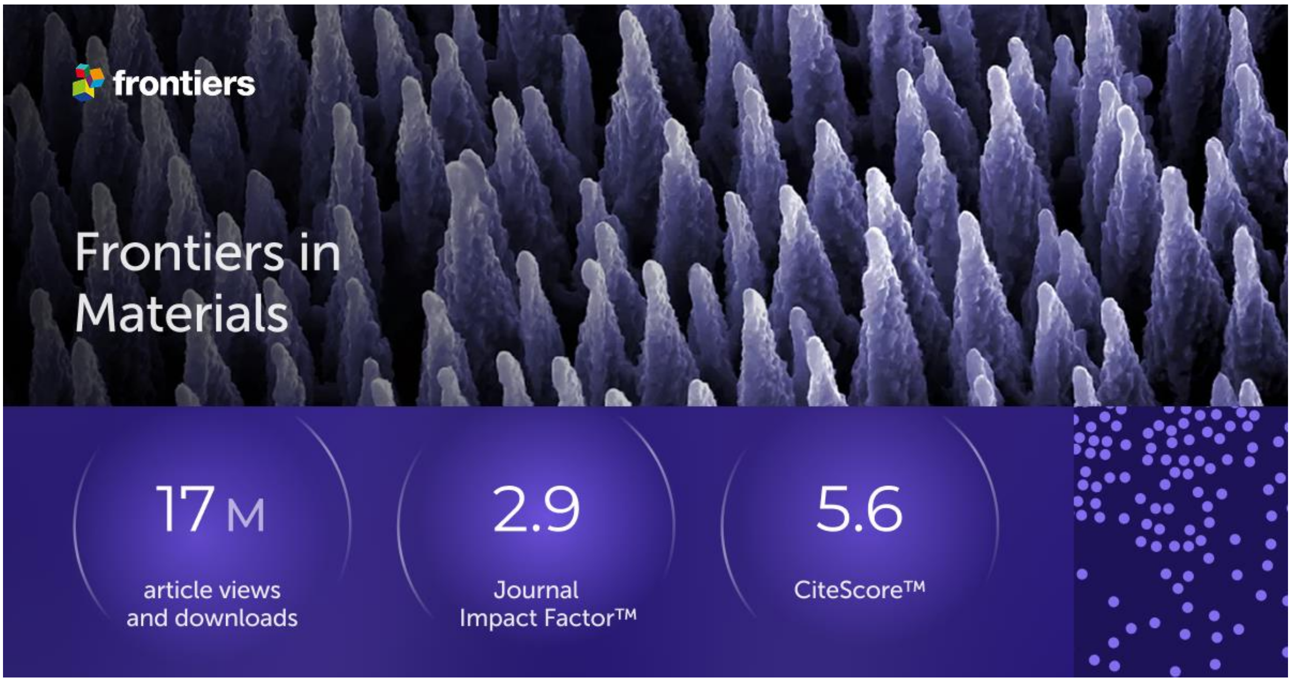
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Frontiers in Materials is an international, community-driven Gold Open Access journal, which publishes high-quality research across the entire breadth of materials science and related engineering disciplines. Led by Field Chief Editor Professor Nicola Maria Pugno (University of Trento, Italy), the journal explores the design and development of materials for future applications.

Covering a broad range of topics, subjects of interest include, but are not limited to: biomaterials and bio-inspired materials; carbon-based materials; ceramics and glass; colloidal materials and interfaces; computational materials science; energy materials; environmental degradation of materials; mechanics of materials; metamaterials; polymeric and composite materials; quantum materials; semiconducting materials and devices; smart materials; structural materials; and thin solid films.

Since launching in 2014, the Journal has published more than 3,700 articles, received more than 17M article views and downloads, as well as more than 44.3K citations.

The Journal is indexed in the SCIE and Scopus, and in 2025 received an Impact Factor of 2.9 and a CiteScore of 5.6 respectively. The Journal is also recognized by independent publishing ethics bodies, as a member of the Committee on Publication Ethics (COPE) and via indexation within the Directory of Open Access Journals (DOAJ).

Frontiers in Materials is committed to advancing and encouraging interdisciplinary developments in the field of materials science by communicating scientific knowledge to researchers and the public alike, to *enable the scientific breakthroughs of the future.*

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Special Issue "Advanced Polymer Materials: Design, Functionality, and Environmental Applications"

Guest Editors:

Dr. Radu Claudiu Fierascu
Emerging Nanotechnologies Group, National Institute for Research & Development in Chemistry and Petrochemistry, ICECHIM Bucharest, 060021 Bucharest, Romania

Dr. Verona Iordache
National Institute for Research & Development in Chemistry and Petrochemistry ICECHIM, 060021 Bucharest, Romania

Deadline for submissions:
30 April 2026

Short information about the Special Issue

This Special Issue aims to showcase recent progress in the synthesis, characterization, and application of advanced polymer-based systems. Topics of interest include, but are not limited to, functional and smart polymers, polymer nanocomposites, biomaterials, stimuli-responsive systems, and polymer-based solutions for environmental challenges.

This Special Issue will feature a selection of contributions presented at the International Symposium PRIOCHEM XXI (2025), and high-quality submissions from the wider scientific community that align with the scope of Polymers. Original research articles and comprehensive reviews are welcome.

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NATIONAL INSTITUTE FOR RESEARCH & DEVELOPMENT IN CHEMISTRY AND PETROCHEMISTRY — ICECHIM Bucharest

202 Splaiul Independentei street, 6th district, Bucharest, 060021,

Romania Phone: +40213153299 / Fax: 021 312 34 93
E-mail: office@icechim.ro / priochem@icechim.ro
Websites: www.icechim.ro / www.servicii.icechim.ro /
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