NATURAL SCIENCE
BALTIC CONFERENCE

27-28.06.2026

Event report

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Prologue

Dear Colleagues,

On behalf of the Student's Science Club for Chemistry at the University of Gdańsk, the Students' Self-Government Council of the Faculty of Chemistry, the Center of Student and Doctoral Activity, and the Doctoral Council of the Doctoral School of Natural Sciences at the University of Gdańsk, I would like to express my sincere gratitude to everyone who participated in the **Natural Science Baltic Conference 2026**. This year's conference once again brought together students, doctoral candidates, researchers, and academics from around the world, creating a unique platform for scientific exchange across chemistry, biomedical chemistry, biochemistry, environmental protection, ecology, and related fields. We are proud that the conference continues to grow, fostering interdisciplinary collaboration and strengthening international scientific networks. We were honored to host four outstanding Special Guests whose inspiring lectures enriched the scientific programme. We extend our sincere thanks to **Dr. Maja Szymczak** (Institute of Low Temperature and Structure Research, Polish Academy of Sciences) for her fascinating presentation *"When Light Becomes a Sensor"*, **Dr. Paulina Parcheta-Szwindowska** (Gdańsk University of Technology) for sharing her research „Polyurethane elastomers with high natural carbon content – synthesis, characteristics, and life cycle analysis", **Dr. Katarzyna Wiktorska, Associate Professor** (Warsaw University of Life Sciences) for her insightful lecture *"The Cell as an Old and New Source of Bioactive Compounds"*, and **Dr. Agata Kućko** (Warsaw University of Life Sciences) for presenting her engaging talk *"To drop or not to drop? The dynamics of flower abscission in lupine"*. We would also like to express our heartfelt appreciation to all authors, reviewers, session chairs, volunteers, sponsors, and honorary patrons whose commitment and support made this event possible. Thanks to your dedication, the conference provided an inspiring environment for presenting innovative research, exchanging ideas, and establishing valuable professional collaborations. As you browse through the abstracts collected in this Book of Abstracts, we hope you will revisit the discussions initiated during the conference and discover new opportunities for future research and cooperation. Every contribution reflects the passion, creativity, and determination of our scientific community to advance knowledge and address global challenges.

Thank you once again for being part of the Natural Science Baltic Conference 2026. We hope the experience has been both scientifically rewarding and personally inspiring. We look forward to welcoming you to the next edition of the Natural Science Baltic Conference!

On behalf of the organizers of Natural Science Baltic Conference

MSc Mateusz A. Baluk

The Baltic Sea:
Europe's Unique Body of Water

The Baltic Sea, often simply referred to as the Baltic, is one of the most distinctive bodies of water in Europe. Located in Northern Europe, it extends from the western coasts of Denmark to the eastern edges of the region near Russia. It is bordered by nine countries: Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. Due to its geographical location, semi-enclosed character and specific environmental conditions, the Baltic Sea forms a unique natural system of great ecological, economic and scientific importance. The Baltic Sea stretches for approximately 1,600 kilometres and covers an area of about 377,000 square kilometres, making it one of the largest brackish seas in the world. Despite its vast surface area, it is relatively shallow, with an average depth of around 55 metres. Its deepest point, the Landsort Deep near Sweden, reaches approximately 459 metres. These physical characteristics strongly influence water circulation, oxygen conditions and the overall functioning of the Baltic marine ecosystem. One of the most remarkable features of the Baltic Sea is its brackish nature. Unlike typical marine environments, the Baltic has a relatively low salinity level. This results from its limited connection with the North Sea through the Danish Straits, combined with substantial freshwater inflow from rivers and precipitation. Salinity varies across the basin, generally increasing from the northern and eastern parts towards the Danish Straits, but it remains much lower than in open ocean waters. This creates a challenging environment for many organisms, as both freshwater and marine species live close to the limits of their ecological tolerance.

The combination of low salinity, cold climate and limited water exchange has led to the development of a unique and fragile ecosystem. The Baltic Sea is inhabited by species adapted to these specific conditions, including commercially and ecologically important fish such as Baltic herring and cod. It also serves as an important resting, feeding and breeding area for numerous bird species. Its coastal zones, wetlands, lagoons and archipelagos support diverse plant and animal communities, making the Baltic region an area of considerable biodiversity. The Baltic Sea has also played a significant role in the history and economy of the surrounding countries. For centuries, it has served as an important trade route connecting Northern and Central Europe. Major ports such as Gdańsk, Kiel, Riga, Stockholm and Helsinki have developed along its shores, supporting maritime transport, fisheries, tourism and regional cooperation. In recent years, the Baltic Sea has also gained importance in the context of renewable energy, particularly offshore wind energy, which is becoming an increasingly relevant element of sustainable development in the region.

From a scientific perspective, the Baltic Sea is an exceptional natural laboratory. Its unique conditions provide valuable opportunities for research in marine biology, oceanography, chemistry, environmental science, biotechnology and climate studies. Because the Baltic Sea is highly sensitive to environmental changes, it is often considered an important indicator of human impact and climate-related processes. Research conducted in this region helps scientists better understand issues such as nutrient cycling, biodiversity changes, water pollution, ecosystem resilience and the long-term consequences of climate change. However, the Baltic Sea also faces serious environmental challenges. Its limited water exchange makes it particularly vulnerable to pollution and nutrient accumulation. Industrial activity, agriculture, urban development and maritime transport have contributed to problems such as eutrophication, plastic pollution, chemical contamination and habitat degradation. Eutrophication is one of the most severe threats, as excessive nutrient input can lead to harmful algal blooms and oxygen depletion, negatively affecting marine organisms and entire ecosystems.

For these reasons, the Baltic Sea requires continuous scientific attention, international cooperation and responsible environmental management. Protecting this unique marine environment is not only important for preserving biodiversity, but also for maintaining the economic, cultural and social value of the region. Sustainable practices, interdisciplinary research and public awareness are essential to addressing the current and future challenges faced by the Baltic Sea. In conclusion, the Baltic Sea is a uniquely brackish marine environment with remarkable ecological diversity, significant economic value and broad scientific relevance. Its distinctive characteristics make it an important subject of study across many fields of natural sciences. At the same time, the environmental pressures affecting the Baltic highlight the urgent need for sustainable solutions, international collaboration and ongoing research aimed at protecting this exceptional European sea.

The Baltic Sea, often simply called the Baltic, is a unique body of water with a range of distinctive features and environmental conditions. Located in Northern Europe, it stretches from the western shores of Denmark to the eastern edges of Russia and is bordered by nine countries: Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia, and Sweden. Spanning approximately 1,600 kilometers (990 miles) in length, the Baltic Sea covers an area of about 377,000 square kilometers (146,000 square miles), making it one of the largest brackish inland seas by area in the world. Its average depth is 55 meters, with the deepest point being the Landsort Deep near Sweden, reaching 459 meters (1,506 feet).

One of the most intriguing aspects of the Baltic Sea is its brackish nature. Unlike most marine environments, the Baltic Sea has a low salinity level. This is due to its semi-enclosed nature, limited water exchange with the North Sea, and significant freshwater input from numerous rivers. The salinity level varies across the Baltic but averages about 0.8% at the surface, much lower than the average salinity of ocean waters, which is typically around 3.5%. The low salinity, combined with the colder climate of Northern Europe, creates a unique ecosystem. Various species adapted to these specific conditions inhabit the Baltic Sea. The Baltic herring and cod are particularly notable, having been vital to the region's fishing industry for centuries. The sea is also an important resting and breeding ground for many bird species, and its coastal regions host diverse flora and fauna. Economically, the Baltic Sea is crucial for the surrounding countries. It has been a vital trade route for hundreds of years, linking major ports such as Kiel, Riga, Stockholm, and Gdansk. The sea provides valuable resources, including fish and, more recently, offshore wind energy. Scientifically, the Baltic Sea is a significant focus of research due to its unique properties. It offers valuable insights into marine biology, oceanography, and environmental science. Its sensitivity to environmental changes makes it a key indicator of climate change. Topics like eutrophication, plastic pollution, and the impact of human activity on marine ecosystems are critical areas of study in the Baltic region. However, the Baltic Sea faces substantial environmental challenges. Its limited water exchange with other bodies of water, coupled with industrial and agricultural runoff, has led to severe eutrophication problems. This process involves an excess of nutrients causing harmful algal blooms and subsequent oxygen depletion in the water, endangering marine life. In conclusion, the Baltic Sea is a uniquely brackish marine environment with rich ecological diversity and significant economic and scientific value. Its unique characteristics make it an interesting subject for various scientific studies. At the same time, it is under considerable environmental stress, underscoring the need for sustainable practices and ongoing research to address and mitigate these challenges.

Baltic Sea, photo author: MSc. Daria Łada

About the Baltic:

Blue Baltic – Scientific Discoveries

The **“Blue Baltic: Scientific Discoveries”** website is dedicated to scientists, researchers, educators, and science communicators whose work focuses on the Baltic Sea. The platform presents recent discoveries, research initiatives, and innovative projects related to the Baltic ecosystem, climate, geology, history, culture, and regional development. It serves as a bridge between the scientific community and a broader audience, promoting knowledge, environmental awareness, and a better understanding of the Baltic Sea based on current studies and interdisciplinary analyses.

The Baltic Sea has long been a space of encounters, exchange of ideas, and scientific inspiration. During this year’s edition of the **Natural Science Baltic Conference 2026**, we emphasized its importance not only as an object of scientific investigation, but also as a symbol of international cooperation and a source of diverse research perspectives. The Baltic region was discussed in relation to environmental processes, cultural heritage, historical narratives, and economic development. Particular attention was also given to Baltic legends and myths, which were reinterpreted as culturally rooted stories, as well as to the business dimension of the region, including the role of ports and international cooperation hubs.

The Baltic Sea is one of the most dynamic marine areas in Europe, both environmentally and scientifically. As a semi-enclosed sea surrounded by nine countries, it represents a highly complex area of international collaboration. Its waters are shaped by riverine inflows, climate conditions, human activity, and natural geological processes. Due to its limited water exchange and high ecological sensitivity, the Baltic Sea responds rapidly to environmental disturbances, changes, and anthropogenic pressures. For this reason, it functions as a natural laboratory in which scientists can observe ecological, chemical, geological, and climatic processes in real time.

Research on the Baltic Sea covers an exceptionally broad spectrum of topics. Scientists investigate processes occurring in the water column, coastal zones, seabed, atmosphere, and living organisms, as well as those directly related to human activity. Contemporary oceanographic and ecological studies focus on several key, interconnected areas. These include the analysis of migration routes of marine animals and their genetic and behavioural adaptations to climate change, as well as studies on the role of phytoplankton and zooplankton in oxygen production, carbon cycling, and the stability of marine food webs. An important part of this research is the monitoring of seawater chemistry and the investigation of mechanisms responsible for cyanobacterial blooms, eutrophication, and the formation of hypoxic or anoxic zones caused by excessive nutrient input.

At the same time, scientists conduct seabed mapping, sediment analyses, and studies on tectonic processes and the geological history of marine basins. These research directions are closely connected with the assessment of anthropogenic pressures, including plastic pollution, overfishing, underwater noise, and maritime transport, all of which influence the condition of Baltic fauna and flora. This diversity demonstrates that the Baltic Sea is a space where science develops in many directions, from basic research to projects of global relevance.

The Baltic Sea also shows how strongly science depends on cooperation. Researchers from Poland, Germany, Sweden, Denmark, Lithuania, Latvia, Estonia, and other countries form an international network that enables the implementation of projects with regional and global significance. These initiatives include environmental monitoring, technological innovations, climate research, marine biodiversity studies, education, and the popularization of scientific knowledge. In this context, the Baltic Sea is not only a subject of research, but also a platform for collaboration between institutions, disciplines, and societies.

Equally important is the role of the Baltic Sea in bringing science closer to the public. Through workshops, lectures, science festivals, educational projects, and outreach initiatives, local communities can learn about recent discoveries and better understand the environmental processes taking place in their surroundings. In this way, scientific knowledge becomes more accessible, engaging, and socially relevant.

The Baltic Sea is more than a body of water. It is a living, dynamic system that constantly changes, reacts to external pressures, and inspires new generations of researchers. Its unique geography, ecological sensitivity, rich history, intensive human use, and economic importance make it one of the key regions for studying the interactions between nature and society. Understanding the Baltic Sea helps us better predict the future of other seas and oceans, while also reminding us that the protection of such a vulnerable ecosystem is a shared international responsibility. This responsibility begins with reliable scientific knowledge and must lead to practical actions aimed at preserving the Baltic Sea for future generations. These ideas were also reflected in a series of posts promoting knowledge about the Baltic Sea and highlighting its scientific, environmental, and cultural importance.

Promotional and Educational Posts about the Baltic Sea

The following section presents a series of posts created to promote knowledge about the Baltic Sea and to communicate selected scientific, environmental, and cultural topics to a wider audience. These materials were designed to combine reliable information with an accessible form of communication, making the Baltic Sea closer and more understandable to both the scientific community and the general public.

The posts included the following thematic areas:

1. Cultural Events by the Baltic Sea

- Culture by the Baltic Sea: festivals, concerts and events that connect the world
  The coastal regions of the Baltic states - from Poland through Lithuania and Latvia to Germany, Denmark and Sweden - create a unique space where international culture meets science, innovation and the exchange of ideas. In summer, the Baltic coastline transforms into a vibrant stage where open-air concerts in Gdańsk, Rostock and Malmö blend seamlessly with interdisciplinary art-and-science festivals in Klaipėda and Riga, while events combining music, technology and ecology energize coastal research hubs, creating a unique space for encounters, inspiration and international exchange of ideas.

Here, artists, researchers and participants from across Europe build a shared space for dialogue - from classical music to experimental multimedia installations. The Baltic Sea inspires, connects and reminds us that culture is a universal language of international cooperation. It's worth diving into this atmosphere and discovering how creativity and science continuously fuel one another. 🌟

- Culture of the Baltic Sea countries: a shared space of tradition and innovation 🌍✨

The Baltic Sea region is a remarkable mosaic of cultures - from Poland, Lithuania, Latvia and Estonia to Germany, Denmark, Sweden and Finland. Each of these countries brings its own traditions, languages, music and art to the coastline, creating a vibrant, international space for cultural exchange.
The Baltic shores come alive with festivals, concerts and events that promote both local heritage and contemporary creativity. Coastal cities become meeting points for artists, researchers and audiences from across Europe - from sea-inspired music and street art to projects that blend culture with science and ecology. The Baltic Sea doesn't just connect coastlines - it connects cultures, building bridges between nations and strengthening the region's shared identity.

2. Maritime Safety

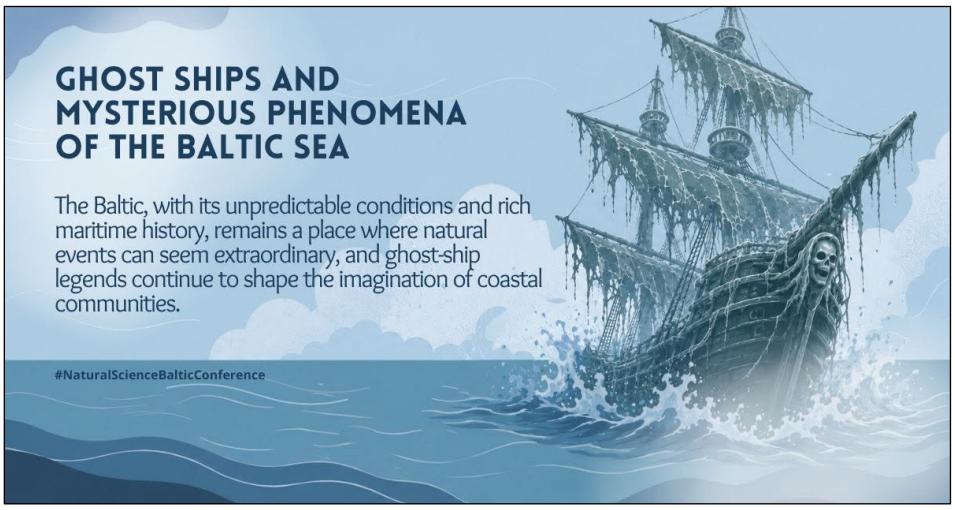
- Scientific Maritime Safety Oversight in the Baltic Sea 🚢🔬

The Baltic Sea is not only one of the busiest maritime areas in Europe, but also a space where international scientific cooperation plays a crucial role in ensuring safety. Research institutes, universities and monitoring centers from Poland, Germany, Sweden, Denmark, Lithuania, Latvia and Estonia work together to analyze satellite data, oceanographic models and navigation systems to better understand risks and respond to threats more effectively. Studies on marine monitoring, storm forecasting and critical infrastructure protection help develop solutions that significantly enhance the safety of navigation and the marine environment. Today, the Baltic Sea stands as one of the strongest examples of how science and international collaboration can jointly protect a region of strategic importance.

- Maritime Accidents in the Baltic Sea and Rescue Operations 🚢🆘

  The Baltic Sea, despite intensive monitoring and modern navigation systems, remains an area where incidents still occur — from vessel collisions and technical failures to sudden weather changes. This is why efficient cooperation between rescue services and scientific institutions across the region is so essential. SAR units from Poland, Germany, Sweden, Denmark, Lithuania, Latvia and Estonia operate using shared procedures, satellite data analysis and advanced weather models, enabling faster detection of threats and better coordination of operations at sea. Research on maritime safety, the development of marine monitoring and the testing of new rescue technologies significantly enhance the effectiveness of response efforts. Every rescue operation in the Baltic Sea demonstrates how science, technology and international collaboration work together to protect human life and ensure safe navigation.

3. Baltic Sea Myths and Legends



- Ghost Ships and Mysterious Phenomena of the Baltic Sea 🚢✨

  The Baltic Sea has long been a place where natural phenomena blend seamlessly with maritime

legend. Along the coasts of Poland, Lithuania, Latvia, Estonia, and around Bornholm and the Øresund Strait, sailors have passed down stories of ghost ships appearing suddenly in thick fog - silent, unlit vessels drifting without a crew. In the waters near Hel and the Gulf of Gdańsk, such sightings were believed to warn of an approaching storm, while around Bornholm people spoke of mysterious lights hovering above the waves, said to be signals from the spirits of lost sailors.
In the Gulf of Riga, tales often described dense, fast-moving fogs that seemed to “swallow” ships whole, giving rise to legends of vanishing crews and vessels disappearing without a trace. Although modern science explains many of these events as mirages, atmospheric reflections or sudden weather shifts, the stories remain deeply rooted in the region’s culture.
The Baltic, with its unpredictable conditions and long maritime history, continues to be a place where ordinary natural events can appear extraordinary - and where ghost-ship legends remind us how profoundly the sea has shaped the imagination of coastal communities.

The Baltic Sea has long inspired stories filled with mystery, nature and the imagination of coastal communities. Across Poland, Lithuania, Latvia, Estonia and Scandinavia, generations have passed down tales of Jurata, the queen of the Baltic, mermaids luring sailors, and sunken cities hidden beneath the waves.

These stories reflect the deep connection between people and the sea, shaping a shared cultural identity across the region. They show how the Baltic became a space of wonder, fear and fascination - and how profoundly it influenced the imagination of those living along its shores.

Together, these posts presented the Baltic Sea not only as an important natural and scientific area, but also as a space shaped by culture, tradition, and human activity.

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About the conference

The Natural Science Baltic Conference 2026 was a continuation of the Baltic Chemistry Conference and previous editions of the Natural Science Baltic Conference, which enjoyed great popularity among students, PhD students and young researchers. The conference was organised as an online international scientific event aimed at enhancing the scientific potential of young scientists and creating a platform for the exchange of research results, scientific ideas and interdisciplinary experience.

During NSBC 2026, young speakers from different countries, including students, doctoral students and early-career researchers, presented the results of their research in the form of oral presentations and poster presentations. The scientific programme also included special guest lectures delivered by invited researchers representing Polish scientific institutions. During the conference, members of the Scientific Committee evaluated individual presentations and posters in order to award the best scientific contributions.

Due to its interdisciplinary nature, the conference covered various areas of natural sciences, including chemistry, biology, biotechnology, environmental sciences, physics and related interdisciplinary fields. The programme brought together participants working on topics ranging from molecular and materials sciences to biological systems, environmental research and applied natural sciences.

The Natural Science Baltic Conference, held on 27–28 June 2026, was a free international conference for students, PhD candidates and early-career researchers, dedicated to fostering the scientific development of young scientists. The 2026 edition brought together **207 participants**. During the conference, **122 scientific presentations** were delivered, including **70 oral presentations**, among them **4 special guest lectures**, and **52 poster presentations**. The active contributors represented **42 research institutions and universities across 14 countries**.

The represented countries were: **Poland, Ecuador, Indonesia, Morocco, Czech Republic, Latvia, Lithuania, Algeria, Austria, Croatia, India, Japan, Republic of Moldova and Ukraine**. The largest number of scientific contributions came from Poland, followed by Ecuador, Indonesia and Morocco.

From Poland, **25 scientific institutions** were represented, including: the University of Gdańsk (13), the Adam Mickiewicz University in Poznań (9), the Wrocław University of Science and Technology (8), the Nicolaus Copernicus University in Toruń (6), the Poznań University of Technology (6), the University of Łódź (6), the Warsaw University of Life Sciences (6), the Institute of Low Temperature and Structure Research of the Polish Academy of Sciences (5), the Gdańsk University of Technology (4), the Cracow University of Technology (3), the Jan Kochanowski University of Kielce (3), the Poznań University of Medical Sciences (3), the University of Rzeszów (3), the Łódź University of Technology (3), the Bydgoszcz University of Science and Technology (2), the Medical University of Gdańsk (2), the Silesian University of Technology (2), the Maria Curie-Skłodowska University in Lublin (1), the Poznań University of Life Sciences (1), the Rzeszów University of Technology (1), the University of Opole (1), the University of Silesia in Katowice (1), the University of Warmia and Mazury in Olsztyn (1), the University of Warsaw (1), and the West Pomeranian University of Technology in Szczecin (1).

In addition, **17 foreign scientific institutions** participated in the conference, including: Yachay Tech University, Ecuador (10), the National Institute of Technology Bandung, Indonesia (5), Ibn Zohr University, Morocco (3), the University of Latvia, Latvia (2), the Czech University of Life Sciences Prague, Czech Republic (1), Kogakuin University, Japan (1), the Lithuanian Research Centre for Agriculture and Forestry, Lithuania (1), Masaryk University, Czech Republic (1), Moldova State University, Republic of Moldova (1), SRM Institute of Science & Technology, India (1), Universitas Pendidikan Indonesia (UPI), Indonesia (1), the University of Djelfa, Algeria (1), the University of Vienna, Austria (1), the University of Zagreb, Croatia (1),

Vasyl Stefanyk Carpathian National University, Ukraine (1), the Veterinary Research Institute Brno, Czech Republic (1), and Vilnius University, Lithuania (1).

The conference further strengthened the international and interdisciplinary character of the Natural Science Baltic Conference, providing young researchers with a valuable forum to present their research, build academic networks, and exchange knowledge across a broad range of natural science disciplines.

Organizers

The Baltic Chemistry Conference was organized by an agreement of four organizations from the University of Gdansk - the Student's Science Club for Chemistry, the Students' Self-Government Council of the Faculty of Chemistry, Center of Student and Doctoral activity and the Doctoral Council of the Doctoral School of Natural Sciences of the University of Gdansk.

The Organizing Committee is composed of:

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We would like to thank sincerely our patrons; thanks to their support our conference has become known in the international scientific

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MSc **Adrianna Kosiróg-Ceynowa** — University of Gdańsk, Poland

Special Guests

NATURAL SCIENCE
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Maja Szymczak, PhD
Institute of Low Temperature and Structure

My name is Maja Szymczak and I am an assistant professor at the Institute of Low Temperature and Structure Research of the Polish Academy of Sciences in Wrocław. My scientific activity focuses on luminescent materials for optical sensing applications, particularly luminescence thermometry, manometry and for thermal history sensing. My research is centered on the development of advanced inorganic phosphors capable of remote, highly sensitive and multimodal detection using luminescence-based approaches. I completed my studies in Chemistry at the University of Wrocław. During my master's studies, I worked on hydrophilic Ag_2S quantum dots, which initiated my interest in luminescent nanomaterials and optical spectroscopy. In October 2025, I obtained my PhD in Chemical Sciences at the Wrocław Doctoral School of Institutes of the Polish Academy of Sciences. My doctoral dissertation, focused on the influence of pressure on the luminescence properties of Cr3+-doped inorganic materials for luminescence manometry applications. My research combines solid-state synthesis, structural characterization, and advanced spectroscopic investigations under extreme conditions. I specialize in studying pressure- and temperature-dependent luminescence properties of transition metal and lanthanide ions. A major objective of my work is the development of luminescent sensors with high sensitivity, multimodal readout capability, and minimized pressure-temperature cross-sensitivity. In particular, I investigate ratiometric, lifetime-based, and time-gated sensing strategies in inorganic phosphors operating in the visible and near-infrared spectral ranges. An important part of my scientific activity, particularly within the framework of the NCN PRELUDIUM grant, concerns the development of novel luminescent manometers based on Cr^{3+} and Ni^{2+} ions. My studies demonstrated record-high pressure sensitivities and introduced new strategies for the development of bifunctional luminescent pressure-temperature sensors, enabling simultaneous and reliable optical detection of both parameters with minimized cross-sensitivity effects. More recently, within the framework of the NCN OPUS project for which I serve as the principal investigator, I have focused on the development of thermal history phosphors based on redox-active dopants. The project aims to design highly sensitive materials capable of irreversible thermal event recording through spectral, kinetic, and visual luminescence readout strategies. Additionally, as the principal investigator of the Polish-Taiwanese Joint Mobility Project between the Polish Academy of Sciences and Academia Sinica, I am currently developing near-infrared bifunctional luminescent pressure-temperature sensors based on Cr4+ emission, aiming to establish structure-property relationships for advanced optical sensing applications. My research has resulted in over 40 scientific publications in high-impact international journals, including Advanced Materials, Advanced Functional Materials, and Chemical Engineering Journal. My work has been cited over 600 times and my current h-index is 15. I am also a co-author of two granted patents and many patent applications related to optical pressure sensing and thermal history detection. My work has been recognized by several prestigious awards and scholarships, including the L'Oréal-UNESCO For Women in Science scholarship and the START scholarship from the Foundation for Polish Science. Beyond research, I actively participate in scientific outreach, mentoring, and academic community activities. I am a member of the Academy of Young Scientists and Artists in Wrocław and engage in initiatives promoting women in science and scientific education. I also contribute to the scientific community through peer review activities for international journals and through mentoring and educational programs for students and young researchers.

Paulina Parcheta-Szwindowska, PhD Eng.
Gdańsk University of Technology, PL

Since 2019, she works as an assistant professor in the Department of Polymer Technology at the Faculty of Chemistry, Gdańsk University of Technology. In 2019, defended the doctoral dissertation entitled: “Synthesis, Properties, and Applications of Linear Polyester Polyols Obtained Using Plant-Derived Monomers.” Her research interests have focused on the use of plant-derived monomers in polymer synthesis, primarily polyurethanes, and the application of biopolymers in various industrial sectors to produce functional materials, ranging from thermoplastic elastomers to flexible polyurethane foams with vibration-damping properties. In addition, her research interests also include the analysis of the life cycle of plastics produced from plant-based raw materials. She is a co-author of 25 scientific articles published in JCR-indexed journals, and her Hirsch index is 14. She is also a co-author of 6 patents and 4 patent applications. Served as the principal investigator for two projects funded by the Ministry of Science and Higher Education (MNiSW): Miniatura 4 and Inkubator Innowacyjności 4.0, as well as five projects funded by Excellence Initiative – Research University Programme at Gdańsk University of Technology, and a co-author and researcher on an international project funded by the National Science Centre (NCN) under the Weave UNISONO grant. She has participated in numerous academic conferences, international and national (a total of 10 oral presentations at international conferences, including one invited lecture). In 2025, she was awarded a scholarship from the Minister of Science and Higher Education for outstanding young scientists. In 2024, she received the W. Świętosławski Award from the Polish Society of Calorimetry and Thermal Analysis for young scientists, in recognition of scientific achievements in the field of calorimetry and thermal analysis. In 2021, she received a START scholarship from the Foundation for Polish Science. In 2020, received the Grand Prize from the Gdańsk Branch of the Polish Chemical Society and the Deans of the Faculty of Chemistry at the University of Gdańsk, the Faculty of Chemistry at Gdańsk University of Technology, and the Faculty of Pharmacy at the Medical University of Gdańsk for the best doctoral dissertation defended in 2019. In 2018, awarded the Minister of Science and Higher Education Scholarship for outstanding achievements during the 2018/2019 academic year for the best doctoral students.

Katarzyna Wiktorska, PhD, Assoc. Prof.
Warsaw University of Life Sciences, PL

I am professor at the Department of Physics and Biophysics, Institute of Biology, Warsaw University of Life Sciences (SGGW), with over 20 years of experience in cell biology, cancer pharmacology, confocal microscopy, and optical imaging. My scientific career has combined academic research, technology transfer, and collaboration with industry. I was previously affiliated with the National Medicines Institute and co-founded the biotechnology spin-off company OncoBoost, where I served as President. My research has focused on cancer pharmacology and the biological activity of natural compounds, particularly sulforaphane and its analogs, their role in cancer prevention and therapy, intracellular detoxification pathways, and drug interactions. At SGGW, I lead the Pharmacological Biophysics Group, where we develop advanced microscopy-based approaches for the quantitative assessment of protein expression, localization, and interactions in cellular models and human biopsy samples. In my current projects, I also expand my research beyond sulforaphane and its analogs into other bioactive compounds of plant and animal origin, including phytohormones, plant secondary metabolites, and biological therapeutics, as well as natural biomaterials that can serve as smart drug delivery systems responsive to pH changes or external physical stimuli. A particular focus of my work is breast cancer, including the most challenging triple-negative breast cancer (TNBC). I have authored almost 70 scientific publications and 14 patents, and I have served as principal investigator or collaborator in numerous national and international research projects funded by NCN, NCBiR, and the EU (CanServ program). My publications span cancer pharmacology, microscopy and imaging, natural bioactive compounds, drug delivery systems, and translational biomedical research and were published in recognized international journals like Biomedicine and Pharmacotherapy, Scientific Reports, International Journal of Pharmaceutics or Cell Death and Disease. Alongside research, I am passionate about education and mentoring. I lecture on physics, biophysics, microscopy, and knowledge transfer at SGGW. In 2024, I established and now lead the postgraduate program in Pharmaceutical Biotechnology, developed in partnership with Polpharma Biologics (Rezon Bio). I also teach biophysics at UKSW Medical School and at the Faculty of Pharmacy at Vizja University. Teaching and mentoring students and early-career researchers are the favorite parts of my academic life.

Agata Kućko, PhD
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Agata Kućko, PhD, is an assistant professor at the Department of Botany and Plant Physiology, Institute of Biology, Warsaw University of Life Sciences (SGGW-WULS). She has held this position since November 2020, following a two-year post-doc position at the same institution (2018-2020). She earned her PhD in Biological Sciences in 2017 from the Faculty of Biology and Environmental Protection at the Nicolaus Copernicus University (NCU) in Toruń. Her doctoral dissertation, focused on the characterization of abscission process in yellow lupine, was conducted under an international co-supervision program with the Estacion Experimental del Zaidin (EEZ-CSIC) in Granada, Spain. Throughout her career, she has maintained active scientific cooperation with NCU, the University of Gdańsk, the University of Agriculture in Kraków, the University oof Warsaw, and EEZ-CSIC, resulting in joint research projects and numerous co-authored publications. Her research focuses on the molecular and physiological mechanisms of plant organ abscission. While her foundational work centered on lupine and model plants such as Ipomoea nil, her current research extends to a variety of crops, including maize, potato, hemp, and carrot. Her specific area of expertise include: (1) The role of phytohormones (abscisic acid, ethylene, jasmonates, auxins, brassinosteroids) in activating organ abscission zones; (2) Plant reactions to soil drought and salinity, particularly how these stressors trigger premature flower shedding; (3) Cell wall remodeling, lipid homeostasis, and redox signaling during organ detachment; (4) Developing methods to mitigate abiotic stress in crops with using phytohormones and biostimulants. She served as the Principal Investigator for the Miniatura4 grant investigating jasmonates in lupine abscission. She has been recognized for her scientific and organizational contributions with several honors, including Polish Lupine Society (2024) award for the best scientific publication related to lupine research; Rector's individual awards (2021, 2023) for scientific achievements; Organizational distinctions (2023, 2024) for contributions to academic and institutional development. She served as a Guest Editor for Special issues in high-impact journals, including Frontiers in Plant Science, Plants, and Molecules. She has supervised two doctoral candidates as an auxiliary supervisor (one defended, one ongoing) and has mentored Master's, Bachelor's, and Engineering's students. She teaches courses in plant physiology, ecophysiology, and adaptations in extreme environments. Her scientific output includes over 45 peer-reviewed experimental and review articles (primarily in Q1/Q2 journals), along with several book chapters published by Springer and Wiley.

Lecture by PhD Maja Szymczak

When Light Becomes a Sensor

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Luminescent materials have attracted considerable attention as platforms for remote optical sensing, offering unique capabilities for monitoring environmental parameters under conditions where conventional sensors are difficult or impossible to employ. My research focuses on the design and development of inorganic phosphors doped with lanthanide and transition metal ions for optical sensing of temperature, pressure, and thermal history[1-6].

The sensing performance of these materials is based on the sensitivity of their luminescence properties to external stimuli. By exploiting temperature- and pressure-induced changes in emission spectra, luminescence intensity ratios, spectral positions, and emission lifetimes, highly sensitive optical sensors can be developed. Particular attention is devoted to identifying structure-property relationships that govern the sensing performance and to developing multifunctional materials capable of monitoring multiple physical parameters simultaneously.

Beyond point sensing, luminescent materials offer exciting opportunities for spatially resolved measurements. The combination of luminescent phosphors with optical imaging techniques enables two-dimensional temperature mapping, providing valuable information about thermal gradients and heat distribution across surfaces. Such approaches have significant potential for applications in materials science, electronics, energy systems, and biomedical diagnostics.

In addition to reversible sensing, my research explores thermal history phosphors (THPs), a novel class of luminescent materials capable of permanently recording the maximum temperature experienced by an object. These materials undergo irreversible changes in their luminescence properties upon thermal exposure, allowing reconstruction of past thermal events. Particular emphasis is placed on understanding the mechanisms responsible for these transformations and on developing spectral, kinetic, and colorimetric readout strategies that enable both quantitative temperature determination and straightforward visual assessment.

This presentation will provide an overview of recent advances in luminescent sensing based on lanthanide- and transition-metal-doped inorganic phosphors, highlighting their potential for temperature sensing, pressure detection, thermal imaging, and thermal history monitoring.

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Opening lecture by PhD Eng. Paulia Parcheta-Szwindowska

Polyurethane elastomers with high natural carbon content – synthesis, characteristics, and life cycle analysis

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Polyurethanes (PUs) represent a major class of polymeric materials. Owing to their remarkable versatility, they can be manufactured as foams, elastomers, coatings, adhesives, and fibers, which enables their use in a broad range of applications. They are typically produced from polyols and isocyanates, while an increasing variety of naturally derived polyols is now commercially available. The development of bio-based monomers plays a crucial role in improving the sustainability of these materials by reducing dependence on petrochemical resources and lowering their environmental footprint [1]. Bio-based monomers offer a promising route for designing polyurethane materials with specific and desirable properties [2, 3].

Recent research has demonstrated that replacing petrochemical feedstock with bio-based monomers can significantly decrease greenhouse gas emissions. As a result, bio-based polyurethanes have emerged as an attractive direction for advancing sustainable materials and green chemistry. Nevertheless, sustainability benefits must be supported by robust quantitative assessments; otherwise, such claims may lack credibility and potentially lead to inaccurate or misleading conclusions [4].

Series of bio-based cast polyurethanes was synthesized via a two-step process using PDI and modified PDI isocyanates, a bio-derived polyester polyol, and two different bio-based chain extenders. The resulting materials were characterized by Fourier-transform infrared spectroscopy (FTIR) to verify their chemical structures. Their thermal behavior and stability were investigated through thermogravimetric analysis (TGA), and differential scanning calorimetry (DSC). The effects of the bio-based monomers on the structural and thermal characteristics of the prepared polyurethanes were examined, offering valuable information about their suitability for sustainable material applications. In addition, a life cycle assessment (LCA) was conducted, based on selected assumptions concerning the use of bio-based monomers in the laboratory-scale production of cast polyurethanes.

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Lecture by PhD, Assoc. Prof. Katarzyna Wiktorska

The Cell as an Old and New Source of Bioactive Compounds

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Let us look at cells as integrated biological systems that serve as continuous sources of bioactive and therapeutically relevant compounds.

The concept of viewing cells as bioreactors that produce bioactive molecules represents an integrative perspective in the life sciences that emphasizes the continuity between biological systems traditionally studied as separate kingdoms and provides a more unified understanding of living systems as interconnected sources of future medicines[1]. Animal- and plant-based bioreactors play complementary roles in this framework. Animal systems, including recombinant cell lines, enable the production of complex biologics such as antibodies, hormones, vaccines, and therapeutic proteins. A well-known example is trastuzumab and its antibody-drug conjugate derivative ado-trastuzumab emtansine (Kadcyla), which illustrates how mammalian cell systems can be used to generate highly specific and effective anticancer therapies[2].

Plant cells, in turn, function as efficient and sustainable bioreactors producing a wide spectrum of secondary metabolites, proteins, and phytohormones with pharmaceutical relevance. A representative example is sulforaphane, a dietary isothiocyanate derived from cruciferous vegetables, which exhibits cytoprotective and anticancer activity and can enhance the efficacy of chemotherapeutic agents[3]. In triple-negative breast cancer models, sulforaphane has demonstrated both antitumor and antimetastatic effects, as well as synergy with anticancer drugs that improve intracellular drug delivery[4,5]. The metabolic output of plant cell can be further modulated through genetic and environmental approaches, enabling the generation of novel or enriched bioactive compounds. Another interesting class of plant-derived molecules is phytohormones. Although traditionally associated with plant growth and stress responses, it has been recently shown that they may also exert biological effects in animal systems, opening new perspectives for their potential role in modulating cancer-related pathways[1].

In this context, the lecture will discuss selected examples from my own research, highlighting this emerging perspective as a promising and rapidly developing area of biomedical science. A brief discussion of the Baltic Sea as a potential source of bioactive molecules and marine bioreactor systems will also be introduced.

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Lecture by PhD Agata Kućko

To drop or not to drop? The dynamics of flower abscission in lupine

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Yellow lupine (Lupinus luteus L.) is an economically significant high-protein legume; however, its productivity is severely limited by specific developmental strategy: the premature shedding of 40-90% of its flowers. This process, known as abscission, is not a random event but a highly programmed physiological response occurring in the abscission zone (AZ) – a specialized, narrow band of cells at the base of the pedicel. Our research identifies the transcription factor LIBOP as a fundamental regulator of AZ differentiation. High LIBOP mRNA accumulation is a prerequisite for AZ cells to acquire competence to respond to abscission-inducing signals, and its expression is rapidly upregulated by stress hormones[1]. The decision to shed a flower is governed by a complex 'hormonal scenario'. Auxin (IAA) acts as a primary stabilizer; as long as a continuous flow from the flower to the stem is maintained, the AZ remains inactive[2,3]. Soil drought serves as a major environmental trigger of flower abortion, disrupting the natural auxin gradient between the distal and proximal parts of the AZ[4]. At the physiological level, water deficit disturbs redox homeostasis and induces lipid peroxidation, indicating membrane destabilization and the loosening of cell-cell adhesion within the AZ[5]. Disruption of the auxin 'brake' enables stress hormones to dominate. Abscisic acid (ABA) acts as a key mediator by stimulating the ethylene (ET) biosynthesis pathway, leading to a burst of its precursor (ACC) directly in AZ cells[6]. Importantly, we identify jasmonates (JAs) as essential downstream components of this cascade. Jasmonic acid and its methyl derivative both significantly accelerate flower abortion[7]. Furthermore, ABA and ET promote JA biosynthesis and activate the signaling machinery, thereby executing organ separation[8]. This hormonal network converges with the IDA-HSL signaling pathway, in which the EPIP peptide (a fragment of LIIDL) functions as a molecular switch[9]. Together, these processes lead to dissolution of the middle lamella – the pectin rich 'glue' between cells – ultimately resulting in flower abscission.

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Best live presentation, recorded presentation and poster

Best presentation:

1. Julia Kwiatkowska
2. Karolina Beton-Mysur
3. Kacper Tomasik

Best poster:

1. Martina Hardcová
2. Patrycja Jutrzenka-Trzebiatowska
3. Anna Kościk

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Presentation

NATURAL SCIENCE
BALTIC CONFERENCE

Conceptual design and analysis of active micro-reservoirs for biomedical applications

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Recent advances in microfabrication and smart materials have enabled the development of miniaturized drug-delivery systems with improved precision and controllability. Among these, active micro-reservoirs represent a promising approach for the on-demand storage and controlled release of therapeutic agents in biomedical devices. This study presents a conceptual design and preliminary analysis of active micro-reservoir systems intended for implantable and wearable biomedical applications.

The proposed concept focuses on micro-scale reservoirs integrated with active release mechanisms capable of externally or internally triggered actuation. The design considers key parameters such as reservoir geometry, material selection, actuation methods (e.g., thermal, electrochemical, or mechanical), and biocompatibility constraints. Particular attention is given to optimizing reservoir volume, and actuation efficiency to achieve precise dosing while maintaining device miniaturization and reliability. The analysis also addresses challenges related to long-term stability, prevention of leakage, and integration with microsystems used in biomedical environments.

The results highlight critical design trade-offs between actuation power, release rate, and structural integrity. The presented analysis provides a first-step framework for the development of micro-reservoir platforms capable of programmable drug delivery and other biomedical functions.

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Functionalized Orbital Reconstruction Implants as Platforms for Targeted Antibiotic Delivery

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Reconstructive implants are widely used in maxillofacial surgery to repair orbital wall defects caused by trauma. In clinical practice, polymeric biomaterials such as polyethylene and polypropylene meshes are commonly applied due to their good biocompatibility, suitable mechanical properties, and ability to adapt to the complex anatomy of the orbit [1]. Despite these advantages, implantation carries a risk of postoperative complications, particularly bacterial infections caused by microbial colonization of implant surfaces [2]. Such infections may lead to inflammation, impaired healing, and in severe cases the need for revision surgery and implant removal. For this reason, surface modification strategies that provide antibacterial properties and enable local antibiotic delivery are an important research focus. Recently, increasing attention has been given to natural bioactive compounds for implant surface modification. Polyphenols are of particular interest because their numerous functional groups provide antioxidant activity and allow interactions with metal ions, enabling the formation of stable functional coatings on biomaterial surfaces [3]. In addition, bioactive metal ions can influence both the stability and biological activity of these layers, including their antimicrobial properties [4]. Another promising approach involves incorporating broad-spectrum antibiotics that can interact with surface components or metal ions, allowing effective binding and controlled drug release from implant surfaces [5]. In this study, the surface of a biomaterial used for orbital reconstruction was modified using an approach that forms a functional surface layer, enabling the subsequent immobilization of antimicrobial agents. The obtained biomaterials were subjected to comprehensive physicochemical characterisation using selected techniques, including UV-Vis spectroscopy, HPLC, FT-IR mapping, SEM/EDS, and XPS. The obtained results confirmed the effectiveness of the proposed modification strategy for orbital reconstruction implants. They demonstrated the investigated biomaterial's ability to adsorb antibiotics and enable their controlled release. The results obtained indicate the promising potential of the developed biomaterials in eliminating the risk of postoperative bacterial infections associated with the implantation of orbital reconstruction implants.

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Mesoporous Silica Nanoparticles (MSNs) as Versatile Platforms for Controlled Drug Delivery Systems

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Mesoporous silica nanoparticles (MSNs) have emerged as premier candidates for drug delivery due to their exceptional physiochemical properties, including high surface area, tunable pore size, and a well-defined internal pore structure [1]. This presentation examines the strategic advantages of the MCM-41 and SBA-15 frameworks in encapsulating poorly water-soluble therapeutic agents [2]. We discuss the role of surface functionalization in modulating drug-loading capacity and achieving controlled release kinetics, specifically focusing on the delivery of hydrophobic anticancer compounds [3]. Furthermore, the discussion touches upon the potential for stimuli-responsive delivery, where gatekeeping molecules regulate drug efflux in response to specific biological triggers [4]. By optimizing the pore architecture, MSNs offer a robust solution to the limitations of conventional systemic administration.

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Tailored Mesoporous Silica Nanoparticles Improve Insulin Stability and Intestinal Permeability for Oral Delivery

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Despite decades of intensive research, oral insulin delivery has yet to be realized in clinical practice due to the challenge of overcoming gastrointestinal barriers. The use of dendritic mesoporous silica nanoparticles (DMSNs) in combination with a protein-based excipient, succinylated β-lactoglobulin (sBL), has enabled the preparation of pH-responsive tablets that prevent premature gastric release and degradation of encapsulated insulin.[1] Nevertheless, important challenges persist—such as controlling insulin release rates, enhancing intestinal permeability, and improving mucoadhesion—that must be addressed to enable reliable translation of these systems to therapeutic applications.[2] To this aim, the influence of the surface chemistry of DMSNs on loading efficiency and insulin release performance was examined.[3] For this purpose, DMSNs (130 nm; pore size: 7.0 nm) were functionalized with polyethylene glycol (PEG, 2 kDa) and a phosphonate-silane, trihydroxysilylpropyl methylphosphonate (THMP) through post-grafting strategies.[4], [5]

The functionalized DMSNs (PEG-MSN and PO3-MSN) exhibited enhanced colloidal stability in aqueous and saline media (PBS) over a wide pH range, improving the solubility of loaded insulin upon peptide confinement within the silica mesopores. Tablet formulations were prepared by mixing sBL with pure and functionalized DMSNs containing insulin (20% w/w), and release tests were performed in simulated body fluids. Compared with DMSN-free formulations, encapsulated insulin showed markedly enhanced protection against proteolysis, with premature release under gastric conditions reduced to <10% and sustained controlled release over 24 h at pH 7.4. In particular, PO3-MSN enabled the transient reorganization of tight junction proteins, thereby promoting the paracellular transport of insulin-loaded DMSNs and overcoming a major biological barrier to oral absorption. Insulin delivered through these formulations retained bioactivity, as demonstrated by activation of insulin-responsive signaling pathways in vitro and reduction of blood glucose levels in hyperglycemic mice.[3] These findings highlight DMSNs as promising carriers for oral peptide delivery, supporting the development of effective, patient-friendly therapies with enhanced efficacy and compliance.

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From Hydrogels to Oleogels: Advanced Lipid-Based Systems for Hydrophobic Active Delivery in Cosmetic Formulations

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Hydrogels have long been widely used in cosmetic and medical formulations due to their high water content, biocompatibility, and ability to efficiently deliver active ingredients. However, their limited stability under changing temperature and humidity conditions, as well as rapid water evaporation, restrict their long-term application in advanced cosmetic systems. In addition, the incorporation of hydrophobic bioactive compounds into hydrogels remains challenging due to their predominantly aqueous nature.

In recent years, oleogels have emerged as a promising alternative, offering improved structural stability and enhanced compatibility with lipophilic active ingredients. These lipid-based gel systems are formed by immobilizing liquid oils within a three-dimensional network of gelators, enabling the development of stable and functional delivery platforms for cosmetic applications.

The presentation provides a comparative overview of hydrogels and oleogels, focusing on the transition from aqueous-based to lipid-based gel systems in modern cosmetic science. Special attention is given to the structural organization of oleogels and the influence of different oils and gelling agents on rheological behavior, texture, stability, and functional performance.

The advantages of oleogels, controlled release of active compounds, enhanced skin compatibility, and efficient incorporation of hydrophobic ingredients, are discussed in the context of next-generation cosmetic formulations. Potential challenges related to formulation optimization and sensory properties are also considered.

Overall, oleogels represent a promising alternative to conventional hydrogel systems, enabling the development of stable and efficient delivery platforms for hydrophobic compounds in advanced cosmetic formulations.

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Dewetting-induced surface morphology of polycaprolactone substrates for in vitro cell studies

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An essential challenge in tissue engineering is the development of substrates that allow precise control over cell distribution and behavior on their surface. Substrates used for cell culture can significantly influence cell adhesion, proliferation, and directed cell growth. The aim of this study was to obtain substrates with controlled surface morphology using the dewetting phenomenon of thin polymer films deposited on glass slides, and to evaluate their properties in the context of potential applications in cell culture.

Substrates with controlled morphology were obtained via the dewetting process, which involves the disintegration of an unstable polymer film under the influence of external factors. One of the key factors is the use of a polar solvent, in which the polymer layer is melted. As a result of this process, polymer droplets are formed on the substrate and subsequently solidify, creating an array of hemispherical particles.

Polycaprolactone (PCL) was used as a surface-modifying material for the preparation of cell culture substrates. The morphology of the obtained films and particles was characterized using optical microscopy, atomic force microscopy (AFM), scanning electron microscopy (SEM), and contact angle measurements.

The application of the dewetting process enabled the fabrication of substrates with controlled morphology. A correlation between the thickness of the polymer film on the glass substrate and the size of the resulting particles was observed, with thicker films leading to the formation of larger particles. The modified substrates exhibited different levels of hydrophobicity depending on the degree of surface modification. In vitro studies conducted on NIH/3T3 fibroblasts confirmed noticeable differences in cell growth compared to unmodified glass substrates.

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From Nature to Novel Anticancer Candidates: Synthesis of New Oleanolic Acid-Cinnamic Acid Derivatives

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Natural compounds have long played a crucial role in pharmaceutical research and drug discovery. Owing to their structural diversity and inherent biological activity, they represent valuable templates for the development of new molecules with potential pharmacological applications. Chemical modification of natural scaffolds is frequently employed to enhance their biological properties and improve their pharmacological profiles.

Among the various directions of contemporary medicinal chemistry, the search for compounds exhibiting cytotoxic activity against cancer cells remains one of the most promising. Both oleanolic acid and cinnamic acid have demonstrated such activity, making them attractive starting points for further structural optimization [1]. Consequently, we undertook the synthesis of novel derivatives based on these natural scaffolds. Preliminary computational analyses, including structure–activity relationship (SAR) studies, suggest that the obtained derivatives may exhibit significant anticancer potential.

The primary objective of this research is the synthesis of new triterpenoid ester-type derivatives with cinnamic acid residue. The synthetic approach employed is based on efficient chemical transformations that do not require expensive or toxic reagents. Furthermore, the reactions proceed rapidly under mild conditions and can be carried out at room temperature, making the methodology both practical and environmentally favorable. Structural characterization of the synthesized compounds will be performed using NMR and MS spectroscopy. In addition, their fundamental physicochemical properties will be determined, followed by the evaluation of their anticancer activity. The compounds obtained will be tested for cytotoxic activity against selected cancer cell lines. Screening studies and investigations into the mechanisms underlying this activity will be conducted at the Lviv National Medical University.

Acknowledgments: The research is funded by Poznan University of Medical Sciences

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Versatile nucleophilic ring-opening of aziridines: a route to chiral bioactive molecules

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Three-membered rings, such as epoxides and aziridines, are important pharmacophoric motifs in medicinal chemistry and are frequently found in both natural products and pharmaceutical agents. They are also widely used in the formulation of pesticides, fragrances, and specialty chemicals [1]. Moreover, three-membered ring-opening reactions are classified as part of the Nobel Prize-winning concept of “click chemistry,” which is based on the principles of ideal chemical reactions, which should be specific, efficient and selective in terms of regioselectivity and stereoselectivity [2].

Due to the high ring strain of aziridines, they readily undergo ring opening with sulfur and nitrogen nucleophiles, whereas oxygen nucleophiles require more demanding conditions. The regioselectivity of this process depends on the degree of ring activation, the nature of the nucleophile, the acid used, and the substituents on the aziridine, which together determine the site of attack (C2 or C3) [3]. Control over these factors enables the design of compounds with desired structures and biological properties.

The project presents a series of reactions involving chiral, optically pure epoxides with chiral aziridines, followed by the opening of the resulting aziridine alcohols using various nucleophiles, including oxygen, sulfur, and nitrogen atoms (Fig.1). Moreover, as an extension of the research, the synthesis of biologically active compounds will be presented. The regiochemistry and stereochemistry of some of the obtained products were confirmed by X-ray structural studies.

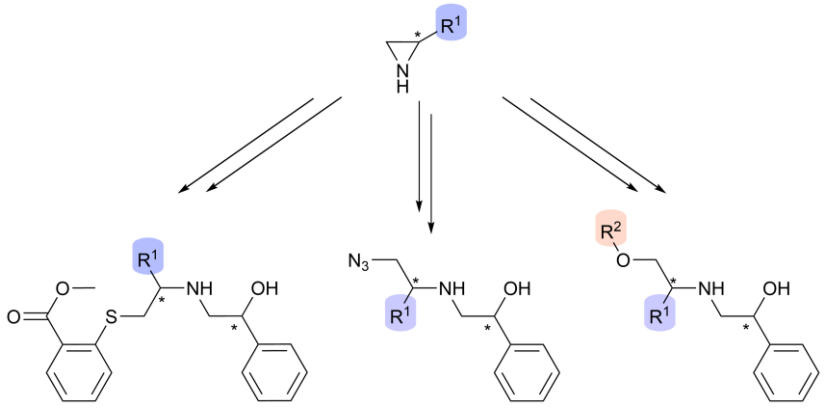

Fig. 1. Schematic representation of syntheses.

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Shining Coumarins: Synthesis of Novel Hydrazide Hydrazones with Luminescent Properties

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Organic Light-Emitting Diode (OLED) technology is a rapidly developing field, with continuous efforts aimed at improving the efficiency and performance of emissive materials. Beyond display applications, OLEDs have found use in diverse areas such as medicine, fashion, and sports, owing to their unique combination of light-emitting properties and structural flexibility [1].

The present work focuses on the design and synthesis of novel hydrazide hydrazones as luminescent coumarin derivatives, with particular emphasis on materials exhibiting aggregation-induced emission (AIE). This phenomenon provides an effective strategy to overcome aggregation-caused quenching (ACQ), a major limitation in the development of efficient solid-state emitters [2].

Coumarin derivatives constitute an attractive class of heterocyclic compounds due to their favorable photophysical properties, as well as their notable biological activity [3]. In this study, a series of new compounds was synthesized and investigated in terms of their luminescent behavior. Thin solid films were prepared using the drop-casting method to evaluate both emission in the solid state and film-forming ability, and were subsequently analyzed using digital microscopy.

Furthermore, the photophysical properties of the obtained compounds were examined through absorption and emission studies.

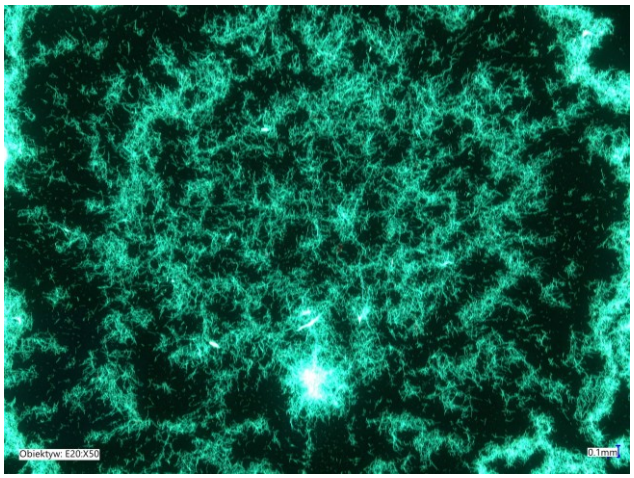

Fig. 1. An image of a thin solid layer of the representative derivative.

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New D-A Fluorophores based on an Azaindolo[3,2,1-*jk*]carbazole Acceptor Core

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Organic push-pull molecules have attracted considerable interest due to their remarkable photophysical properties arising from the presence of electron-accepting (A) and electron-donating groups (D) connected through a π-conjugated bridge (π). Heterocyclic polycyclic aromatic hydrocarbons (PAHs), especially those containing nitrogen, are widely employed in D-A architectures because they offer broad electronic tunability through substituent modification and heteroatom variation. Indolo[3,2,1-*jk*]carbazole is a versatile building block in optoelectronic materials.[1] Incorporation of an additional nitrogen atom into this framework leads to an even stronger electron-accepting core. Pyridino[3',2':4,5]pyrrolo[3,2,1-*jk*]carbazole is a planar that has not received much attention in the literature on push-pull systems.[2,3]

This study presents the multistage synthesis of D-A and D-π-A systems in which pyridino[3',2':4,5]pyrrolo[3,2,1-*jk*]carbazole serves as the acceptor unit, while fluorene- and carbazole-based moieties with various alkyl chains were used as donor groups. An acetylene unit was applied as the π-bridge. The structures of the obtained compounds were confirmed by ^{1}H and ^{13}C NMR, and their physical properties were investigated using differential scanning calorimetry, thermogravimetric analysis, UV-Vis absorption, and photoelectron emission spectroscopy. Additionally, DFT and TD-DFT calculations were performed to gain deeper insight into the relationship between the molecular structures and properties of the synthesized compounds.

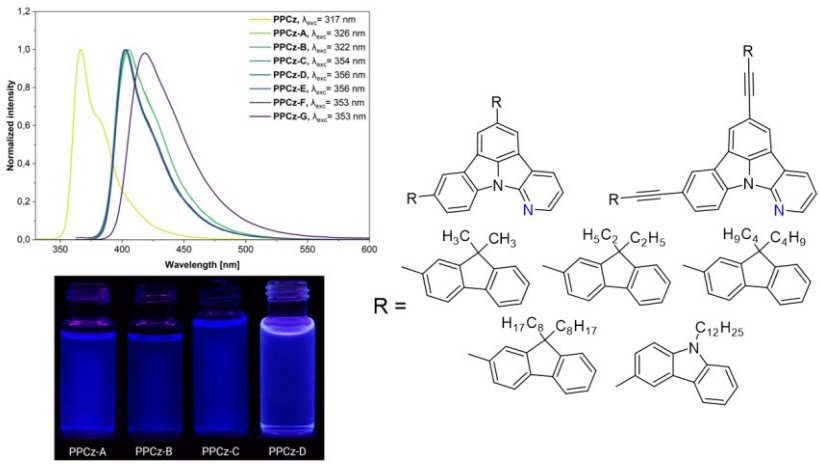

Fig. 1. Structures of obtained derivatives PPCz.

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Fluorescent labelling and functionalization of cell-penetrating peptides Tat(47-57) and TP10

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Cell-penetrating peptides (CPPs) are a group of short biologically active peptides that have the ability to cross biological membranes without damaging them. They can also transport various biologically active molecules into the cell interior, therefore, they are often referred to as “Trojan horse” carriers. These unique properties of CPPs make them excellent candidates for conjugation with different molecules in order to enhance their bioavailability and thereby modulate their activity [1,2].

This strategy has proven particularly effective in improving the activity of vancomycin (Van) – a glycopeptide antibiotic that is gradually losing its efficacy due to increasing bacterial resistance, mainly among staphylococcal and enterococcal strains. In our recent studies, we synthesized and evaluated a series of Van-CPP conjugates that exhibited significantly enhanced antimicrobial activity against both clinical and drug-resistant bacterial strains, as well as reduced cytotoxicity in comparison to unmodified Van. The peptides that showed the strongest effect on Van’s activity were Tat(47-57) and TP10, which also exhibit antimicrobial activity on their own [2].

These promising findings encourage further investigation into the mechanisms of conjugates’ transport into bacterial cells. One of the approaches enabling these studies is fluorescent labelling of the peptides [3]. In our current studies, we synthesized and physicochemically characterized fluorescently labelled Tat(47-57) and TP10. The modification was achieved by introducing 5(6)-carboxyfluorescein into the peptide side chain. The peptides were also functionalized with a propyl group at the *N*-terminus to enable further conjugation with azide-functionalized Van derivatives *via* “click” reaction.

Fluorescent labelling of the peptides will allow investigation of cellular localization and internalization processes using fluorescence-based techniques and may provide insight into their mechanism of action. The studies constitute an important stage in the development of new Van-CPP conjugates and the optimization of their properties as potential agents for antibacterial therapies.

This research was funded by University of Gdańsk (BMN 539-T060-B282-26)

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Selective Oxidation of β-Caryophyllene Using Ozone: Process Optimization and Product Distribution Analysis

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β-Caryophyllene is the main bioactive sesquiterpene in clove oil that has the potential to be developed into value-added compounds through oxidation reactions. This study investigated the ozonolysis of β-caryophyllene in a solventless gas-liquid system and evaluated the effects of reaction temperature, ozone concentration, and reaction time on substrate conversion and product distribution. Ozone generated in situ was directly introduced into the liquid phase of pure β-caryophyllene, and the reaction products were analyzed using gas chromatography with a flame ionization detector (GC-FID). The results showed that the reaction conditions significantly controlled both the conversion rate and product selectivity. Increasing the reaction temperature accelerated the conversion of β-caryophyllene, while varying the ozone concentration significantly affected the product distribution and indicated the existence of optimum conditions favoring the formation of the main oxidation product. At higher ozone concentrations, competitive reaction pathways became more dominant, resulting in decreased selectivity. Reaction time further controlled the conversion rate, with longer durations resulting in total substrate conversion and the dominance of one component in the chromatogram. The optimum reaction conditions were obtained at 80 °C, 30% ozone concentration, and 6 h reaction time, which resulted in full conversion of β-caryophyllene with high selectivity to the main product. This study demonstrates that solventless ozonolysis can be precisely controlled by adjusting the reaction conditions to direct the selective transformation of β-caryophyllene, while providing insights into the oxidation behavior of terpenes towards value-added oxygenated derivatives.

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Metallodrug meet nanotechnology: Responsive nanomaterials for Ruthenium based anticancer active complexes

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Ruthenium complexes have been actively explored to overcome the limitations of platinum-based anticancer drugs, which are clinically approved for treating different types of cancer. However, the clinical translation of Ru-based anticancer agents is significantly hampered by their poor stability, solubility issues, lack of specificity, and toxicity.[1] Several advantages can be exploited when the conventional metal complex is converted into metallodrug-nanoconjugate or by delivering metallodrugs using engineered nanocarriers.[2-4]

We prepared novel organoruthenium complexes bearing natural products/bio-active ligands, explored their structure-activity relationship, and investigated the molecular mechanism of anticancer activity against different cancer cells. To further enhance the antiproliferative activity of complexes, two different strategies have been adopted using polydiacetylene-based nanosystems — physical encapsulation and chemical conjugation to achieve the sustained-release, enhanced cancer cell uptake, reduced In vivo toxicity, and real-time release monitoring of delivery. Our recent findings will be presented and discussed.

Acknowledgment to Anusandhan National Research Foundation for Core Research Grant and SRMIST for providing research facilities

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Phenoxyiminato Cobalt(II) complexes in hydroboration of terminal and internal alkenes

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Phenoxyiminato cobalt(II) complexes have been developed as efficient catalysts for the hydroboration of alkenes, providing an operationally simple and selective system based on an Earth-abundant metal, offering an alternative to noble metal systems, aiming at more sustainable base metal catalysis. Homoleptic bis(phenoxyiminato)cobalt(II) complexes enable the Markovnikov-selective hydroboration of vinyl arenes with pinacolborane under mild, activator-free conditions at room temperature. In contrast, simple aliphatic terminal alkenes undergo hydroboration with exclusive anti-Markovnikov selectivity. Styrenes with diverse electronic properties as well as functionalised aliphatic alkenes, including vinylsilanes and a vinylphosphonate, were hydroborated with excellent functional-group tolerance and high regioselectivity. Hydroboration of internal alkenes requires modified conditions and proceeds in the presence of a nucleophilic activator, affording moderate to good conversions and revealing the alkene isomerisation processes characteristic of cobalt catalysis.

Mechanistic insights into the process were gained using paramagnetic NMR spectroscopy supported by DFT calculations of the reference spectra, which suggest a ligand-assisted activation pathway and the formation of a cobalt hydride as the active form of the complex.

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Highly Efficient Synthesis of Silyl Building Blocks Based on Endiynes

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This research focuses on the development of highly efficient and selective methods for the synthesis of silyl building blocks based on endiynes - organic compounds of significant importance in medicinal chemistry, materials science, and organic synthesis. Due to the high reactivity and limited natural availability of endiynes, there is a need to develop new strategies enabling their controlled synthesis.

The aim of this research is to establish protocols for the synthesis of silyl endiynes using transition metal–catalyzed coupling reactions such as Hiyama-Denmark, Suzuki, Sonogashira, and Cadiot–Chodkiewicz (Glaser-type) reactions. A key aspect of this approach is the use of reagents containing silyl groups, which enable precise control over molecular structure and the stepwise construction of conjugated systems.

This work includes the synthesis of a series of new silyl endiynes and the optimization of reaction conditions with respect to yield and selectivity. The obtained compounds will be thoroughly characterized using spectroscopic methods (NMR, IR, UV), mass spectrometry, and X-ray diffraction, enabling full structural determination.

The expected outcome of this research is the development of new, well-characterized building blocks that can be applied in the synthesis of more complex endiyne systems. The developed methods may contribute to increasing the availability of this class of compounds and expanding their applications in biology, medicine, and materials chemistry. Authors: Julia Żwirskaa, b, Kinga Stefanowskaa, Adrian Franczyka a Center for Advanced Technologies, Adam Mickiewicz University, Uniwersytetu Poznańskiego 10, 61-690 Poznań, Poland

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Highly Efficient Synthesis of Novel Halogeno-1-en-3-ynes

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The aim of the studies is to develop an efficient and selective method for the synthesis of halogeno-1-en-3-ynes via halogenodesilylation of appropriately designed organosilicon precursors. Halogeno-1,3-enynes constitute a unique class of conjugated π-systems whose chemical properties and reactivity are significantly influenced by the presence of a halogen atom adjacent to the enyne fragment. These compounds exhibit high synthetic potential as versatile intermediates in coupling reactions.

Within the research, the synthesis of bromo- and iodo-substituted enynes via a halogenodesilylation approach is planned. Appropriate reagents, catalysts, and reaction conditions will be systematically optimized to establish the most efficient synthetic protocols. The obtained compounds will be isolated and purified using flash chromatography, conventional column chromatography, extraction, or crystallization. Their structures will be comprehensively characterized using NMR, IR, and UV spectroscopy, mass spectrometry, and X-ray diffraction analysis.

The expected outcome of the work is the development of an efficient strategy for the synthesis of previously undescribed halogeno-1-en-3-ynes, together with an expanded understanding of their structural features, properties, and reactivity. The results may contribute to the development of new and highly effective methods for the synthesis of organic compounds and functional materials. Aleksandra Zajączkowska a,b, Kinga Stefanowskaa, Adrian Franczyka a Center for Advanced Technologies, Adam Mickiewicz University, Uniwersytetu Poznańskiego 10, 61-690 Poznań, Poland b Faculty of Chemistry, Adam Mickiewicz University, Uniwersytetu Poznańskiego 8, 61-690 Poznań, Poland

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3D printed flow-mode atmospheric pressure glow discharge reactor for the synthesis of multi-metallic d-block metal nanocluster catalysts

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In recent years, plasma-based systems have attracted increasing attention as tools for the synthesis of nanoparticles. Due to the presence of reactive oxygen and nitrogen species at the plasma-liquid interface, rapid synthesis of multi-metallic nanocluster catalysts (NCs) is possible without the need for reducing agents.

The synthesis of NCs was carried out using direct current atmospheric pressure glow discharge (dc-APGD) in configurations with a flowing liquid acting as either the cathode (FLC) or the anode (FLA). The plasma system, tailored to the conducted studies, was designed and fabricated using 3D printing via stereolithography. The investigated precursors included compounds containing elements such as Os, Pd, Pt, Re, Ru, and W.

The synthesized NCs were evaluated in terms of particle size distribution, zeta potential, polydispersity index, and catalytic activity. Additionally, their crystalline and granulometric properties were analyzed using X-ray photoelectron spectroscopy (XPS) and high-resolution transmission electron microscopy (HRTEM). The catalytic performance of the obtained NCs was assessed using a model reaction, the reduction of 4-nitrophenol with sodium borohydride as the reducing agent. $Os^{Pd/Cr}$NCs and Ru^{W}NCs exhibited the most favorable catalytic properties. HRTEM analysis revealed that $Os^{Pd/Cr}$NCs and Ru^{W}NCs were characterized by particle sizes below 10 nm [1].

The use of cold atmospheric plasma enabled a straightforward synthesis of NCs without the need for additional reagents or discharge gases. The obtained NCs demonstrate significant application potential, particularly in the fields of catalysis and functional materials.

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Sensitive Determination of Glucocorticosteroids in Environmental Waters Using SPE and LC–MS/MS

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The wide use of glucocorticoids in medicine and veterinary medicine makes them one of the most rapidly growing groups of contaminants of emerging concern. It is believed that up to 20% of their initial concentration is being excreted to the environment in the unchanged form [1]. The biggest source of glucocorticoids in the river water originates from domestic sewage that is leaving the treatment plants [2]. Present-day methods for wastewater treatment do not provide sufficient removal rates, making this pollution a potential high risk to the environment [1].

In this work, analytical research based on solid phase extraction (SPE) and liquid chromatography combined with tandem mass spectrometry (LC–MS/MS) was performed to demonstrate the potential for the determination of selected glucocorticoids from environmental samples. The conditions of SPE were optimized using water solutions as the matrix to ensure a high level of extraction. The best conditions for parameters like type of column, solvent, and volume of the solutions were selected, and the method was used for analyzing environmental samples. Silica-based end-capped C18 sorbent and ethanol as an eluting solvent proved to be the most efficient from all tested condition sets. It proved to be much more difficult to replicate these results using real samples, as other parameters needed to be taken into account. That is why the optimal conditions varied between these two tests. Prepared analytes, in both instances, were later analyzed using LC–MS/MS.

The results obtained served as a basis to provide an insight into the possibility of determining glucocorticoids from environmental samples. The comparison of the level of detection of these compounds in controlled conditions (water solutions) with real samples (lake water) gave a clear view of the sample matrix effect on the determination of selected pharmaceuticals. The proposed method proved to be very effective, which allowed us to draw meaningful conclusions for further research.

This work was supported by the Polish Ministry of Education and Science (0911/SBAD/2606).

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Development of a Method for the Determination of Homocysteine Thiolactone in Human Urine Using HPLC-UV

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In recent decades, the results of clinical studies have indicated a growing number of individuals affected by so-called civilization diseases. The development of these disorders is associated, among other factors, with disturbances in the metabolism of sulfur-containing compounds, including homocysteine (Hcy) and its intramolecular ester—homocysteine thiolactone (HTL). However, the exact role of this compound under physiological and pathological conditions in the human body has not yet been fully elucidated. This highlights the need to develop new, sensitive, and simple analytical tools for monitoring HTL levels in biological fluids.

Currently available methods for HTL determination are mainly based on separation techniques, particularly chromatographic approaches, and have been applied to plasma, urine, and saliva samples. Notably, no method based on high-performance liquid chromatography coupled with UV detection (HPLC-UV) has yet been developed for the determination of HTL in urine, despite the fact that this technique is one of the most widely used in bioanalytical laboratories worldwide. Therefore, the aim of our study was to fill this gap by developing such a method.

During the oral presentation, the results obtained at the stage of optimizing experimental conditions, including urine sample preparation, analysis, and validation of the newly developed analytical method, will be presented.

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Application of phytoremediation in the elimination of 17β-estradiol from surface waters

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17β-Estradiol (E2) is one of the most potent natural estrogens among endocrine disrupting substances (EDCs) and poses a serious threat to the aquatic environment. This chemical is released into surface waters via wastewater treatment plants and agricultural activities[1].Even at low concentrations (ng/L range), the presence of 17β-Estradiol in surface waters is responsible for endocrine disruption in aquatic species, including fish feminization and changes in the ecosystem[2]

In light of the low efficiency of conventional wastewater treatment processes, there is a greater interest in the use of biological processes, including phytoremediation processes. Phytoremediation is defined as the use of the bio-remedial potential of aquatic plants and their rhizosphere in the removal of pollutants by adsorption, bioaccumulation, or biotransformation processes. Constructed wetlands are reported to be highly efficient in removing estrogens by aquatic plants[3]

The objective of the presentation is to evaluate the potential of phytoremediation for removing 17β-estradiol from surface waters.

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Assessment of Total and Bioavailable Silicon Content in Urtica dioica and Equisetum arvense: Effects of Harvest Season and Drying Method

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Silicon is a vital trace element increasingly acknowledged for its contribution to human health, particularly in the integrity of connective tissue and bone metabolism. Medicinal flora such as *Urtica dioica* and *Equisetum arvense* are regarded as abundant dietary sources of silicon; however, its bioavailability is significantly influenced by both plant-associated and processing determinants [1].

The objective of this study was to assess the concentration of total silicon and bioavailable silicon in *Urtica dioica* and *Equisetum arvense*, with particular focus on the impact of harvest season and drying method. Specimens were gathered during two growth cycles (spring and autumn) and subjected to two distinct drying methodologies: air-drying and freeze-drying. Silicon concentration was quantified using spectrophotometric techniques using molybdenite assay.

The results demonstrated considerable variability contingent on species, season, and processing approach. In general, *Urtica dioica* displayed elevated silicon content (total: 3.17 - 4.33 mg Si/g; bioavailable: 2.61 - 3.69 mg Si/g) in comparison to *Equisetum arvense* (total: 1.33 - 3.47 mg Si/g; bioavailable: 1.36 - 2.92 mg Si/g). Seasonal discrepancies were notable, with autumn specimens exhibiting significantly enhanced silicon levels compared to spring specimens, with increases surpassing up to 100% for bioavailable silicon. Moreover, the drying technique exerted a pronounced influence on silicon availability: freeze-drying yielded approximately 43% greater bioavailable silicon content relative to air-drying.

The results suggest that both harvest timing and post-harvest processing are integral determinants of silicon bioavailability in medicinal plants. These findings may enhance the understanding of factors influencing the nutritional and functional quality of plant-derived products and may hold significance for the optimization of processing techniques in the food and pharmaceutical sectors.

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DEVELOPMENT OF BIODEGRADABLE CAR SHAMPOO CONCENTRATES

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Biodegradable car shampoo concentrates are being developed to reduce the environmental impact of surfactants released into wastewater during vehicle washing. Due to the large volumes of water used in washing processes, even single cleaning events may generate wastewater containing surfactants, oils, greases, heavy metals, and other contaminants. Therefore, the design of highly biodegradable formulations is an important challenge in the development of modern automotive cleaning products. At the same time, high biodegradability must be achieved without compromising other essential product characteristics. Water-based formulations are particularly vulnerable to microbiological contamination, which may negatively affect their physicochemical stability, sensory properties, performance, and safety of use. For this reason, the selection of effective preservative systems and the evaluation of microbiological protection are crucial steps in formulation development. Equally important are consumer-oriented properties, including ease of use, odor, appearance, foaming behavior, and overall acceptance of the product. [1-3] This study presents an integrated approach to the development of biodegradable car shampoo concentrates, combining environmental, microbiological, and consumer-related criteria in order to obtain formulations that are both sustainable and functionally effective.Only raw materials characterized by a high degree of biodegradability and favorable performance properties were used in the study. The formulations were based on mixtures of biosurfactants, including alkyl polyglucosides and octyl alcohol ethoxylates. As a result, a series of two car shampoo concentrates was developed, both demonstrating 100% biodegradability under aerobic conditions in an aqueous environment. The obtained formulations showed no identified harmful effects for users and exhibited very good functional properties, including effective cleaning performance and desirable foaming behavior.

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Microwave-assisted catalytic pyrolysis of polyolefin waste into hydrogen-rich gas

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Plastic waste is one of the most serious problems of our times. Its excessive production and lack of proper management, causes, that huge amounts of waste being accumulated on the landfills. One of the reasons for this is the lack of an effective and environmentally friendly method of plastic waste processing. This is partly due to the absence of efficient and environmentally friendly methods for processing plastic waste. While traditional pyrolysis methods focus primarily on producing liquid hydrocarbons or, to a lesser extent, gaseous products , the conversion of plastic waste into hydrogen and solid carbon can be much more promising and carbon-neutral path.

The primary goal of this research was to verify the hypothesis about the occurrence of secondary catalytic reactions, which were observed in previous studies conducted in a continuous process. This study aimed to determine whether this mechanism could be successfully transferred to a batch system to increase hydrogen yield and to simulate continuous process in a batch reactor.

A modified batch system with an additional catalyst bed in the form of a separate layer was used.. A mixture of iron oxides was used as the primary catalyst. In the secondary zone, an iron-impregnated carbon catalyst (5%Fe/AC) was used to mimic the solid product generated in a continuous reactor, which consists mainly of carbon and iron from the primary catalyst. This additional zone was designed to facilitate the further decomposition of hydrocarbons rising from the lower part of the reactor. The application of the two-zone batch system resulted in an approximately threefold increase in hydrogen yield compared to the single-zone batch process. The resulting gas composition was similar to the results achieved in a continuous reactor, confirming the effectiveness of simulating of a continuous process in a batch system. In the final stage, the efficiency of catalyst recycling was evaluated. Despite a decrease in activity, the yield in the two-zone system remained twice as high as that achieved using traditional methods without the dual-zone configuration.

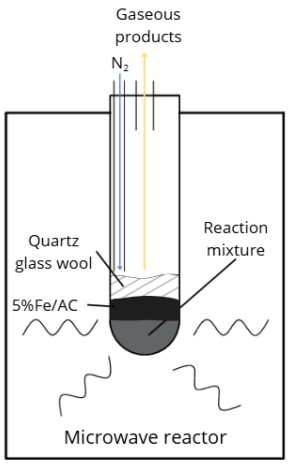

Fig. 1. Schematic of the setup for batch pyrolysis of polyolefin waste.

Photocatalytic CO_2 reduction to formic acid in presence of NH_2-MIL-125@ZIF-8

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The accumulation of CO_2 in industrial waste streams presents an opportunity for the economically viable production of chemical fuels. Photocatalytic CO_2 reduction offers a pathway to transform these emissions into useful chemicals, such as formic acid, by using solar energy as an energy source to enhance the overall process economics[1][2]. MOF-MOF composites offer a possibility to overcome limitations caused by singular MOF structures by joining their advantages. For instance, NH_2-MIL-125 is recognized for its stability and photocatalytic activity, it's CO_2 capture capacity can be augmented by other material. ZIF-8 is known for its good CO_2 adsorption and concentration capabilities, though it lacks photocatalytic activity on it's own. By integrating these materials, there is a possibility to couple high-capacity CO_2 sorption with photocatalytic properties. This research details an investigation into the synthesis and evaluation of NH_2-MIL-125@ZIF-8 composite materials optimized for the photocatalytic CO_2 reduction to formic acid.

In the first stage, a range of synthesis parameters was explored to identify the most reproducible and morphologically uniform candidates. This process resulted in the selection of four composite variants. These composites, along with pristine NH_2-MIL-125[3] and ZIF-8[4], were subjected to process of physicochemical characterization involving pXRD, BET, SEM, TEM and EDS mapping confirming the presence of core-shell and core-satellite structures with desired properties.

Next stage involved photocatalytic testing to identify the most efficient candidate for CO_2 reduction. NH_2-MIL-125 activity served as a baseline, the 2x2-MIM composite demonstrated significantly enhanced performancein relation to that baseline. This indicates a synergistic effect arising from the structural interaction between materials within the composite.

To ensure the produced formic acid was a direct product of the substrate rather than impurities in 2x2-MIM variant, ^{13}C-labeled CO_2 experiments were conducted; GC-MS analysis confirmed the presence of labeled formic acid, confirming the assumed pathway. Action spectra analysis (400–600 nm) was utilized to map the wavelength-dependent photoactivity. The photoactivity observed after illumination at 440 nm aligns precisely with the DRS UV-Vis absorption profile, further validating the assumption. This study demonstrates that it is possible to engineer MOF-MOF composites that exploit synergistic effects for superior photocatalytic CO_2 conversion.

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EXPLORING EXPERIMENTAL METHODS FOR TIN INTRODUCTION INTO HARD CARBON-BASED COMPOSITES FOR NA-ION BATTERY ANODES

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Developing high-performance anode materials is a critical challenge in advancing sodium-ion battery technology. Among the available anode materials, hard carbon is considered one of the most promising candidates due to its abundance, structural stability, and suitable electrochemical properties for sodium storage. However, its limited reversible capacity and moderate cycling stability hinder practical use. To improve the electrochemical performance of hard carbon, incorporating high-capacity alloying elements such as tin has been widely explored. Nevertheless, achieving homogeneous tin distribution and maintaining structural stability during repeated sodiation and desodiation cycles are still difficult due to the sodium-tin alloy's extensive swelling behavior.

This study explored two synthesis routes for tin-hard carbon composites. In the first, hard carbon and tin salt were hydrothermally treated at 180 °C and annealed at 700 °C under hydrogen. In the second, chitin, tin salt, and ammonia underwent hydrothermal treatment under identical conditions, followed by annealing at 800 °C in ammonia. The ammonia-assisted synthesis route delivered the best performance of the anode material, achieving a specific capacity of nearly 400 mAh g−1 after 500 cycles. These results demonstrate that controlled synthesis environments significantly influence composite structure and electrochemical behavior. The proposed strategy provides a promising pathway for designing stable and high-capacity hard carbon/tin composite anodes for advanced sodium-ion batteries.

Computational Design of a Mixed-Matrix Membrane (Cellulose Acetate/MOFs) for Highly Selective Filtration of Heavy Metals and Toxins in Cigarette Smoke

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Conventional cellulose acetate (CA) cigarette filters exhibit limited selectivity, showing poor efficiency toward highly toxic heavy metals and volatile gaseous species while non-selectively retaining larger compounds. In this computational study, an advanced Mixed-Matrix Membrane (MMM) was designed by incorporating Metal-Organic Frameworks (MOFs) into a CA matrix to achieve synergistic and selective toxin removal from cigarette smoke.

Molecular Dynamics (MD) and Monte Carlo simulations performed in LAMMPS were used to investigate the thermodynamic interactions between toxic species and their hydration environments. The results revealed that heavy metal ions such as Cd2+, Pb 2+, and Ni 2+ exhibit strong solvation energies, reaching values as low as −125 kcal/mol for Ni 2+, indicating that efficient capture requires chemically active adsorption sites. To address this challenge, UiO-66-NH2 was incorporated as a chelating component capable of overcoming hydration barriers through strong coordination between amine functional groups and metal cations. To selectively target small gaseous toxins while preserving nicotine transport, the ultramicroporous MOF SIFSIX-3-Ni was introduced. Structural characterization using Zeo++ and PoreBlazer confirmed a pore limiting diameter (PLD) of approximately 3.4 Å, enabling selective adsorption of small toxic gases such as CO and HCN while sterically excluding larger molecules, including nicotine (~6.0 Å kinetic diameter). The complete MMM system was successfully modeled and compressed to a realistic density of approximately 1.30 g/cm3. Spatial domain partitioning analysis demonstrated a continuous and defect-free polymer network with intrinsic pore limiting diameters below 2.20 Å, supporting activated diffusion mechanisms and preventing the formation of macroscopic voids.

Overall, this study demonstrates the geometric and thermodynamic feasibility of a highly selective MMM-based cigarette filter and highlights the potential of MOF-integrated membranes as a new strategy for targeted toxin reduction in tobacco filtration technologies .

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$SiC–SiO_2$ Monolithic Electrode Fabrication from Recycled Oil and Starchless Avocado Seeds

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Hierarchically porous $SiC–SiO_2$ monolithic electrodes were fabricated from starchless avocado seed residues and recycled cooking oil through a copolymer-emulsion high internal phase emulsion (HIPE) approach. This methodology proposes the valorization of agroindustrial and urban waste as sustainable carbon sources for the development of advanced electrochemical materials.

The synthesis involved the preparation of HIPE-derived monoliths followed by thermal treatment to promote the formation of carbonaceous and silicon-containing phases. The obtained monoliths were characterized by X-ray diffraction (XRD), ATR-FTIR, scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), and energy dispersive spectroscopy (EDS).

Electrochemical performance was evaluated by cyclic voltammetry at different scan rates. The electrodes exhibited capacitive behavior in KOH electrolyte and pseudocapacitive behavior in $LiClO_4$, demonstrating their potential for energy storage and electrochemical applications.

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Flammulina velutipes – an underappreciated mushroom in Poland

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The goal of this study is to analyze the most recent publications from 2026 on the nutritional properties and other uses of a mushroom commonly found in the natural environment - *Flammulina velutipes* (hereinafter FV). It is characterized by a rich nutritional profile. Despite being one of the most cultivated mushrooms in Asia and long approved for sale in Poland, you won't find it in grocery stores. FV is a low-calorie food, while also contains all the vital nutrients: proteins (all exogenous amino acids), fats (including omega-3), and polysaccharides. Phytochemical studies have revealed the presence of vitamins, as well as significant levels of polyphenols, saponins, flavonoids, potassium, magnesium, and calcium. Thanks to its bioactive compounds, FV exhibits antibacterial, anti-inflammatory, antidiabetic, anticancer, antiviral, and immunomodulatory effects, as well as neuroprotective properties, and helps prevent heart and liver diseases. In terms of anti-inflammatory activity, as demonstrated in protein denaturation inhibition assay, it is even more effective than prednisolone. It is also difficult to overstate the importance of FV polysaccharides in protecting the digestive tract (by shaping the gut microbiota) and reducing the harmful effects of drugs, pathogens, poor nutritional habits, and psychological stress. Fermented FV post-production residues can be used as a feed additive with antibacterial and antifungal properties, as an alternative to antibiotics. Due to its bioactive reducing compounds, FV can be used in the biosynthesis of nanoparticles with therapeutic applications. The substances contained in FV exosomes are used as a natural preservative in meat products. FV polysaccharides do not have the disadvantages of synthetic compounds (short shelf life, high costs, health hazards), so they are increasingly used in the food and cosmetics industries such as hydrogels, films, and coatings. This study summarizes the properties and potential uses of FV as a usable mushroom with unexplored potential in Poland. Unfortunately the season when FV fruiting bodies occur in late autumn and winter, when wild mushroom markets are closed, making it impossible to distribute them. However the development of a cultivation methodology by Prof. H. Muszynska's team offers hope for the wider distribution of this highly valuable anf delicious mushroom.

The author is sincerely grateful to Ph D. Aleksander Łukanowski for his valuable mentorship and comments.

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[2] Fengxiang Liang et al. "Valorization of Flammulina velutipes residue into a feed additive via co-fermentation to control Escherichia coli" Bioresource Technology 2026

[3] Yucheng He et al. "A multi-functional strategy using mushroom exosomes to control oxidation and suppress hazardous compounds in chicken sausages" Current Research in Food Science 2026

[4] Naveen Thakur et al. "Mushroom-mediated synthesis of nanoparticles: A green route to functional nanomaterials for biomedical and optoelectronic integration" Next Materials 2026

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Antioxidant Activity of Organic and Conventional Broccoli Stems for Upcycling

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Broccoli stems make up 21% of the plant's total mass and are a significant source of global agricultural waste largely underexplored. This research assesses the antioxidant potential of both conventional and organic Ecuadorian broccoli stems to determine their suitability for upcycling into food and pharmaceutical products.

Four broccoli stem experimental units (OBS, CBS, OBS_L, and CBS_L) were dehydrated at 45°C in a forced-air oven for 48 hours and then ground into powder. Bioactive compounds were extracted using ultrasound-assisted extraction (UAE) and freeze-dried through sublimation and ultra-freezing. The antioxidant activity of the extracts was assessed with the ABTS assay. IC50 values were calculated to measure their potency and compared with pure standards of Ascorbic Acid and Trolox. All dose-response models showed very high reliability. The standards, Ascorbic Acid and Trolox, displayed the highest overall potencies, with IC50 values of 97.70 ppm and 112.41 ppm, respectively. Among the agricultural samples, the CBS_L extract was the most potent (IC50= 194.66 ppm), nearly matching the pure standards. Additionally, standard organic broccoli stems (OBS, IC50 = 233.68 ppm) had approximately twice the antioxidant capacity of standard conventional stems (CBS, IC50 = 485.13 ppm).

The results support the idea that crops grown without synthetic chemicals produce higher levels of defensive phytochemicals, which explains why OBS outperforms CBS. Extreme high-altitude stressors like UV radiation and cold also stimulate increased antioxidant production for protection, enhancing the plant's antioxidant profile. Ultimately, the CBS_L extract emerged as the most effective and sustainable natural antioxidant among all samples, indicating that regional agricultural waste can be a valuable and commercial source of natural antioxidants and upcycling.

Thank you to my thesis tutors for always push me forward to participate in congresses and scientific event presentations, without their guidance, I would not achieve as much

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From Waste to Growth Medium: Coffee Waste as a Substrate for Oleaginous Yeast Growth

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Coffee waste, especially spent coffee grounds, represents a significant stream of biomass waste, and its valorization is consistent with circular economy principles and the search for new applications of organic residues. [1,4]

The aim of this study was to evaluate the potential of coffee waste as a substrate for microbial growth. Yeast cultivation was performed on a hydrolysate obtained from spent coffee grounds and on solid media supplemented with raw and defatted spent coffee grounds. Particular attention was given to the growth of different Yarrowia lipolytica strains. [2,3]

The average biomass yield obtained on SCG hydrolysate was 2.59±0.44 g dry weight/dm3, whereas the control YPG medium reached 8.87±0.34 g dry weight/dm3. In addition, determination of reducing sugars by the DNS method showed a decrease in SCG hydrolysate from 17.81±1.07 g glucose/dm3 on day 0 to 11.68±2.25 g glucose/dm3 on day 4, indicating substrate utilization by the yeast. [5]

On solid media containing raw and defatted spent coffee grounds, microbial growth was expressed as CFU. The growth of different strains on solid media supplemented with coffee extracts was evaluated using an original qualitative scale developed for this study, enabling a comparative assessment of strain responses to different coffee-based media.

The obtained results indicate that coffee waste may be a promising raw material for bioprocess applications

Keywords: coffee waste, Yarrowia lipolytica, oleaginous yeasts, waste valorization, circular economy

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Lignocellulosic agri-food wastes as substrates for biomass production and biochemical profiling of *Yarrowia* spp.

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Yeasts of the genus *Yarrowia* represent a group of unconventional yeasts characterized by unique metabolic features and the ability to utilize unusual substrates and produce valuable secondary metabolites. In recent years, new species of this genus have been described, showing similarity to *Yarrowia lipolytica*, whose biochemical characteristics, metabolism, and potential applications are still under investigation. Lignocellulosic wastes constitute a potentially valuable carbon source. Sugar beet pulp and orange peels, as readily available by-products, are rich in cellulose, hemicellulose, and pectins, making them promising fermentation substrates. The presence of minerals and nutrients supports yeast growth and promotes biomass production, single-cell protein formation, and other metabolites.

The aim of the study was to evaluate the effect of selected lignocellulosic wastes (sugar beet pulp and orange peels) on biomass yield and biochemical composition of three yeast strains: *Y. lipolytica* W29, *Y. lipolytica* KKP379, and *Y. deformans* KKP3841, including protein and lipid content as well as fatty acid profile. Due to the lack of cellulolytic enzyme activity in the studied yeasts, the substrates were subjected to acid hydrolysis, and the obtained hydrolysates were used as carbon sources in the culture media.

The results demonstrated a clear effect of the carbon source on biomass yield in all tested yeast strains. The use of lignocellulosic waste hydrolysates resulted in a marked increase in biomass yield compared to the glucose control, with the highest values obtained for orange peel hydrolysate. The protein content in biomass ranged from 15,7% to 25,0%, while lipid content ranged from 4,99% to 12,4%, depending on the substrate and strain. The use of lignocellulosic wastes also influenced the fatty acid profile, increasing the proportion of polyunsaturated fatty acids (PUFA) up to 46,2% in cultures grown on orange peel hydrolysate, compared to 12,7% in the control.

The obtained results indicate that lignocellulosic agri-food wastes can serve as efficient and sustainable substrates for the cultivation of *Yarrowia* spp., enabling the production of biomass with high nutritional value and application potential.

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PREPARATION AND CHARACTERIZATION OF CHITOSAN-POLYPHENOL BASED FILMS CONTAINING BERBERIS VULGARIS FRUITS EXTRACT

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Biopolymer-based materials are increasingly considered as sustainable alternatives to conventional plastic packaging. Among these materials, chitosan has attracted considerable attention due to its biodegradability, biocompatibility, and excellent film-forming ability [1]. The incorporation of plant-derived polyphenols into chitosan matrices can enhance the physicochemical and functional properties of active packaging materials [2]. In this study, a polyphenol-rich extract from Berberis vulgaris fruits, obtained using NADES (ChCl:LA:H2O), is incorporated into chitosan matrices to fabricate the composite films through the solvent-casting technique.

To evaluate the effect of different components on film properties, films based on pure chitosan, chitosan containing NADES, and films enriched with B. vulgaris extract are investigated. Mechanical properties are analyzed to determine tensile strength and flexibility, while the release behavior of polyphenolic compounds is examined in different food simulants, including aqueous and ethanolic media (10%, 20%, and 50%). The obtained results indicate that the presence of NADES and plant extract influences the mechanical strength of the films and enables controlled diffusion of bioactive compounds. FTIR analysis confirmed interactions among chitosan, NADES, and the polyphenol-rich extract in the developed films. Further characterization including SEM analysis, antioxidant and antimicrobial activity, stability and biodegradation are employed to investigate the molecular interactions and the functional performance of the developed films.

The developed films are intended for potential application in active food packaging systems to improve product stability and extend shelf life. This study provides insight into structure-property relationships of chitosan-polyphenol-based films and highlights their potential as biodegradable active packaging materials.

Keywords: chitosan, Berberis vulgaris, polyphenols, active packaging

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Conformational Instability of Monoclonal Antibodies During Chromatographic Processes: Analysis and Mitigation Strategies

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Monoclonal antibodies (mAbs) have become a cornerstone of modern biopharmaceuticals due to their high specificity and broad application in the treatment of cancer, autoimmune, and infectious diseases [1,2]. Conformational instability of monoclonal antibodies during chromatographic processes represents a significant challenge in downstream bioprocessing, directly impacting product quality, yield, and therapeutic efficacy [3]. This study analyzes the molecular and physicochemical factors contributing to structural perturbations of mAbs under chromatographic conditions, including pH fluctuations, ionic strength, shear stress, and interactions with stationary phases. Particular attention is given to mechanisms such as partial unfolding, aggregation, and surface-induced denaturation occurring during protein capture and polishing steps [3,4].

The work further reviews analytical techniques used to monitor conformational changes, such as spectroscopy and chromatography-based assays, highlighting their role in early detection of instability. Based on these insights, strategies for minimizing conformational degradation are discussed, including optimization of buffer systems, selection of milder chromatographic media, control of process parameters, and implementation of stabilizing excipients [4,5].

The findings emphasize the importance of integrating structural stability considerations into process design to ensure robustness and reproducibility in mAb purification. This contributes to improved product consistency and supports the development of efficient, scalable, and regulatory-compliant biopharmaceutical manufacturing processes.

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Analysis of SERPINA3 protein expression in inverted papillomas of the paranasal sinuses

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Inverted papilloma (IP) is a benign, though locally aggressive epithelial tumor of the paranasal sinuses and nasal cavity. It is characterized by a high recurrence rate and a possible potential for malignant transformation. The exact molecular mechanisms underlying its pathogenesis are still not completely understood. SERPINA3 (alpha-1-antichymotrypsin) is a serine protease inhibitor that plays an important role in inflammatory mechanisms and tissue remodeling. However, its specific expression patterns in sinonasal inverted papillomas have not been thoroughly investigated. [1–3]

Our study aimed to evaluate the expression of the SERPINA3 protein in IP tissue samples to explore its potential involvement in the transformation of normal tissue into abnormal. The study material consisted of histopathological slides (56 investigated samples and 8 control samples) obtained from patients of the Department of Otolaryngology and Laryngological Oncology, Poznan University of Medical Sciences. SERPINA3 expression was assessed by specific immunohistochemistry staining. After digital scanning, the SERPINA3 expression levels were subjected to quantitative and statistical analysis.

Statistical analysis revealed a significantly higher expression of SERPINA3 protein in inverted papilloma tissues compared to the control group. These preliminary findings indicate that increased SERPINA3 levels are present in inverted papillomas, suggesting its potential association with the tumor's pathophysiology and local tissue remodeling.

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Ophiobolin A Modulates Apoptosis-Related and Antioxidant Gene Expression in T98G Glioblastoma Cells

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Background: Gliomas are the most common group of primary brain tumors, among which glioblastoma multiforme (GBM) is characterized by a particularly poor prognosis and the limited effectiveness of available treatments. Ophiobolin A (OP-A), a natural sesquiterpenoid, exhibits promising anticancer properties, including the ability to cross the blood-brain barrier and induce paraptosis-like cell death. However, the molecular mechanisms underlying its action, especially in the early phase of the cellular response, remain not fully understood.

Aim: The aim of this study was to analyze early changes in the expression of genes associated with apoptosis, ferroptosis, and antioxidant mechanisms in T98G glioma cells under the influence of OP-A.

Methods: Gene expression was assessed by RT-qPCR, and statistical analysis was performed using the Mann–Whitney U test.

Results: A significant increase in the *BAX/BCL2* ratio and significantly increased *FAS* expression were demonstrated, indicating activation of both the intrinsic (mitochondrial) and extrinsic (receptor-mediated) apoptotic pathways. At the same time, only a statistically non-significant trend toward increased *CASP3* expression was observed. No significant changes were found in the expression of genes associated with ferroptosis (*GPX4*, *ACSL4*, *GCH1*). In contrast, *SLC7A11* expression was significantly elevated, suggesting the activation of compensatory antioxidant mechanisms.

Conclusions: The results indicate that OP-A induces an early transcriptional response associated with the activation of apoptotic pathways and selective modulation of redox homeostasis, without significant activation of ferroptosis. The observed changes are consistent with the mechanism of action of OP-A based on disruption of thiol homeostasis and support its potential as a compound capable of overcoming GBM cell resistance to apoptosis.

Analysis of the Effects of oxLDL on the Organization and Dynamics of Endothelial Cell Migration

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The aim of this study was to evaluate the effect of oxidized low-density lipoprotein (oxLDL) on the organization and migration dynamics of endothelial cells (HUVECs) under *in vitro* conditions. The investigated topic concerned the role of endothelial dysfunction, chronic inflammation, and oxidative stress in the development of cardiovascular diseases, particularly atherosclerosis [1, 2].

In the experimental part, HUVEC cell cultures were prepared and divided into a control group and an experimental group exposed to oxLDL at a concentration of 50 µg/mL. Cell migration was recorded using time-lapse microscopy with the Celloger Nano system for 12 hours with a 5-minute interval, yielding 145 images for each group. Trajectories of 20 cells per group were analyzed. Data analysis was performed using *ImageJ* and the *Chemotaxis and Migration Tool*, enabling the determination of parameters describing cell migration.

The analysis showed that exposure of endothelial cells to oxLDL led to a statistically significant increase in cell migratory activity. The mean migration speed increased from 0.58 ± 0.08 µm/min in the control group to 1.34 ± 0.21 µm/min in the oxLDL-exposed group ($p < 0.05$). At the same time, accumulated distance increased from 420.54 ± 57.94 µm to 963.75 ± 154.05 µm ($p < 0.05$). Despite a substantial increase in motility, no statistically significant differences in Euclidean distance between groups were observed. A decrease in migration directness from 0.18 ± 0.09 to 0.10 ± 0.07 was also observed, as well as a change in the Forward Migration Index (*FMI*) along the y-axis from 0.09 ± 0.15 to −0.04 ± 0.08, indicating impaired organization and directionality of cell movement.

The obtained results suggest that oxLDL induces chemokinesis, leading to increased spontaneous motility of endothelial cells without triggering an organized chemotactic response. The observed changes may be associated with LOX-1 receptor activation, induction of oxidative stress, and disruption of actin cytoskeleton reorganization [2, 3, 4]. The applied research approach enabled a quantitative assessment of changes in endothelial cell migration parameters under the influence of oxLDL and may serve as a valuable tool in further studies on the mechanisms of endothelial dysfunction and the impact of pro-inflammatory factors on regenerative processes and vascular remodeling.

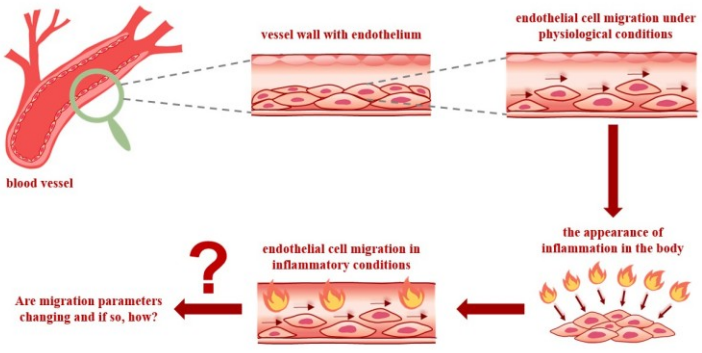

Fig. 1. Graphical abstract

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Exploring Extra-Neuronal Effects of Citalopram on Human Colon Cells

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Selective serotonin reuptake inhibitors (SSRIs), including citalopram, are widely prescribed in the treatment of depression among colorectal cancer (CRC) patients, yet their direct effects on intestinal cellular metabolism remain poorly understood. This study presents an integrated spectroscopic analysis of citalopram-induced biochemical and metabolic responses in human colon cells, combining data from multiple CRC models (Caco-2, LoVo) and normal fibroblasts (CCD-18Co) using label-free Raman spectroscopy and imaging.

Single-cell Raman imaging enabled high-resolution mapping of subcellular structures, including the endoplasmic reticulum (ER) and lipid droplets (LDs), providing insight into drug-induced molecular reorganization. Multivariate statistical analysis (PCA and cluster analysis) combined with ratiometric approaches revealed significant alterations in key biochemical markers, such as I1444/1660, I1055/1444, I1660/1256, I1080/1292, and I1004/1660, associated with lipid metabolism, cholesterol homeostasis, protein conformation, and nucleic acid activity.

Citalopram exposure induced metabolic reprogramming in cancer cells, characterized by increased lipid accumulation, disrupted protein phosphorylation, and enhanced oxidative stress susceptibility, consistent with ER stress and activation of apoptotic pathways. Morphological analysis demonstrated a reduction in ER and LD areas, indicating impaired metabolic stability. In contrast, normal CCD-18Co cells exhibited adaptive responses, including increased lipid droplet accumulation and partial recovery of metabolic balance, suggesting enhanced detoxification mechanisms. Complementary XTT assays confirmed a dual, time- and dose-dependent effect: stimulation of normal cell viability and inhibition of cancer cell proliferation, particularly after prolonged exposure. These findings indicate selective vulnerability of metabolically reprogrammed cancer cells, linked to mitochondrial dysfunction, ROS accumulation, and interference with serotonin-dependent signaling.

Overall, this work demonstrates the utility of Raman spectroscopy as a powerful, non-invasive tool for monitoring drug-induced biochemical changes at the subcellular level. Citalopram exerts context-dependent effects, promoting homeostasis in normal cells while inducing metabolic stress and anti-proliferative responses in cancer cells, supporting its potential repositioning as an adjuvant agent in CRC therapy.

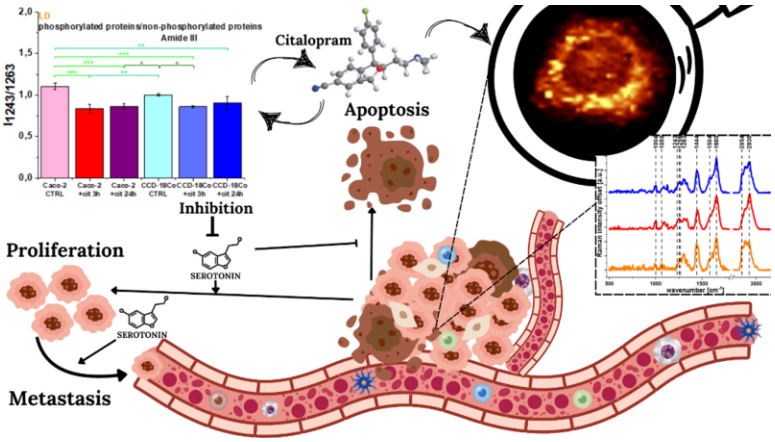

Fig. 1. Schematic presentation of the mechanism of pharmacokinetic profile of citalopram and the application of Raman spectroscopy in tracking citalopram-induced changes in human colon cells

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14-3-3 proteins as partners of NPAS4, a bHLH-PAS family member

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14-3-3 proteins are highly expressed throughout the body and implicated in many diseases, from cancer to neurodegenerative disorders. These proteins belongs to family of homologous proteins existing in seven different isoforms (β, γ, ε, η, ζ, σ, and τ/θ) involved in many cellular signalling pathways via protein-protein interactions (PIP). In mammals, their highest expression has been observed in the brain. NPAS4 (Neuronal PAS domain-containing protein 4) functioning as a neuroprotective factor, belongs to the basic helix-loop-helix-Per-ARNT-Sim (bHLH-PAS) family of transcription factors. The bHLH-PAS transcription factors play a significant role as crucial sensors of environmental and cellular signals, with their activity tightly regulated by nucleocytoplasmic shuttling. Some members of the bHLH family were shown as partners of 14-3-3 proteins, that influence their localization and activity. To date, no data was shown whether NPAS4 interacts with 14-3-3 proteins, though such interaction would be important for understanding complex pathways of neurodegeneration development involving Tau (Microtubule associated protein) .

The aim of this study is to test the hypothesis concerning the interaction between 14-3-3 and NPAS4. To predict putative 14-3-3 binding sites in NPAS4, we performed in silico analysis using Scansite 4.0 and ELM. Interestingly, the predicted motifs were found within intrinsically disordered regions (IDRs). For preliminary verification, we performed co-localization studies of NPAS4 and 14-3-3 in neuronal cells using confocal microscopy. Our analysis showed that fluorescently tagged NPAS4 and 14-3-3 co-localize in transfected N2a cells, supporting a possible interaction between these proteins.

The findings suggest that 14-3-3 proteins may regulate NPAS4 subcellular localization and activity. Interaction will be studied further in living neuronal cells using pull-down assays. To test structural basis of 14-3-3-NPAS4 interaction we will use purified recombinant proteins. We were able for the first time to obtain full-length NPAS4 expression in Pichia pastoris. Further experiments are needed to optimize purification procedure of NPAS4 and 14-3-3.

Impact of the Baltic Sea Environmental Conditions on the Aerodynamic Characteristics of Laminar Airfoils Used in Offshore Wind Turbines

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The rapid development of offshore wind energy in the Baltic Sea requires a deep understanding of the environmental impact on wind turbine blade efficiency. This study presents a numerical analysis of the aerodynamic characteristics of a lifting surface based on the *NACA 63-212* laminar airfoil under harsh marine conditions. The simulations were conducted using the *XFLR5* software utilizing the Lifting Line Theory (*LLT*). A clean, ideal wing at a Reynolds number of Re = 2.6 x 10^6 and a turbulence parameter of N_{crit} = 9 was used as a baseline. The aggressive Baltic environment, characterized by high air turbulence, salt deposition, and leading-edge erosion, was modeled by forcing an early boundary layer transition at 5% of the chord on the upper surface and 10% on the lower surface. Additionally, the turbulence parameter was reduced to N_{crit} = 4, and the technological drag coefficient C_{xtech} was tripled to account for surface degradation. The results demonstrate a drastic reduction in the maximum lift-to-drag ratio (C_z/C_x) and a significant narrowing of the usable angle of attack envelope. The contaminated airfoil experienced premature flow separation and stall compared to the baseline model. This study proves that high-performance laminar airfoils are highly sensitive to surface contamination. Consequently, maintaining the designed energy efficiency of offshore wind turbines in the Baltic Sea necessitates the application of specialized protective coatings or the selection of airfoils less susceptible to aerodynamic degradation.

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Surface EMG Signal Characterization and Feature Extraction from Upper-Limb Musculature for Low-Cost Prosthetic Control Applications

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This study presents a method for acquisition and analysis of surface electromyography (EMG) signals from upper-limb musculature with potential application in prosthetic control systems [1]. The goal is to extract stable and informative signal features using a low-cost embedded platform suitable for real-time bio-signal processing.

The proposed system enables six-channel EMG recording using an analog front-end based on MCP6004 operational amplifiers configured in an instrumentation-amplifier-like structure, followed by band-pass conditioning and virtual ground biasing. Signals are digitized using the ESP32 microcontroller at 1 kHz per channel and transmitted wirelessly in buffered segments. Emphasis is placed on mitigating interference associated with wireless communication and non-idealities of multiplexed ADC sampling.

Signal processing includes band-pass filtering, rectification, and amplitude envelope extraction to characterize muscle activation dynamics. Additional time- and frequency-domain features are computed to evaluate signal structure and potential discriminability for control applications [2]. The analysis focuses on signal stability, repeatability, and robustness under controlled muscle contraction conditions.

Results demonstrate that meaningful EMG patterns can be reliably extracted despite hardware constraints, with clearly identifiable activation envelopes suitable for feature-based control strategies. The study confirms feasibility of using compact embedded systems for EMG acquisition while highlighting trade-offs between system cost, noise performance, and signal quality in prosthetic-oriented applications.

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Spontaneous Formation of Photonic Structures in PS-PMMA Polymer Blends

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Photonic crystals are materials with a periodically varying refractive index in one or more dimensions. This causes unusual light interactions, such as wavelength and angular transmission dependence. Consequently, these structures serve as optical filters, waveguides and optical logic gates.

Self-assembly methods for preparing photonic structures are widely studied because, unlike conventional lithography, they enable economical large-scale production. Phase segregation and structuring during solvent evaporation in heterogeneous polymer mixtures have been explored. However, few studies describe the optical properties of the resulting structures, particularly in PS-PMMA systems. Our research demonstrates that altering the relative polymer concentrations controls the size of the resulting photonic structures. This enables a tunable photonic crystal platform, which we evaluated using light amplification techniques to achieve amplified spontaneous emission, random lasing and well-defined structures facilitating single-frequency narrow-band emission.

This work establishes a new branch of photonic crystal synthesis. The findings open further investigation into how parameters like interfacial tension and solvent evaporation rate impact structure size and morphology, ultimately providing a long-sought tool for the straightforward, tailored fabrication of photonic structures.

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Nephelauxetic Effect-Driven Control of Mn^{4+} Emission for Lifetime-Based Temperature Sensing.

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Luminescence thermometry has gained significant attention for its applications in diverse fields ranging from industrial process to biomedical diagnostics. It has emerged as a versatile, remote technique for temperature sensing, exploiting the luminescence properties of materials in response to temperature fluctuations, and thereby overcoming the limitations of conventional contact thermometers. Among the luminescent parameters, used in luminescence thermometry, luminescence kinetics is considered the most reliable, as it is inherently immune to spectral distortions.

Luminescence in transition metal ions doped phosphors arises from *d-d* transitions, where the *d* orbitals are not shielded by outer electrons, making them sensitive to both temperature changes and local crystal field variations [1,2]. What is especially interesting from the thermometric perspective, is that changes in the host material composition enables optimization of emission band position and thermal quenching rate [3]. Hence, thermometric performance of transition metal ions-based thermometer can be modulated to meet requirements of specific applications.

Although the potential of luminescence thermometry based on the emission kinetics of Mn^{4+} has been widely demonstrated, reliable tools for the intentional prediction of thermometric performance remain limited. Designing such thermometer requires a thorough understanding on the correlation between host material composition and the thermometric behaviour. To address this challenge, the present work introduces an approach that enables a theoretical description of the ^2E-state lifetime of Mn^{4+} ions, as well as the absolute and relative sensitivities, in terms of the nephelauxetic effect.

In this study, we systematically examine the luminescence of Mn^{4+} ions in four different double perovskite hosts: Sr_2InNbO_6, Sr_2InTaO_6, Ba_2InNbO_6, and Ba_2InTaO_6. By systematically varying both the *A*-site and *B'*-site cations, we aim to establish structure-luminescent property correlations that govern the relative sensitivity and overall thermometric performance of these Mn^{4+}-doped phosphors. The results clearly show that, contrary to common assumptions, the *Dq/B* is not the only factor controlling the temperature dependent spectroscopic properties of Mn^{4+} doped phosphors. This methodology enables the selection of hosts that provide desired sensitivity and optimal operating temperature range for Mn^{4+} based luminescence thermometers.

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Collagen–SPION Magnetic Nanocomposites for Small-Scale Oil Spill Remediation in Water Basins

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Latvia, a country in Northern Europe, has a long coastline and ten seaports. Almost all of the ships and vessels that works at ports operate on diesel, which occasionally has fuel or motor oil leaks during refueling and servicing. These small and medium oil spills in ports, rivers and lakes cause long-term ecological damage despite their limited spatial extent. In addition to port areas, Latvia also hosts several protected natural water reserves, where maintaining high water quality is critically important and even small-scale oil contamination may cause disproportionate ecological harm. This project aims to develop an environmentally friendly magnetic adsorbent based on superparamagnetic Fe_3O_4 nanoparticles (SPIONs) stabilized by collagen derived from animal and fish processing waste, following circular economy principles. The objective is to validate oil film removal at laboratory scale (TRL4) and progress toward relevant environment testing (TRL5). SPION–collagen nanocomposites were synthesized starting from dried collagen powder and citric-acid-treated iron oxide nanoparticles. The collagen coating ensured hydrophobic/oleophilic surface properties and improved hydrothermal stability compared to pure collagen. Structural characterization was performed by XRD.

Oil adsorption experiments were performed in controlled laboratory conditions using a model motor oil layer on water. The composite was dispersed over the oil film and collected by an external magnetic field. Synthesized material demonstrated stable magnetic response and efficient oil capture. Removal of a medium-sized oil spot (3–5 m in diameter) requires approximately 1 kg of adsorbent, and complete collection can be achieved within 10–20 minutes under magnetic guidance. The material remained magnetically recoverable after repeated cycles, indicating potential reusability. These results confirm successful synthesis and demonstrate enhanced oil removal performance, supporting further validation at TRL5 in a controlled pool environment. The developed approach offers a cost-effective and sustainable solution for rapid remediation of localized oil spills in calm water basins.

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Vibration Spectrum-Based Fault Identification in a Twin-Screw Air Compressor

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Twin-screw air compressors are widely used in industrial systems due to their high efficiency and stable operation. However, mechanical faults such as unbalance, misalignment, looseness, and bearing defects can generate excessive vibration that reduces machine reliability and may lead to failure. Vibration analysis is applied as a predictive maintenance method for early fault detection in rotating machinery systems [1][2].

This study aims to identify potential mechanical faults in a rotary twin-screw air compressor using vibration spectrum analysis. Vibration measurements were conducted on a Sullair 3710 AC twin-screw air compressor operating at 1475 RPM using an Emerson CSI 2130 Machinery Health Analyzer equipped with a triaxial accelerometer sensor. The acquired vibration signals were processed using Fast Fourier Transform (FFT) to obtain frequency-domain spectra, and the vibration severity levels were evaluated based on ISO 10816-3 standards [3][4]. The analysis identified dominant vibration peaks near the rotational frequency of 24.74 Hz and at approximately 253 Hz, followed by harmonic frequencies around 506 Hz and 759 Hz. The dominant frequency around 253 Hz corresponds to the lobe mesh frequency (LMF), indicating periodic excitation caused by rotor interaction during compression. The vibration spectrum also indicates potential mechanical abnormalities associated with rotor dynamics and shaft alignment [4][5].

The results shows that vibration spectrum analysis is effective for identifying fault signatures and evaluating the mechanical condition of twin-screw air compressors. This approach can support condition-based maintenance strategies to improve machine reliability and reduce unexpected downtime.

The synopsis of this scientific work is released as an outcome of the partnership between Institut Teknologi Nasional Bandung (ITENAS Bandung), Indonesia, and PT Performa Integritas Indonesia (Fortasindo), Indonesia, an engineering consulting company specializing in risk and integrity management.

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Identification of *Ochrobactrum anthropi* ATCC49188 genes essential for the colonization of biotic and abiotic surfaces.

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Ochrobactrum anthropi, member of *Brucellaceae* family, is a cosmopolitan species found in diverse environments, including soil, water, and the plant rhizosphere. It often acts as an opportunistic pathogen responsible for nosocomial infections, particularly in patients with comorbidities. *O. anthropi* exhibits quorum quenching (QQ) activity; it disrupts the quorum sensing (QS) systems of phytopathogens, such as *Pectobacterium* or *Dickeya*, by secreting AHL-degrading enzymes that destroy QS signaling molecules. The ability to form biofilms allows O. anthropi to effectively occupy the rhizosphere niche.

In this study, transposon mutagenesis was employed to identify the genes responsible for biofilm formation. Following the generation of a transposon mutant library, the mutants were screened for their ability to form biofilms on abiotic surfaces and adhere to biotic surfaces. Biofilm formation on abiotic surfaces was quantified using the crystal violet assay, while root attachment was assessed by isolating bacteria from inoculated tomato seedlings. Several mutants displayed an altered phenotype in which biofilm formation was significantly reduced. Understanding the mechanisms of biofilm formation is critical due to its dual implications: it facilitates the design of novel eradication protocols for multidrug-resistant bacteria in hospital settings and enables the enhancement of agricultural productivity by exploiting QQ strategies to suppress the virulence of plant pathogens.

Treatment of carbapenemase-resistant *Pseudomonas aeruginosa* wound infections in a porcine model using cathelicidins

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Given the global rise in antibiotic resistance, this study focuses on developing an alternative treatment for deep skin and soft tissue infections (SSTIs) caused by a carbapenem-resistant *Pseudomonas aeruginosa*. An injectable hydrogel composed of polyvinyl alcohol and chitosan was developed as a stable carrier for the porcine cathelicidins PR-39 and Protegrin-1.

In vitro tests demonstrated that the addition of 8 mM EDTA fully restores the activity of antibacterial peptides in fetal bovine serum and eliminates the influence of divalent cations. In a porcine model, the application of this hydrogel resulted in a significant reduction in bacterial load after only two doses, with levels dropping below 10^5 CFU/g of tissue. In addition to eliminating the infection, the treated group showed early granulation tissue formation, reduced necrosis and inflammation, and the development of a continuous epidermis, all of which were completely absent in the untreated group.

The research confirms that the combination of cathelicidins and EDTA in a hydrogel carrier represents a highly effective approach for treating complicated bacterial infections.

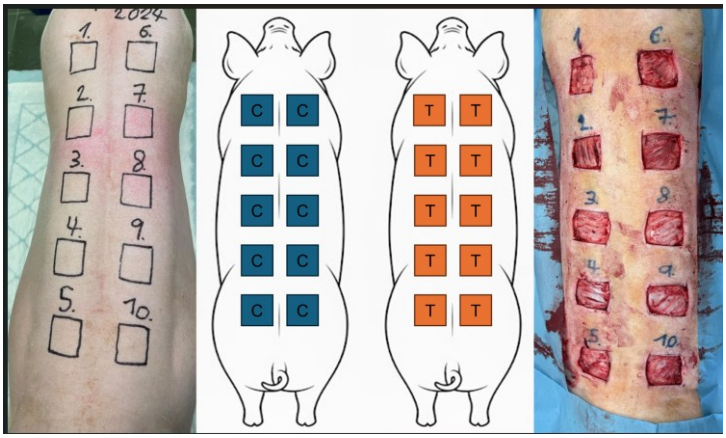

Fig. 1. Position of skin defects on the back of a pig in the animal model. The middle schema shows the back of a pig with untreated control wounds (C) and wounds treated with cathelicidin (T).

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P2D1 tailocins target *Pseudomonas* strains with contrasting roles in potato soft rot

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Soft rot of potato is a common plant disease associated with tissue maceration caused by diverse pathogenic and opportunistic bacteria. *Dickeya dadantii* 3937 is a well-characterized soft-rot pathogen belonging to the Soft Rot *Pectobacteriaceae* (SRP), a group of plant-associated bacteria widespread in natural and agricultural environments. In such habitats, SRP bacteria compete each other for nutrients and space. Some, including *D. dadantii* 3937, produce tailocins that may provide a competitive advantage under appropriate conditions.

Tailocins are contractile, phage tail-like bacteriocins that recognize susceptible bacterial cells and induce phage-like death by puncturing the cell envelope. Although their release requires lysis of the producer cell, tailocins are thought to enhance bacterial fitness by mediating interference competition. They are commonly regarded as kin-restricted weapons targeting closely related strains. However, increasing evidence suggests that some tailocins may act across taxonomic boundaries, while their potential role in interactions between plant pathogens, opportunistic competitors, and beneficial microbiota remains unclear.

In this study, the target range of P2D1 was assessed against bacteria isolated from diverse soil- and rhizosphere-associated habitats in Poland, including near-Baltic environments. A total of 480 environmental isolates were screened for susceptibility to P2D1 using a spot assay. Nine susceptible strains were identified and characterized phenotypically and genetically. Antagonism was confirmed to be mediated by P2D1 using a tailocin-deficient *D. dadantii* mutant, which failed to inhibit the susceptible isolates, in contrast to the wild-type strain.

Taxonomic identification revealed that the susceptible strains did not belong to the SRP group but phylogenetically distant *P. germanica*, *P. tensinigenes*, and *P. parakoreensis*. Plant tissue assays revealed contrasting ecological roles among strains: some exhibited opportunistic pathogenicity by inducing soft-rot on potato tissue, whereas others reduced *D. dadantii*-induced soft rot, indicating biocontrol potential. Together, these findings suggest that P2D1 may function not only as a weapon against closely related bacteria, but also as a competitive factor targeting *Pseudomonas* strains with divergent effects on plant health. This supports a broader ecological role for tailocins in plant-associated microbiomes and suggests that they may influence microbial competition and community assembly across taxonomic boundaries.

This research was financially supported by the National Science Center, Poland (Narodowe Centrum Nauki, Polska) via a research grant SONATA BIS 10 (2020/38/E/NZ9/00007) to Robert Czajkowski and by the University of Gdansk, UGrants-start (533-BGB0-GS04-25) to Marcin Borowicz.

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Biofilm and its significance for human health

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Biofilm is a multicellular structure composed of various microorganisms producing extracellular polymeric substance (EPS). It is estimated that 40% - 80% of naturally occurring bacteria and archea live inside such systems[1]. Thanks to the specific conditions inside the biofilm, organisms are more likely to survive when exposed to negative elements and to exchange genetic material in the process of horizontal gene transfer (HGT)[2].

Bacterial biofilm has a significant impact on human civilization. It is calculated that annual, global cost generated by their activity is $1,3 trillon, not counting the loses due to corrosion ($4 trillion overall)[3]. Furthermore, previous studies estimate that biofilms are the main cause behind 65%-80% microbial infections and chronic diseases related to microbial activity[4].

Due to the rising threat of MDR (multi-drug resistance) especially present within biofilms, new treatment strategies must be developed. By searching PubMed database using keywords such as: antibiofilm, biofilm degrading enzymes, bacterial biofilm, numerous articles describing novel approaches and models can be found. Multiple, interdisciplinary treatments are tested, including biological (phage therapy combined with antimicrobial peptides, EPS degrading enzymes, plant secondary metabolites), physical (photodynamic therapy, ultrasound treatment) and chemical (metal nanoparticles such as AgNPs, chelating agents, bactericidal agents)[5]. To combat the biofilm menace, further research of said strategies must be conducted.

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Evaluation of the Antioxidant Potential of Postbiotics Produced by Lactic Acid Bacteria Strains

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Postbiotics, defined as preparations of inactivated microorganisms and/or their cellular components that confer health benefits on the host, are promising bioactive substances with antioxidant potential. Compared with live cultures, they offer greater stability, improved microbiological safety, and easier standardization. Their antioxidant activity is associated with bioactive metabolites.

The aim of this study was to evaluate the antioxidant properties of postbiotics obtained from lactic acid bacteria (LAB, n = 23) belonging to the strain collection of the Department of Food Microbiology, Meat Technology and Chemistry. To obtain postbiotics, LAB strains were reactivated by inoculation onto De Man, Rogosa, and Sharpe (MRS) broth medium and incubated at 30 ± 1°C for 24 h. The study included 23 LAB strains belonging to the genus *Lactococcus*, *Leuconostoc*, *Enterococcus*, *Lactobacillus*, and *Pediococcus*. Each strain was cultivated separately in 100 mL of fresh MRS broth for 48 h at 30 ± 1°C. After incubation, the suspensions were centrifuged (6000 rpm, 10 min, 4°C), and bacterial biomass was removed. The obtained cell-free supernatants (CFS) were purified by membrane filtration using 0.22 µm pore-size filters. The postbiotics were characterized for their in vitro antioxidant activity using the DPPH radical scavenging assay and reducing power (RP) assay.

The obtained results confirmed that all tested postbiotics exhibited antioxidant activity, although significant differences between strains were observed. DPPH radical scavenging activity ranged from approximately 65% to 85%, indicating a high ability of the analyzed postbiotics to neutralize free radicals. Among the tested strains, the highest DPPH activity was observed for *Lc. lactis* P3 (84.74%), *E. hirae* P10 (84.59%), and *Lc. lactis* P1 (84.57%). Similarly, RP values showed substantial variability, suggesting strain-dependent differences in electron-donating ability and reducing potential. In the RP assay, the strongest reducing properties were demonstrated by *Lc. mesenteroides* ssp. *cremoris* P7 (RP = 0.2084), followed by *Lc. lactis* P11 (RP = 0.1929) and *Leuconostoc* sp. P9 (RP = 0.1591). Strains showing the highest activity in the DPPH assay did not always exhibit the highest reducing power, which indicates differences in antioxidant mechanisms and metabolite composition among individual postbiotics.

The results indicate that LAB-derived postbiotics may represent promising natural antioxidant additives for applications in the food industry.

Characterization of chitosan-based materials in use as anti-acne face masks

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Cosmetic masks are one of the most popular home skincare treatments, and their market is developing dynamically. This is why innovations and new solutions that can better meet consumer needs are constantly being sought. One interesting direction of development is research into the use of natural or partially modified biopolymers as a base for face sheet masks [1]. One such polymer is chitosan, which is valued in cosmetic products not only for its ecological benefits but also for its biological properties, such as antioxidant and antimicrobial activity, as well as biocompatibility [2]. In the presented study, caffeic acid was added to this biopolymer. It is an active ingredient used in cosmetics for its antioxidant, antibacterial, and anti-inflammatory effects. It was used to help improve the condition of acne-affected skin [3]. Gluconolactone was also introduced into the chitosan as a moisturizing and plasticizing agent.

Chitosan and caffeic acid were dissolved in 0,1 M acetic acid (1% w/w solutions), while gluconolactone was used as a 2% (w/w) aqueous solution. The chitosan and caffeic acid solutions were then combined in ratios of 95:5 and 97.5:2.5. Gluconolactone was also added in amounts of 10 and 20% (w/w). After stirring the mixtures for one hour using magnetic stirrer, the materials were poured into plastic holders and left to allow the solvent to evaporate. In order to characterize the materials, the obtained films were analyzed. Surface properties were examined by analyzing contact angles, and surface free energy was determined. Water vapor permeability of the resulting materials was also examined, as well as mechanical properties and antioxidant activity.

Each modification of the chitosan film results in changes to the properties of the samples. Therefore, both the concentration and type of additives used are key factors determining the characteristics of the materials. Considering the application of the films as cosmetic products, the addition of caffeic acid leads to beneficial changes in mechanical and antioxidant properties. Other analyses indicate that the best properties are observed in samples combining both caffeic acid and gluconolactone. In the case of a chitosan-based matrix, the use of these proposed additives may thus indicate their potential for use in cosmetic masks, particularly those intended for individuals with acne-prone skin.

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Vibration-Based Condition Monitoring of a Mitsubishi Pajero Dakar SUV

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The Mitsubishi Pajero Dakar is a Sport Utility Vehicle (SUV) powered by a 4N15 diesel engine equipped with Common Rail Direct Injection (CRDI) technology. This engine is designed to provide high fuel efficiency, improved combustion performance, and reliable operation under various driving conditions. However, during operation, diesel engines are subjected to dynamic loads that can generate excessive vibration due to factors such as mechanical looseness, imbalance, misalignment, or component wear. If left undetected, these vibration-related issues may reduce engine performance, accelerate component deterioration, and lead to unexpected failures.

To address this challenge, vibration analysis is employed as a predictive maintenance approach for monitoring engine condition and detecting potential faults at an early stage. Through vibration measurements and frequency spectrum analysis, the characteristics and sources of abnormal vibrations can be identified based on their vibration patterns. The research activities are conducted by measuring vibration parameters, including displacement, velocity, and acceleration, expressed as Root Mean Square (RMS) values using a vibration analyzer. Measurements are performed at selected engine locations under various operating conditions, and the results are evaluated according to applicable vibration severity standards. The findings of this study are expected to assist in identifying the sources of engine vibration, assessing the overall condition of the diesel engine, and improving maintenance planning to enhance the reliability, safety, and operational performance of the Mitsubishi Pajero Dakar SUV.

The synopsis of this scientific work is released as an outcome of the partnership between Institut Teknologi Nasional Bandung (ITENAS Bandung), Indonesia, and PT Performa Integritas Indonesia (Fortasindo), Indonesia, an engineering consulting company specializing in risk and integrity management.

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Predictive Maintenance on a Fire Diesel Pump Using Infrared Thermography and Vibration Analysis.

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Fire diesel pumps are critical equipment that requires an effective, non-invasive predictive maintenance strategy. Infrared Thermography (IRT) is a non-destructive testing technique that is able to detect the distribution of surface temperature without direct contact, thus identifying thermal anomalies as an early indicator of potential damage. This study applied IRT to the Patterson 1821-P-8002B fire diesel pump unit operating at 3060 rpm (exceeding the 3000 rpm design). Temperature measurements were carried out on the exhaust manifold, engine block, and pump body using the FLIR TG165-X thermal camera.

The test results showed the exhaust manifold temperature was 204°C, the engine block was 109°C, and the pump body was 31.8°C. Both engine temperature values are still within normal limits for naturally aspirated diesel engines under full load conditions, while low pump body temperatures indicate good natural cooling. No significant thermal anomalies were found such as exhaust gas leakage or component overheating. Thus, IRT is proven to be able to monitor thermal conditions in real-time and is the basis for scheduling systematic predictive maintenance on fire diesel pumps. The synopsis of this scientific work is released as an outcome of the partnership between ITENAS Bandung, Indonesia, and PT Performa Integritas Indonesia (Fortasindo), Indonesia, an engineering consulting company specializing in risk and integrity management.

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Fluoromethylated nitrile imine in the synthesis of unsymmetrical *N*',*N*'-diarylhydrazides

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The *N*',*N*'-diarylacylhydrazide scaffold is a privileged structural motif in numerous pharmaceuticals and agrochemicals but is rare in nature.[1] These hydrazides also serve as versatile precursors for synthesizing complex heterocycles, such as indazoles and benzo-1,2,4-triazines.[2] Despite the well-known benefits of incorporating fluoroalkyl groups into organic molecules, fluorinated acylhydrazides remain under-explored. This scarcity is due to the limitations of traditional synthetic routes involving carboxylic acid-hydrazine condensations, catalytic Ullmann-type N-arylations, or azaphilic additions.[3]

Expanding our research on fluorinated 1,3-dipolar reagents,[4] we developed an efficient two-step protocol for the synthesis of unsymmetrical *N*',*N*'-diaryl-trifluoroacetohydrazides. Our strategy involves the *in situ* generation of a CF_3-nitrile imine, followed by its capture with a phenolate. Initially formed hydrazonyl ester undergoes a subsequent Smiles rearrangement resulting in the formation of desired unsymmetrical product as the final product in good overall yield.

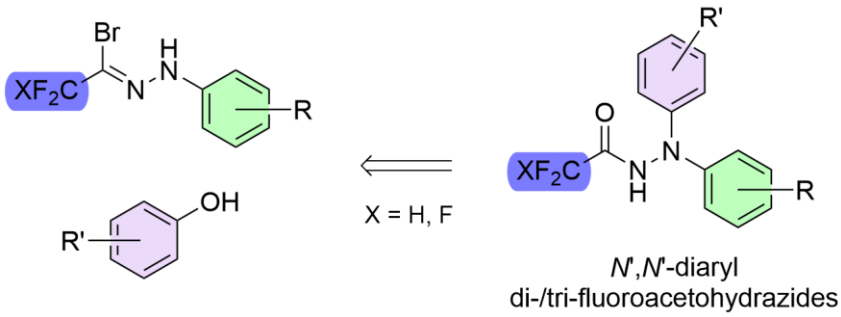

Fig 1. Synthesis of unsymmetrical *N,N'*-diaryl di-/trifluoroacetohydrazides via nitrile imine capture and Smiles rearrangement.

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Thermally Amplified Mn^{2+} Emission for Filter-Free Luminescent Thermal Imaging with RGB Channels

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Luminescent thermometry, which makes use of temperature-dependent changes in the spectroscopic properties of phosphor materials, has become a strong alternative to traditional contact-based thermometry[1]. Traditionally, two-dimensional thermal imaging is achieved using band-pass optical filters. However, the time delay because of the exchanging filters prevents accurate thermal imaging. To overcome these limitations, a filter-free imaging strategy based on the RGB channels of a standard camera was recently reported[2]. Spatially resolved intensity maps for the red (R), green (G), and blue (B) channels from a single photograph allows to achieve fast, low-cost, and real-time thermal imaging.

In this study, we focused on phosphors co-doped with lanthanide-ions and transition-metal ions. In particular, Ce^{3+} and Mn^{2+} ions are attractive candidates because of their electronic structures, which enable to be strongly modulated by temperature. In addition, Ce^{3+} ions enable to improve low emission efficiency of Mn^{2+} ions resulting from spin-forbidden electronic transitions through $Ce^{3+}\rightarrow Mn^{2+}$ energy transfer[3]. We observed two rare and thermally activated mechanisms: (1) a temperature-induced blueshift of the $^4T_1\rightarrow{}^6A_1$ emission band of Mn^{2+} ions, and (2) thermally assisted population of the $^4T_2$ excited state through electron trap states. These mechanisms results in an intense thermal enhancement of the Mn^{2+} emission intensity within the spectral range corresponding to the G channel, while the signals recorded in the B channel exhibit the expected thermal quenching. These unusual thermally behaviors of Mn^{2+} ions allow investigated $Ca_{19}Zn_2(PO_4)_{14}$:Mn^{2+}, Ce^{3+} to support not only sensitive filter-free thermal imaging, but also two additional ratiometric readout schemes. The thermal evolution of the emission spectra, as well as the thermometric performance of the Mn^{2+},Ce^{3+}-doped $Ca_{19}Zn_2(PO_4)_{14}$, were systematically investigated as a function of dopant concentration and temperature and are discussed in detail in this work.

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Multimodal Down-shifting and Up-converting Luminescence Thermometry Based on Structural Phase Transition and Cooperative Luminescence in $K_3Yb(PO_4)_2:Eu^{3+}$

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In this study, a versatile luminescent thermometer was developed by utilizing $K_3Yb(PO_4)_2:Eu^{3+}$ system combining both high relative sensitivity and its capability to determine temperature under different excitation wavelengths and spectral ranges [1]. Above 450K, this material exhibited phase transition from monoclinic structure to the hexagonal structure. Owing to this phase transition, a ratiometric thermometer was developed using the luminescence intensities ratio between the Stark line emissions of Eu^{3+} and Yb^{3+} ions with *SRmax* values of 4.2% K^{-1} and 1.15% K^{-1}, respectively. Furthermore, it was observed that phase transition temperature increases with increasing concentration of Eu^{3+} ions, resulting in shifting the thermal operating range of both luminescent thermometers. When excited at 980nm, $K_3Yb(PO_4)_2:Eu^{3+}$ exhibits dual emission processes involving Yb^{3+} pairs cooperative luminescence and Eu^{3+} up-conversion emission. A systematic increase in Eu^{3+} concentration enhances the Eu^{3+} emission relative to Yb^{3+} pairs cooperative luminescence, thereby modifying the emission color. Taking advantage of different thermal quenching behaviors of these two emissions, another ratiometric thermometer was developed, achieving an *SRmax* of 0.58% K^{-1}. These results highlight $K_3Yb(PO_4)_2:Eu^{3+}$ as a potential candidate for multimodal temperature sensing.

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Luminescence Thermometry Based on Structural Phase Transition and Phonon-Assisted Energy Transfer in $LiYO_2:Yb^{3+}$, Nd^{3+}

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≫The luminescence thermometry has attracted considerable research interest recently, due to its unique characteristics such as remote measurements, fast response, high accuracy, and reliability. Many approaches have been developed to enhance the thermometric performance of the luminescence thermometer. Among them, the thermally induced phase transition-based luminescence thermometry has attracted notable attention due to its excellent thermometric performance [1,2]. In this work, a dual mode luminescence thermometer based on structural phase transition and phonon assisted energy transfer in $LiYO_2:Yb^{3+}$, Nd^{3+} was developed. The spectroscopic properties of $LiYO_2$:10%Yb^{3+}, x%Nd^{3+} (x=1, 5, 15, 20) were investigated as a function of temperature. Thermally induced changes in the shape of emission band of Yb^{3+} facilitated the development of ratiometric luminescence thermometer with maximum relative sensitivity of 3.1% K^{-1} at 290 K for $LiYO_2$:10%Yb^{3+},1%Nd^{3+}. On the other hand, thermal dependence of energy transfer from Yb^{3+} to Nd^{3+} enabled the development of lifetime-based luminescence thermometer with maximum S_R = 1.5% K^{-1} for 20%Nd^{3+} at 378 K. In both thermometric approaches, variation of Nd^{3+} concentration allowed tuning of both sensitivity and the temperature at which maximum S_R was achieved. Additionally, thermometric performance of $LiYO_2:Yb^{3+}$, Nd^{3+} based on ratio of luminescence intensities measured at two distinct time gates was explored. The obtained results revealed that phonon-assisted energy transfer has more pronounced effect on luminescence kinetics than structural phase transition, highlighting the potential of $LiYO_2:Yb^{3+}$, Nd^{3+} for multimodal luminescence thermometry.

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From the Argan Tree to Bioactive Compounds: A Sustainable Valorization Approach of Its Biomass and Co-products

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The argan tree sector mobilizes various plant biomasses, including resources directly derived from the tree, such as leaves, as well as co-products generated during fruit pressing for argan oil production, namely the pulp, shell, and press cake. Despite their abundance, these biomasses remain insufficiently valorized, even though they exhibit considerable potential as sources of bioactive compounds of interest. In the context of the transition toward a circular economy and the development of sustainable processes, their valorization represents a strategic lever for enhancing the sustainability and competitiveness of the argan sector. The present work proposes an integrated approach to the valorization of argan tree biomasses, combining green extraction, advanced chemical characterization, and evaluation of industrial applications. Various environmentally friendly extraction techniques, including maceration, ultrasound-assisted, microwave-assisted, and pressurized fluid extractions, were applied. The resulting extracts were evaluated in terms of yield, TPC, TFC, CT content, and antioxidant activity, and subsequently characterized by HPLC-DAD-ELSD and UHPLC-HRMS. The results demonstrate that argan leaves and co-products constitute promising sources of bioactive compounds. The incorporation of selected extracts into lipid matrices improved the oxidative stability of the enriched oils, illustrating a concrete industrial valorization pathway.

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Antioxidant Defense in Paulownia sp. under Lead-Induced Stress

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Contaminated land areas are expanding globally as a result of industrial, agricultural, and military activities, with lead recognized as a primary hazardous inorganic pollutant due to its extreme toxicity and bioaccumulation potential. The human nervous, cardiovascular, gastrointestinal, and renal systems face devastating impacts from this toxicant, which also provokes oxidative stress across various living organisms [1]. Lead acts as a potent abiotic stressor within plant organisms, leading to photosystem disruption and the excessive formation of reactive oxygen species (ROS). Essential low-molecular-weight compounds, including polyphenols and flavonoids, are susceptible to damage caused by the accumulation of these radicals. Phytoremediant plants that exhibit resistance to lead toxicity and the capacity for effective decontamination of polluted territories represent a key priority for study in modern biotechnology [2].

The aim of the study was to evaluate the state of the antioxidant system in *Paulownia* sp. under lead-induced stress in controlled *in vitro* conditions. For 40 days, the plants were grown on Murashige and Skoog medium with adjusted nitrate content at a temperature of 25-28°C and a 16/8-hour light/dark photoperiod. Plants cultivated on a metal-free medium served as a control, while $Pb(NO_3)_2$ was added to the experimental samples at concentrations of 2, 20, 100, and 200 mg of lead per liter. Following the cultivation period, the leaves were analyzed for key biochemical indicators of resistance.

It was found that the chlorophyll *a* content changed significantly at metal concentrations of 2, 100, and 200 mg/L, while the chlorophyll *b* content remained unchanged; the carotenoid content increased significantly at concentrations of 2, 20, and 100 mg/L, the anthocyanin content decreased significantly at all toxin concentrations. The total phenol content did not change at any toxin concentration, while the flavonoid content changed at all lead ion concentrations. The content of low-molecular-weight thiols did not change, while the content of high-molecular-weight thiols increased only at the highest concentration of the toxicant. The proline content increased at concentrations of 20 and 100 mg/L.

The data obtained indicate that the non-enzymatic antioxidant defense system is capable of counteracting lead-induced stress in paulownia. The plant has also proven to be a promising candidate for the phytoremediation of this toxic metal.

We express our sincere gratitude to the head of the phytoremediation research, Associate Professor, Candidate of Biological Sciences Viktor Husak

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Assessment of genetic diversity in selected rocket genotypes representing Diplotaxis tenuifolia and Eruca spp. using SCoT molecular markers

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Rocket comprises plants belonging to the Brassicaceae family, valued for their distinctive taste, nutritional properties, and the presence of bioactive compounds. However, the commercial name “rocket” refers to different taxa, primarily *Diplotaxis tenuifolia*, commonly known as wild rocket, and representatives of the genus *Eruca*, including *Eruca sativa*, known as garden rocket. Their similar use as leafy vegetables, combined with morphological and genetic variation, may hinder the unambiguous identification of plant material available on the market. Therefore, molecular markers represent a valuable tool for assessing genetic diversity and determining relationships among rocket genotypes.

The aim of this study was to evaluate the genetic diversity of 23 rocket genotypes using 11 SCoT (Start Codon Targeted) primers targeting regions flanking the translation start sites. The obtained banding profiles were used to generate a genetic similarity matrix and to construct a dendrogram illustrating the relationships among the studied genotypes based on cluster analysis. Genetic similarity values ranged from 0.24 to 0.80. The highest similarity was observed between genotypes RS1 and RS2, whereas the lowest values were recorded between genotypes belonging to different taxonomic groups. Dendrogram analysis revealed a clear separation of the studied genotypes into two main clusters corresponding to *Eruca* spp. and *Diplotaxis tenuifolia*.

The obtained results confirm the usefulness of SCoT markers for differentiating rocket genotypes and assessing their genetic relationships.

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Genotype-Dependent Effects of Blue and Red Light on Antioxidant Activity in *Solanum lycopersicum* L.

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Light is one of the most important environmental factors affecting plant development. Blue (B) and red (R) light are key determinants of plant growth and the biosynthesis of secondary metabolites because they are the main sources of energy used in photosynthetic CO2 assimilation. Additionally, the light spectrum influences the formation of reactive oxygen species and the activity of the antioxidant system. The aim of this study was to evaluate the effects of light spectral composition on the antioxidant activity of the tomato varieties *Solanum lycopersicum* L. cv. Green Zebra and Blackball.

Analyses demonstrated that, in *S. lycopersicum* L. cv. Blackball, blue light and its combination with red light at a 3:1 ratio significantly enhanced carotenoid accumulation. These plants also exhibited improved photosynthetic performance, reflected by higher ΦPSII and lower ΦNPQ values. Moreover, elevated SPAD index values indicated higher chlorophyll content in the leaves. Blue light treatment also promoted the accumulation of phenolic compounds and increased DPPH radical scavenging activity, indicating enhanced antioxidant potential in this variety. In contrast, the Green Zebra variety exhibited a negative response to blue light and its combination with red light in terms of carotenoid accumulation. These plants showed reduced concentrations of chlorophyll *a*, chlorophyll *b*, and carotenoids, despite maintaining higher Fv/Fm, ΦPSII, and ETR values. The observed decrease in ΦNO accompanied by an increase in ΦNPQ suggests reduced passive energy dissipation and activation of photoprotective thermal energy dissipation mechanisms. Furthermore, the Green Zebra variety was characterized by lower phenolic compound content and consequently reduced DPPH radical scavenging activity. The progressive decline in antioxidant activity with decreasing proportions of blue light in the spectrum may indicate a limited antioxidant capacity and reduced ability to mitigate light-induced oxidative stress in this variety.

Overall, these findings demonstrate that the physiological and antioxidant responses of tomato plants to spectral light modifications are highly genotype-dependent, highlighting the potential application of blue and red light manipulation for optimizing photosynthetic efficiency and antioxidant capacity in tomato cultivation.

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Comparative Nutritional Evaluation of Three Cucumis melo Seed Varieties

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Cucumis melo L. (Cucurbitaceae) is an economically important crop whose seeds, representing approximately 10–15% of fruit fresh weight, are systematically discarded during processing, constituting a significant agro-industrial by-product. This study aimed to characterise the nutritional potential and oil quality of seeds from three commercial melon varieties — Canari, Ananas, and Galia — through proximate composition, mineral profile, bioactive compounds, antioxidant activity, and fatty acid composition determined by GC-FID.

Results showed that each variety presents a distinct and complementary nutritional profile. Canari excelled in oil content, phenolic compounds, antioxidant capacity, and polyunsaturated fatty acid content, with the most favourable UFA/SFA ratio. Galia recorded the highest protein, magnesium, calcium, and phosphorus levels. Ananas stood out for its potassium and iron content, and exhibited the best radical scavenging activity. Linoleic acid (C18:2, ω-6) was the dominant fatty acid across all varieties, and total unsaturated fatty acids exceeded 83% in all cases, confirming excellent lipid nutritional quality.

These findings demonstrate that Cucumis melo seeds from these three varieties are nutrient-rich by-products with significant potential for valorisation as functional ingredients in food, nutraceutical, and non-food applications.

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Microplastics as Trojan Horses: Machine Learning Prediction of Pollutant Partitioning

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Microplastics are increasingly recognized as potential “Trojan horses” for hydrophobic organic pollutants in aquatic environments. However, quantitative assessment of this phenomenon remains challenging due to the limited availability of experimental data on microplastic–water partition coefficients (logKd), particularly across different polymer types and environmental conditions.

This study aimed to develop predictive models enabling rapid estimation of logKd values for multiple microplastics simultaneously, thereby helping to address current data gaps and reduce the need for extensive experimental testing. Experimental logKd values for organic compounds were compiled from the dataset reported by Li et al. [1], covering three common polymers: polyethylene (PE), polypropylene (PP), and polystyrene (PS). Two descriptor sets were evaluated: a Gaussian-based set including quantum-chemical descriptors, and an RDKit-based set consisting of open-source molecular descriptors calculated from SMILES. In both cases, logD was included as an additional descriptor. Multi-output regression using a gradient boosting algorithm was applied to simultaneously predict logKd values for the three polymers. Both models demonstrated strong predictive performance, with the Gaussian-based approach showing slightly improved accuracy. External validation and applicability domain analysis confirmed reasonable generalization to previously unseen compounds. The validated models were implemented in a freely accessible web application that enables rapid single-compound and batch predictions, together with prediction reliability assessment.

The resulting tool facilitates rapid screening and prioritization of organic pollutants with respect to their interaction with microplastics, supporting exposure assessment and reducing reliance on additional experimental measurements.

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Why is it getting warmer?

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The greenhouse effect is a natural process occurring in the Earth's atmosphere that is responsible for maintaining a temperature suitable for the development of life on Earth. In recent decades, however, a significant intensification of this phenomenon has been observed, associated with the increasing concentration of anthropogenic greenhouse gases. A particularly important role is played by carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), whose emissions are primarily related to industrial development, fossil fuel combustion, transportation, and the intensification of human activities[1].

The aim of the presentation is to discuss changes in the concentration of selected greenhouse gases on a global scale from the late 20th century to the present day, as well as to examine the relationship between civilizational development and the intensification of the greenhouse effect. The presentation will explain the mechanism of the greenhouse effect, its importance for the functioning of the biosphere, and the consequences resulting from the excessive increase in greenhouse gas concentrations in the atmosphere[2].

The presentation will also address the main anthropogenic sources of greenhouse gas emissions, the dynamics of changes in their concentrations over recent decades, and the current and potential future environmental and climatic consequences, such as the increase in global average temperature, glacier melting, sea level rise, and the more frequent occurrence of extreme weather events. The presentation was prepared based on an analysis of contemporary scientific literature, climate reports, and data concerning changes in greenhouse gas concentrations[2,3].

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The nitrification cycle as a key stage in the nitrogen cycle in ecosystems

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The nitrification cycle is an aerobic microbial process that constitutes a key stage in the nitrogen cycle in nature, in which reduced forms of nitrogen (ammonia and ammonium ions) are oxidized first to nitrites and then to nitrates. This process occurs in two stages and is catalyzed by specialized chemoautotrophic microorganisms. In the first stage, ammonia-oxidizing bacteria and archaea, such as *Nitrosomonas* and representatives of *Thaumarchaeota*, convert ammonia into nitrite. In the second stage, bacteria, including *Nitrobacter*, oxidize nitrites to nitrates.

Nitrates formed as a result of nitrification constitute the primary, easily assimilable form of nitrogen for most plants. Their incorporation into plant metabolism enables the synthesis of amino acids, proteins, and nucleic acids, which directly determines plant growth and resistance. Nitrification plays a significant role in stabilizing soil and aquatic ecosystems by regulating nitrogen availability and reducing the toxicity of ammonia and nitrites.

The nitrification process is highly dependent on environmental conditions, such as oxygen availability, temperature, pH, and humidity. In natural environments, it occurs primarily in soils and surface waters, whereas in engineered systems it forms the basis of biological wastewater treatment, where it enables the conversion of toxic ammonia into less harmful nitrates.

Human activity significantly influences the course of the nitrification cycle. Excessive use of nitrogen fertilizers increases the availability of nitrogen compounds, which can lead to their leaching into groundwater and surface water, and ultimately even to the eutrophication of water bodies. Additionally, this process is associated with the emission of nitrous oxide (N_2O), a potent greenhouse gas.

The nitrification cycle is therefore a fundamental mechanism regulating nitrogen availability in the biosphere, linking microbial processes with ecosystem functioning and human activities, and its balance is crucial for environmental quality.

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Ecotoxicity assessment of the lactobionic acid synthesis using the Microtox test

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The assessment of environmental toxicity is a key component of the safety analysis of new chemical processes. This study focuses on the ecotoxicity assessment of lactobionic acid (LBA) and its synthesis process using the marine bioluminescent bacterium Aliivibrio fischeri (Microtox® test according to ISO 11348-3).

The study was conducted in two stages: a screening test and a primary test with dilutions for samples exceeding 20% of the toxic effect (PE). The analysis showed that the components of the mixture prior to the reaction (acetate buffer, ABTS mediator and lactose) exhibit high toxicity at 59–69%, corresponding to toxicity class III (acute hazard) with TU values in the range of 1–10.

A milestone result was the analysis of the mixture after the reaction, which showed a decrease in toxicity to 21–26% PE, classifying the final product as low risk (Class II). The results obtained demonstrate that the LBA synthesis process effectively eliminates the toxic properties of the substrates, transforming them into safer products. This confirms the high ecological efficiency of the process and its full compatibility with the principles of green chemistry.

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Food waste upcycling to artificial humic substances using hydrothermal carbonisation

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Food waste (FW) is an emerging major challenge of 21st century not only from economical standpoint, but also from circular economy climate neutrality goals. It is estimated that around 2.6 trillion USD is spent on FW management, and European Union generates a combined amount of 59 million tonnes of FW, which translates to 130 kg of food wasted per capita, with a total market value of 132 billion Euros. Besides the economic losses, FW contributes to huge amount of greenhouse gas emissions – around 3.49 billion tonnes of CO_2 equivalent each year, which is projected to be 8-10 % of global greenhouse gas emissions. Traditional FW management practices include landfilling, incineration and composting, which do not ensure full resource recovery, nor do they contribute to climate-neutrality goals.

To reach climate goals and promote circular economy principles, hydrothermal carbonisation has emerged as a promising green technology for food waste management. This technology is suitable for wet feedstocks, so it eliminates the need for material drying prior to handling. The process takes place in a closed system, using water as a reaction medium in a temperature range of 160-260 ºC in an autogenous pressure up to 50 bar. Using strong alkali as a catalyst (e.g. KOH), it is possible to convert wet heterogenous biomass like food waste into valuable humic substances. The process mimics natural humification and time required for the process is up to 8 hours, compared to natural humification, which may take up to 15000 years.

In this study, common household food products, that include all major nutritional groups (proteins, carbohydrates, fats and lignocellulose) were used as model materials for production of artificial humic substances, using hydrothermal carbonisation. Experiments were carried out using 0.65 M KOH as a catalyst in a temperature range of 170-230 ºC for 1-8 hours. Obtained artificial humic acids were separated from the reaction medium, purified and characterized, using contemporary spectroscopic methods, such as UV-Vis, FTIR and 3D fluorescence excitation-emission matrix spectra. Key findings indicate that the main artificial humic acid skeleton is similar to natural humic acids derived from peat, however the artificial humic acids had relatively more aliphatic side chains than their natural counterpart.

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Posters

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Exploring Microbial Diversity in Algerian Hypersaline Environments

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Hypersaline environments harbor highly specialized and diverse microbial communities shaped by extreme conditions.

This study investigates the microbial diversity of two hypersaline water samples from Algeria: Hadjer El-Melh (Salt Rock) (S1) and Zahrez-Gharbi (S2). Using 16S rRNA gene amplicon sequencing via the Illumina MiSeq platform, we characterized bacterial and archaeal communities at multiple taxonomic levels. Alpha diversity indices (Chao1, Shannon, ACE) indicated higher species richness and evenness in S1. Taxonomic profiling revealed dominance of Firmicutes, Proteobacteria, and Bacteroidota in both sites, with sample-specific archaeal phyla such as Halobacterota (S2) and Euryarchaeota (S1).

At finer taxonomic levels, clear differences were observed between sites: S1 was enriched in Salinibacter, Methanobrevibacter smithii, and Finegoldia magna, whereas S2 was characterized by Bacillus, Veillonella, and Campylobacter. The presence of numerous unclassified taxa in both samples highlights the potential for novel microbial lineages in these extreme habitats. Overall, these findings provide insights into microbial community structure and diversity in hypersaline ecosystems and their adaptation to extreme saline environments.

Keywords: Hypersaline environments, Microbial diversity16S rRNA sequencing, Hadjer El-Melh, Zahrez-Gharbi,Halophiles.

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New horizons in molecular viral detection: A review of LAMP technology as a rapid diagnostic tool for HPV screening

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The rapid evolution of molecular viral detection has significantly changed the overall approach to diagnostic frameworks nowadays, particularly in terms of high-risk Human Papillomavirus (HPV) genotyping. Precise identification of oncogenic types from clinical specimens, including cervical swabs, is fundamental for the efficacy of modern screening tests. Although Polymerase Chain Reaction (PCR) remains the diagnostic gold standard, its practical usage is frequently limited by the requirement for expensive equipment and time-intensive protocols. Consequently, Loop-mediated isothermal amplification (LAMP) has emerged as a promising alternative, offering robust and rapid options for point-of-care (POC) diagnostic applications [1].

This review analyzes recent advancements in the LAMP technique and its combinations with innovative analytical platforms. Unlike traditional methods, modern LAMP assays can provide rapid DNA amplification under isothermal conditions (60–65°C), thus reducing complex technical requirements. Current research highlights combining LAMP and microfluidic systems (Lab-on-a-Chip), as well as electrochemical biosensors, which enable high sensitivity and specificity for HPV-16 and HPV-18 genotyping. What's more, the development of colorimetric and lateral flow detection methods allows for rapid naked-eye preliminary result interpretation, which eliminates the need for electrophoresis. These new technological solutions suggest that LAMP-based platforms could revolutionize viral diagnostics by providing cost-effective and rapid high-risk HPV genotypes detection in low-resource settings[2].

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How Well Do We Know New Guinea Orchids? Species Richness, Sampling Bias, and Priority Areas for Future Research

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New Guinea is the largest tropical island in the world. Due to its climatic and geographical conditions, it is characterized by exceptionally high biodiversity and endemism. One of the important plant groups found on the island is the orchid family. The number of species in New Guinea is estimated at approximately 2,800, but it is likely underestimated due to insufficient knowledge. The aim of this study was to compare data on the occurrence of orchids in New Guinea with the origins of collections and to determine the extent of knowledge about New Guinea in terms of orchid biodiversity.

The study revealed the existence of both a biodiversity hotspot and a site with the most intensive collection activity in the southeastern part of New Guinea. A statistically significant correlation was found between the number of collected specimens and the species richness in a given area. An unexplored region, where no specimens had been collected so far, was also identified and compared with the distribution of plant formations. The incompleteness of available data on orchids in New Guinea and the need for further research in this area were identified.

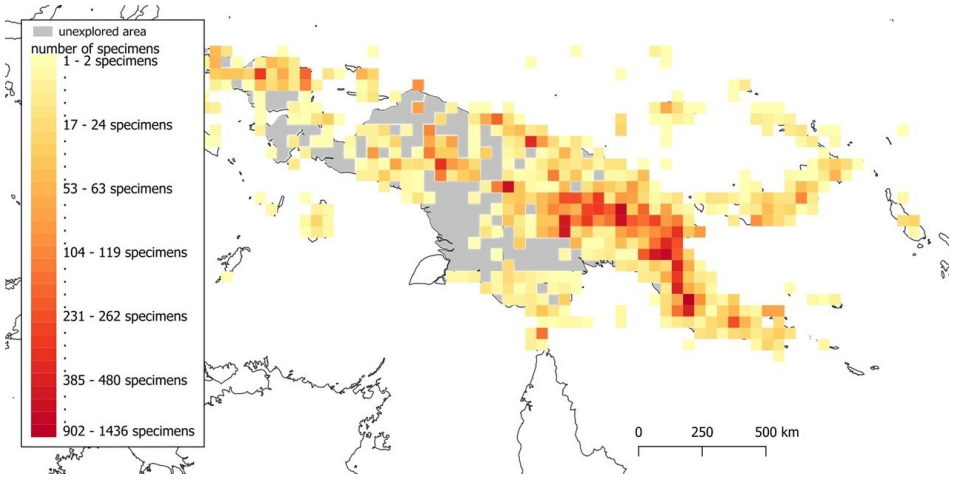

Fig. 1. Origin of herbarium collections and records of Orchidaceae in New Guinea and areas where no herbarium collections or observations of Orchidaceae have been made

OSMOTIC RESPONSE OF SELECTED GRAPEVINE (*Vitis vinifera* L.) GENOTYPES TO MANNITOL-INDUCED STRESS IN VITRO

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Drought stress represents one of the major environmental factors limiting grapevine growth and productivity. Osmotic adjustment is an important physiological mechanism enabling plants to maintain cell turgor and metabolic activity under water deficit conditions. The aim of this study was to evaluate the response of selected grapevine genotypes to osmotic stress induced under in vitro conditions.

Micropropagated plants of two grapevine cultivars, ‘Blauer Portugieser’ and ‘Müller Thurgau’, were cultivated on modified QL medium supplemented with different concentrations of mannitol in the range from 0.01 to 0.5 M in order to simulate osmotic stress. Plants were grown under controlled cultivation conditions for eight weeks. Growth parameters, including shoot length and dry weight, were evaluated. Osmotic potential was determined using an osmometer and calculated according to the Van’t Hoff equation. Relative growth responses were expressed in comparison with the untreated control.

Increasing mannitol concentration negatively affected shoot growth and biomass accumulation in both cultivars. The reduction in plant length and dry matter production was accompanied by significant changes in osmotic potential, indicating activation of osmotic adjustment mechanisms. Differences between cultivars were observed, suggesting genotype-dependent tolerance to osmotic stress. ‘Blauer Portugieser’ showed lower reduction in growth parameters and more stable osmotic characteristics under higher osmotic stress levels compared to ‘Müller Thurgau’.

The obtained results confirm that in vitro cultivation combined with mannitol-induced osmotic stress represents a suitable system for rapid screening of grapevine tolerance to drought-related stress. The study also indicates that osmotic potential may serve as a useful physiological marker for the evaluation of genotype adaptability to water deficit conditions.

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Impact of Bacillus sp. and Glomus inoculation on drought-induced oxidative stress and flower abscission in yellow lupine stress

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Drought is a major abiotic factor limiting legume productivity, accelerating flower abscission and reducing reproductive success in yellow lupine (*Lupinus luteus* L.). Plant associated microorganisms represent a promising, low input strategy for alleviating water deficit stress by modulating physiological responses at both whole plant and tissue levels [1].

This study investigated whether inoculation with Bacillus sp. and arbuscular mycorrhizal fungi (*Glomus sp.*) mitigates the effects of soil drought on flower abscission zone (AZ) activity and oxidative damage in yellow lupine [3].

Plants were cultivated in pots under optimal watering (75% water holding capacity, WHC) or drought stress (25% WHC) [2] and inoculated with *Bacillus sp.*, *Glomus sp.* or their combination. Morphological traits, leaf relative water content, AZ structure, and malondialdehyde (MDA) content were analysed.

Drought strongly enhanced AZ development and activity, increased flower abscission, and caused a several fold increase in MDA concentration. Inoculation with *Bacillus sp.* or Glomus sp. partially alleviated these effects, whereas their combined application most effectively reduced MDA accumulation and limited the extent of structurally active AZ. Inoculated plants maintained a more favourable generative development than non inoculated, drought stressed controls.

The combined application of *Bacillus sp.* and *Glomus sp.* mitigates drought induced oxidative damage and excessive activation of the flower AZ in yellow lupine, thereby supporting reproductive performance under water limited conditions. These findings indicate the potential of tailored microbial consortia to stabilise legume yield in drought prone agroecosystems [3].

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The effect of poly-γ-glutamic acid (γ-PGA) on mitigating drought stress in yellow lupine (*Lupinus luteus L.*) in microscopic analyses

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Drought is one of the most significant factors limiting the growth and yield of crops, including yellow lupine (*Lupinus luteus L.*). In recent years, there has been growing interest in biostimulants, such as poly-γ-glutamic acid (γ-PGA), which may enhance plant tolerance to water stress. The aim of this study was to evaluate the effect of γ-PGA on the condition of root nodules of yellow lupine subjected to drought, using microscopic analyses.

The research material consisted of yellow lupine grown under controlled conditions, under limited soil water availability and under limited soil water availability with γ-PGA treatment. Microscopic analyses were performed on root nodule preparations, evaluating cell integrity, cell wall morphology, and the organization of intracellular structures.

In plants subjected to drought and treated with γ-PGA, no significant differences in cell structure were observed compared to the control group. The cells preserved their normal organization, with no visible damage or deformation. A different picture was observed for the root nodules of plants grown exclusively under drought conditions, where degradation processes were observed, including cell deformation, plasmolysis and disruptions in tissue continuity. These results may indicate that the application of γ-PGA reduces the negative impact of water stress on the cellular structures of yellow lupine and supports the maintenance of tissue integrity.

The conducted studies suggest a potential protective effect of γ-PGA under conditions of water deficit. Further physiological and biochemical analyses will allow for a more precise determination of the mechanisms responsible for the observed effect.

Spectral light quality shapes photosynthetic and metabolic responses in tomato seedlings through CRY1-dependent signaling

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Light spectrum composition is a major factor influencing plant development, photosynthetic efficiency and metabolic regulation. Cryptochrome 1 (CRY1), a blue/UV-light photoreceptor, plays an important role in mediating light-dependent physiological responses. However, its involvement in integrating diverse spectral cues into coordinated photosynthetic and metabolic adaptations remains poorly understood.

The present study examined the role of CRY1-dependent signaling in tomato (Solanum lycopersicum L., cv. Blackball) seedlings cultivated under monochromatic red (630 nm), green (515 nm), blue (455 nm), blue supplemented with UV-A (444 + 399 nm), and mixed RGB light. To evaluate the contribution of CRY1, seedlings with functional photoreceptor activity were compared with plants treated with the CRY1 inhibitor 3-bromo-7-nitroindazole (3B7N). Morphological parameters, photosynthetic pigment accumulation, chlorophyll a fluorescence, phenolic compound content and abundance of selected photosynthetic proteins were analyzed. Seedling growth responses strongly depended on spectral composition. Red and green light promoted hypocotyl elongation, whereas blue light significantly inhibited shoot growth. The B+UV treatment enhanced root elongation and resulted in the highest accumulation of chlorophyll a, chlorophyll b and carotenoids, indicating improved photosynthetic acclimation under short-wavelength radiation.

CRY1 inhibition markedly modified both physiological and metabolic responses. Under green light, inhibition of CRY1 enhanced elongation growth and reduced pigment accumulation, suggesting an important role of CRY1 in spectral signal integration beyond well-known blue- light perception. The highest accumulation of phenolic compounds was observed under monochromatic blue light in seedlings with active CRY1 signaling, while red and green light significantly reduced phenolic content.

Chlorophyll fluorescence analysis revealed the highest effective quantum yield of photosystem II [Y(II)] under RGB and B/B+UV treatments, whereas monochromatic red light resulted in decreased photosynthetic efficiency and elevated non-photochemical quenching [Y(NPQ)]. Furthermore, CRY1 inhibition under B+UV conditions increased the abundance of key photosynthetic proteins, including Rubisco subunits, light-harvesting complex proteins and ATP synthase, indicating compensatory remodeling of the photosynthetic apparatus.

The obtained results demonstrate that spectral light quality differentially regulates photosynthetic and metabolic processes in tomato seedlings through CRY1-dependent signaling pathways. The study highlights the role of CRY1 as an integrative regulator coordinating physiological acclimation and secondary metabolism under changing spectral environments.

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Frontal Alpha Asymmetry and ERP Responses to Emotional Valence Incongruity in Sentence Processing

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This study investigated the relationship between frontal alpha asymmetry (FAA) and event-related potentials (ERP) during emotional sentence processing, using FAA as a neural marker previously associated with Adverse Childhood Experiences (ACE). EEG and ERP data were collected during an emotional sentence processing task. Sentences were constructed such that emotional valence (positive, neutral, or negative) was independently assigned to context and sentence-ending components. Participants were presented with both congruent conditions, in which contextual and terminal valence matched, and incongruent conditions, in which the valence was reversed, and ERP responses were compared between these conditions.

Resting-state FAA was measured before and after the experiment. Results indicated that stronger right-dominant FAA was associated with shorter ERP latencies during the processing of emotionally incongruent sentences, suggesting greater neural sensitivity to emotional conflict in individuals with higher right-lateralized frontal activity.

These findings suggest a potential link between individual differences in frontal asymmetry and the temporal dynamics of emotional conflict processing. The results may contribute to the development of neurophysiological markers for emotional processing and have potential applications in clinical screening related to adverse childhood experiences.

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Application of cDNA vectors to study expression and localization of fluorescently tagged Tau and PARP1 proteins in mammalian cells

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Neurodegenerative diseases are a growing problem in aging societies, and understanding the mechanisms underlying their development is one of the key challenges of modern molecular biology. Previous studies have demonstrated the role of numerous proteins in the development of these diseases, including Tau and PARP1.

The aim of presented study was to prepare cDNA vectors encoding human Tau and PARP1 proteins fused with fluorescent proteins: enhanced yellow fluorescent protein (EYFP) and monomeric red fluorescent protein (mRFP), enabling the study of their intracellular distribution under a fluorescence microscope.

Obtaining of desired constructs: pEYFP-C1/Tau, pEYFP-C1/PARP1, pmRFP/Tau, and pmRFP/PARP1 was confirmed by restriction analysis and sequencing, and preliminary expression of the constructs in mammalian N2a and COS-7 cell lines demonstrated intracellular localization of fusion proteins corresponding to Tau and PARP1 under physiological conditions.

It was confirmed, that resulting vectors constitute a useful tool for studying changes in Tau and PARP1 localization under various experimental conditions. Such studies may help understand the role of both proteins in the development of neurodegenerative diseases. Importantly, the ability to simultaneously visualize both proteins allows for the analysis of their interaction and potential interplay.

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Bacterial cellulose membranes as barrier materials: The influence of material properties on NaCl permeability.

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Bacterial cellulose (BC) is a natural biopolymer with a hydrogel-like, layered, and three-dimensional structure, whose properties strongly depend on fiber arrangement, degree of crystallinity, and the presence of pores and free spaces within the material. Due to the small pore size, BC membranes allow the diffusion of liquids and small molecules, such as gases (O_2, N_2) and ions, whereas the transport of larger particles, including proteins and polysaccharides, is significantly limited. Therefore, the optimization of synthesis conditions and control of BC structural properties remain crucial for achieving controlled and efficient molecular transport.

The aim of this study was to analyze the effect of structural changes occurring in bacterial cellulose membranes during biosynthesis on NaCl permeability.

BC biosynthesis was carried out under static culture conditions using the bacterial strain *Komagataibacter xylinus* (ATCC 53524) in Hestrin–Schramm medium for 3, 5, and 10 days. The obtained membranes were purified in NaOH solution and subsequently characterized by ATR-FTIR spectroscopy to determine selected structural indices (TCI, HBI, LOI, and Iα). Additionally, water-related parameters, including moisture content ratio (MCR) and water holding capacity (WHC), were evaluated. The permeability of BC membranes toward NaCl solutions (75 mM and 150 mM) was investigated using a modified Franz diffusion cell.

ATR-FTIR analysis confirmed the presence of characteristic bands typical for BC. Prolonged cultivation time resulted in decreased crystallinity and reduced Iα allomorph content, accompanied by an increase in HBI values. Water-related analyses showed a decrease in both WHC and MCR with increasing cultivation time. The permeability of the obtained bacterial cellulose membranes was evaluated based on the k constant, describing the rate of concentration change in the acceptor chamber. The highest k value was observed for the 3-day membrane, whereas the lowest was found for the 10-day sample, regardless of the applied salt concentration. Similar results were obtained for the effective permeability coefficient (Peff). These findings suggest that extended cultivation leads to membrane reorganization and structural densification, thereby limiting substance transport through the material.

The obtained results indicate that the structural properties of bacterial cellulose play a key role in transport processes, which may be important for the design of cellulose-based membranes intended for filtration and separation applications.

Bacterial Inoculation Effects on Biochemical Responses of Scots Pine Seedlings: A Greenhouse Study

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Plant growth-promoting (PGP) bacteria are increasingly recognized as sustainable tools for improving seedling quality in forest nursery production. However, their effects on conifer physiology under controlled conditions remain insufficiently studied, particularly across genotypes.

This study assessed the biochemical responses of three Scots pine (*Pinus sylvestris* L.) genotypes (8J, 16J, and 519J) to foliar inoculation with two native to Scots pine trees bacterial strains exhibiting PGP traits — *Bacillus velezensis* (BA) and *Priestia megaterium* (PR) [1] – under greenhouse conditions. Three-year-old Scots pine seedlings were sprayed with bacterial inoculants on day 1 and at week 3. Photosynthetic pigments (total chlorophyll, carotenoids), secondary metabolites (total phenolic and flavonoid content, soluble sugars), and malondialdehyde (MDA) as an oxidative stress indicator were measured at weeks 4 and 10.

The most consistent and significant effect of bacterial inoculation was observed in total chlorophyll content, where PR-treated genotype 519J and BA-treated genotype 16J seedlings showed strongly elevated pigment levels at week 10 compared to controls. MDA levels revealed genotype-dependent oxidative stress responses: BA inoculation significantly reduced MDA in genotype 16J at week 4, and PR reduced MDA in genotype 8J at week 4, suggesting early antioxidant priming. However, BA-treated genotype 519J showed elevated MDA at week 10, indicating a genotype-specific oxidative response to bacterial inoculation. Soluble sugar accumulation was significantly elevated in BA-treated genotype 519J at week 10, reflecting enhanced carbon metabolism. Secondary metabolite responses were variable and genotype-dependent.

These findings demonstrate that PGP bacteria inoculation measurably enhances photosynthetic capacity in Scots pine under greenhouse conditions, with protective antioxidant effects that are strongly genotype-specific. The results support the potential of targeted bacterial inoculants in pine nursery management, while highlighting the importance of matching bacterial strain to seedling genotype.

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The Role of TOR Signaling Modulators in Tomato Seed Germination and Early Seedling Development

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The Target of Rapamycin (TOR) signaling pathway plays a central role in the regulation of plant growth and development through the integration of environmental and hormonal signals, including gibberellic acid (GA) and abscisic acid (ABA). The present study aimed to evaluate the effects of selected TOR activity modulators and hormonal regulators, including rapamycin (RAPA), KU-63794, AZD8055, TORIN1, GA, and ABA on seed germination, seedling growth, and photosynthetic activity in tomato (*Solanum lycopersicum* L. cv. Black Cherry). Plants were cultivated on Petri dishes containing Murashige-Skoog medium in growth chambers at 25°C under a 16 h light/8 h dark photoperiod with a light intensity of 100 µmol m^{-2} s^{-1} for 10 days.

The results indicated that seeds treated with ABA exhibited the lowest germination index (GI), whereas GA treatment resulted in the highest GI values. Among the ATP-competitive TOR regulators (TORIN1, AZD8055, KU63794, and RAPA), seeds treated with RAPA showed the highest GI. Accordingly, the mean germination time (MGT) increased in the ABA-treated group and decreased in the GA- and RAPA-treated groups. Analysis of the seedling vigor indices based on seedling length and seedling dry weight (SLVI and SWVI) demonstrated that seedlings treated with RAPA and KU63794 exhibited the lowest values of these parameters. Morphological analysis revealed that the longest seedlings were observed in the GA- and KU63794-treated groups. Moreover, GA, TORIN1, and RAPA treatments stimulated root growth, while seedlings treated with TORIN1, RAPA, and ABA developed a greater number of roots compared to the other groups. The highest ΦPSII values were observed in ABA- and RAPA-treated seedlings, which correlated with elevated ETR values in the KU63794-, ABA-, TORIN1-, and AZD8055-treated groups, indicating enhanced efficiency of photosynthetic electron transport. Furthermore, reduced ΦNPQ and ΦN0 values were observed in all treated groups, suggesting more efficient photochemical energy utilization. Protein analysis revealed the highest protein accumulation in ABA-treated seedlings and the lowest in RAPA-treated plants, along with changes in the levels of photosynthesis-related proteins, including RuBisCO LSU and Lhcb1–3. The obtained results indicate that modulation of the TOR signaling pathway significantly affects seed germination, seedling growth, and photosynthetic activity in tomato, confirming the crucial role of TOR in the regulation of plant growth and development.

Genetic Analysis of Sosnowsky's hogweed (*Heracleum sosnowskyi*) Populations in Lithuania Using ISSR Molecular Markers

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Sosnowsky's hogweed (*Heracleum sosnowskyi* Manden.) is an invasive species widely spread throughout the Baltic region and former Soviet Union countries [1,2]. This monocarpic perennial plant of the carrot family (Apiaceae), originating from the Caucasus region, poses serious health risks to humans as its sap causes severe photosensitivity and burns [3]. It sprouts early in the spring, has the ability to form dense vegetation therefore easily outcompeting native species. While the plant is widespread in Lithuania, it is primarily studied botanically and ecologically. To date, the molecular studies of the species is very limited.

This study focuses on molecular perspective to better understand the invasiveness. The aim of the study was to investigate the genetic structure of Lithuanian *Heracleum sosnowskyi* populations through Inter-Simple Sequence Repeats (ISSR) analysis. The objectives covered (1) the evaluation of ISSR loci polymorphism in the species and (2) analysis of genetic relationships within and among the studied populations.

In total, 329 collected samples of *Heracleum sosnowskyi* was analyzed covering 16 Lithuanian populations. For the analysis, PCR was conducted using 6 ISSR markers. The DNA fragment analysis was performed using agarose gel electrophoresis. The data underwent GeneAlEx Microsoft Excel addon [4] and PAST software (v1.14c) [5] analysis.

Analysis of molecular variance (AMOVA) showed that 53% of genetic variation was attributed to within-population differences, while 41 % was observed for among population variation. The remaining 6% was attributed to variation among 4 Lithuanian regions. The medium polymorphism level for ISSR markers was estimated to be 56%. Overall, the analysis demonstrated genetic variation ranging from moderate to low. These findings should be taken into consideration when trying to explain the observed difficulties related to species eradication in Lithuania.

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Lipid modification in argan-hemp oil systems catalyzed by lipases

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Interest in enzymatically modified lipids has increased considerably in recent years due to the growing demand for food ingredients with tailored nutritional and functional properties. Structured lipids obtained through lipase-catalyzed reactions allow modification of triacylglycerol (TAG) architecture without extensive degradation of thermolabile bioactive compounds. Argan oil (AO) is distinguished by its unique composition rich in oleic and linoleic acids, tocopherols, and other minor constituents associated with oxidative protection and nutritional value. Hemp seed oil (HO), on the other hand, is considered an important source of essential fatty acids, especially ω-6 and ω-3 fatty acids occurring in a favorable ratio. Combining these two oils and modifying their lipid structure via enzymatic interesterification may provide an attractive approach for designing novel lipid systems with targeted technological and nutritional characteristics [1,2]. The aim of this study was to investigate lipid modification in argan–hemp oil systems catalyzed by lipases. Oil blends prepared at selected weight ratios were subjected to enzymatic interesterification to obtain structured lipids with modified TAG composition. The effect of enzymatic modification on the obtained lipid systems was evaluated by determining fatty acid composition and positional distribution of fatty acids in TAGs. Oxidative stability was assessed using pressure differential scanning calorimetry (PDSC). Moreover, selected physicochemical quality parameters, including acid value, peroxide value, p-anisidine value, and total oxidation index (TOTOX), were determined to evaluate the quality and oxidative condition of the obtained structured lipids. The results of this study may expand current knowledge regarding enzymatic modification of mixed vegetable oil systems and its influence on lipid quality and stability. The developed structured lipids may also represent promising candidates for application in functional food products and nutraceutical formulations requiring both high nutritional value and appropriate oxidative stability.

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Novel and rapid synthesis of MIV-based multimetal–organic frameworks for photopolymerization of methyl methacrylate under visible light

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Metal–organic frameworks (MOFs) are porous materials that have attracted increasing interest for photocatalytic applications. Conventional solvothermal synthesis of photoactive MOFs typically requires high-pressure reactors and time-consuming preparative protocols. This study reports the preparation of Ti-, Zr-, and/or Hf-based MOFs using a novel hot injection approach. Among the prepared materials, NH2-UiO-66 (Zr/Hf) exhibited high photocatalytic activity for the polymerization of methyl methacrylate under visible light irradiation and under monochromatic visible light at a wavelength of 430 nm (xenon lamp or light-emitting diode). The ability to produce these materials using simple, low-pressure equipment makes this method a promising route for process scale-up and cost reduction. The obtained MOFs demonstrated high photostability, maintaining nearly unchanged activity over three photocatalytic cycles and during long-term operation (44 h).

Moreover, the polymer products were analyzed via size exclusion chromatography and complementary analytical techniques, thereby elucidating the photopolymerization process under different irradiation conditions and reaction times.

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SYNTHESIS AND CHARACTERIZATION OF POLY (METHYL METHACRYLATE) NANOPARTICLES FOR QUERCETIN ENCAPSULATION

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This study investigates the synthesis and characterization of poly (methyl methacrylate) (PMMA) nanoparticles for potential pharmaceutical applications, particularly in drug delivery systems. The nanoparticles were synthesized via emulsion polymerization using methyl methacrylate (MMA) as the monomer, sodium dodecyl sulfate (SDS) as a stabilizer, and potassium persulfate as an initiator under an inert nitrogen atmosphere. Quercetin, a bioactive flavonoid with well-known antioxidant and therapeutic properties, was encapsulated within the PMMA matrix to evaluate the influence of drug loading on nanoparticle size, morphology, and stability. Nanoparticle formation was confirmed by the Tyndall effect and scanning electron microscopy (SEM), which demonstrated the successful formation of nanoscale particles.

The synthesized nanoparticles were characterized in terms of particle size and morphology. SEM analysis revealed an average particle size of 183±44 nm. These findings demonstrate the potential of PMMA nanoparticles as effective carriers for the encapsulation and controlled delivery of bioactive compounds and support their application in nanomedicine, advanced drug formulation technologies, and targeted therapeutic systems, including photothermal therapy assisted cancer treatment.

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From Form to Function: Copper Availability as a Function of Its Speciation in Deep Eutectic Solvents

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Copper speciation determines its reactivity, release behavior and environmental impact in agricultural systems. Deep eutectic solvents (DES) enable control over copper form by influencing nanoparticle synthesis and stability.

The aim of this study was to investigate how DES composition affects copper speciation and its availability in Cu-DES systems. Materials based on betaine with glucose, fructose, glycerol and ascorbic acid were prepared and evaluated.

Significant differences in Cu/Cu_2O phase composition were observed. In Cu-DES2, Cu content reached 85.9% (Cu_2O 14.1%), while in Cu-DES4 it was 73.7% (Cu_2O 26.3%). These variations in copper speciation directly determined its availability, with ion release stabilizing at 4–8% in soil. The systems also exhibited antimicrobial activity (MIC 15.6 mg Cu/dm^3).

The results demonstrate that copper speciation governs its availability, which in turn controls its biological activity and functional performance. DES composition enables speciation-driven tuning of copper behavior.

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Pushing the Boundaries of π-Conjugation: Development of Hexasubstituted Pyrene Fluorophores

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Pyrene derivatives have long attracted considerable attention owing to their exceptional photophysical properties and broad applicability in modern optoelectronic materials. While tetrasubstituted pyrenes are well established and extensively described in the literature, their hexasubstituted counterparts were for many years considered difficult to access because of the steric hindrance associated with multiple substitutions on the aromatic core. Recent advances in synthetic organic chemistry have shown that this limitation can be overcome, opening a largely unexplored area of research. Over the past seven months, members of our student research group have focused on developing efficient synthetic routes toward highly substituted pyrene derivatives. Our work aimed both to expand the synthetic toolbox available for pyrene functionalization and to examine how increased substitution affects the optical properties of these π-conjugated systems. As a result, we successfully synthesized a series of 1,2,3,6,7,8-hexasubstituted pyrene derivatives bearing various functional groups. The obtained compounds were investigated using spectroscopic techniques, with particular emphasis on UV-Vis absorption and fluorescence behaviour under UV irradiation. The extended π-conjugation introduced by the substituents was found to significantly influence the photophysical properties of the molecules, leading to intense fluorescence emission and tunable optical responses. These findings contribute to a better understanding of structure-property relationships in highly substituted polycyclic aromatic hydrocarbons and demonstrate the potential of hexasubstituted pyrenes as promising fluorophores for future applications in organic light-emitting diodes (OLEDs), photonic materials and advanced sensing technologies.

This work was supported by the ORLEN Foundation under the programme “From Molecule to Galaxy” within the project “Pyrene Is Not Always the Same – Breaking the Four-Substituent Barrier: Hexasubstituted Derivatives as Efficient Fluorophores Visible Even from Space”. Computational calculations were performed using the resources of the Wrocław Centre for Networking and Supercomputing (WCSS), computational grant No. 568.

Electrochemical Synthesis of Polymethylene Blue: A Green Method for the Development of Advanced Functional Materials

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This study focuses on the electrochemical synthesis of poly(methylene blue) as a green and sustainable alternative for the development of functional and advanced materials. Conventional synthesis methods typically require hazardous reagents and solvents that are harmful to the environment. In contrast, electrochemical synthesis offers a cleaner and more controllable alternative, allowing materials to be formed under mild conditions with less waste generation.[1,2]

PMB films were synthesized by electrochemical polymerization using cyclic voltammetry in aqueous medium. Different potential windows and methylene blue concentrations were evaluated to optimize film growth and electrochemical performance. The optimal polymerization conditions were obtained within a potential range from −0.2 to 1.3 V using a methylene blue concentration of 1 mM. The electrochemical behavior of the synthesized films was further studied at different scan rates through the relationships between peak current and scan rate, as well as peak current and the square root of scan rate. The higher linear correlation obtained for Ip versus the square root of scan rate indicated that the electrochemical process is predominantly diffusion-controlled.

The synthesized PMB films exhibited good electrochemical performance, with an areal capacitance of 8.6 mF cm−2 and a capacitance retention of 87.97% after 50 cyclic voltammetry cycles, demonstrating favorable charge storage capability and good electrochemical stability. These results highlight the potential of PMB as an electroactive material for sustainable energy storage applications and demonstrate the relevance of electrochemical synthesis as a green approach for the development of high-performance functional materials.

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Isothiocyanate-triazine conjugates synthesis which contains azetidine rings

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1,3,5-Triazines are an extremely interesting group of organic compounds due to their ability to accommodate three different substituents. A core containing a 1,3,5-triazine ring substituted with three structurally diverse substituents is present in many compounds exhibiting biological properties. Another widely studied group of compounds are isothiocyanates (ITCs) which are occurred from cruciferous vegetables. A natural source of ITCs are cruciferous vegetables, in which isothiocyanates are formed from biologically inactive glucosinolates. In addition to natural ITCs, non-natural ITCs with improved biological properties are being synthesised.

The aim of the study was to obtain conjugates, not previously described in the literature, consisting of two biologically active fragments: ethyl 6-(isothiocyanatohexyl)phosphonate and an altretamine derivative containing a 1,3,5-triazine core substituted with two azetidine rings or an azetidine ring and a dimethylamine group, linked together via an ethylenediamine linker. Both conjugates were obtained in yields of 63% and 67%, respectively.

The structures of the synthesised compounds were confirmed by 1H, 31P and 13C NMR spectra, and their purity and molecular weight were determined by liquid chromatography coupled with mass spectrometry. The compounds were tested for their anticancer properties against melanoma tumor (HS-294T) and bladder cancer (RT-112).

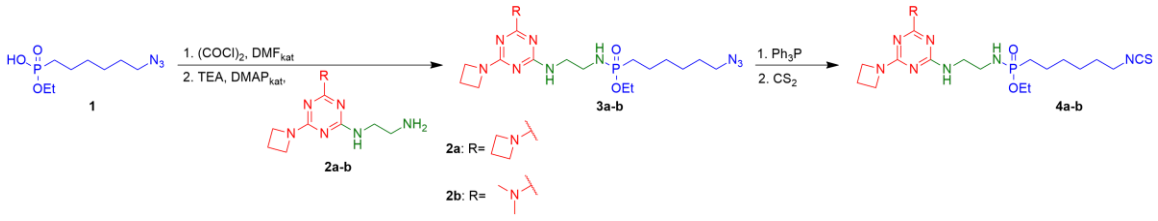

Fig. 1. Synthesis of isothiocyanate-triazine conjugates containing azetidine rings.

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Antibacterial Activity of Copper(II) Complexes with 1-(Morpholin-4-yl)propane-1,2-dione 4-Phenylthiosemicarbazone against *Bacillus cereus*

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Thiosemicarbazones and their copper(II) complexes have attracted significant interest owing to their broad spectrum of biological activities, particularly their antibacterial properties. Coordination of thiosemicarbazone ligands to copper(II) ions often enhances biological activity by increasing molecular stability, lipophilicity, and the ability to interact with cellular targets. The investigation of their antibacterial activity against *Bacillus cereus* is of particular importance, as this Gram-positive bacterium is a common cause of foodborne illnesses and is capable of producing toxins that pose serious risks to human health. Moreover, the emergence of bacterial resistance to conventional antimicrobial agents highlights the need for the development of new and effective antibacterial compounds. Therefore, copper(II) thiosemicarbazone complexes represent promising candidates for the design of novel antibacterial agents active against *Bacillus cereus*.

The 1-(morpholin-4-yl)propane-1,2-dione 4-phenylthiosemicarbazone (HL) was prepared by the condensation of equimolar amounts of 4-phenylthiosemicarbazide and 1-(morpholin-4-yl)propane-1,2-dione in refluxing ethanol. The synthesized ligand was characterized using ^{1}H and ^{13}C NMR spectroscopy, FTIR spectroscopy, and elemental analysis.

Subsequently, a series of copper(II) complexes was obtained through the reaction of HL with various copper(II) salts in ethanol at a 1:1 molar ratio. This procedure yielded the complexes [CuLCl], [CuLBr], [$CuLNO_3$], [$CuL(Cl_2CHCOO)$], and [CuL(OAc)]. The structures and compositions of the resulting compounds were investigated by elemental analysis, FTIR spectroscopy, and molar conductivity measurements.

The antibacterial properties were evaluated against *Bacillus cereus* (ATCC 11778), with minimum inhibitory concentrations (MIC, μg mL^{-1}) and minimum bactericidal concentrations (MBC, μg mL^{-1}) determined by the serial dilution method in liquid broth. The results demonstrated that coordination of the thiosemicarbazone ligand to the copper(II) center led to a significant enhancement of antibacterial activity for all complexes. The activity was found to depend on the nature of the counterion present in the complexes and decreased in the following order: OAc^{-} > Cl_2CHCOO^{-} > Cl^{-} > $NO3^{-}$ > Br^{-}. The highest activity was observed for the complex [CuL(OAc)], with MIC and MBC values of 1.953 μg/mL and 1.953 μg/mL, respectively.

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Porphyrin SURMOF (Surface Coordinated Metal Organic Framework)

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According to the latest data, global GHG emissions in 2024 reached 53.2 Gt CO_2eq. This marks an increase of 1.3%, or 665 Mt CO_2eq, compared to 2023.[1] The overproduction of carbon dioxide necessitates the development of technologies capable of reducing this amount. Heterogeneous photocatalysis with the use of semiconductors appears to be a promising solution. One of the promising semiconductor materials is MOF (Metal Organic Framework). A MOF is a hybrid material consisting of organic linkers and inorganic metal centers. Compared to powder MOFs, SURMOFs (Surface Coordinated Metal Organic Frameworks) offer several advantages. The main advantages include easier processability, greater control over the MOF structure, and higher photocatalytic activity.

To obtain a SURMOF, a substrate must be functionalized with appropriate functional groups to ensure the formation of a uniform and stable film. The functionalization of a substrate can be carried out using various methods, such as solvothermal synthesis, electrochemical treatment, or plasma treatment. In the present work, copper foam was functionalized electrochemically.[2] A three-electrode system (Hg/HgO as the reference electrode, Pt as the counter electrode, and copper foam as the working electrode) was immersed in an electrolyte solution (3 M NaOH). A constant current of 30 mA was applied for 1000 s. As a result, the color of the copper foam changed from orange to blue. XRD results and SEM images confirmed the presence of –OH groups, which serve as anchoring sites for MOF growth.

The functionalized substrate was first immersed in a metal precursor solution ($ZrOCl_2 \cdot H_2O$) for 30 min, then rinsed with water and ethanol for 5 min. Subsequently, the substrate was immersed in the linker solution (Tetrakis (4-carboxyphenyl)porphyrin) for another 30 min. Finally, the sample was dried at 60°C overnight. As a result of the deposition, the substrate color changed from blue to purple.[3]

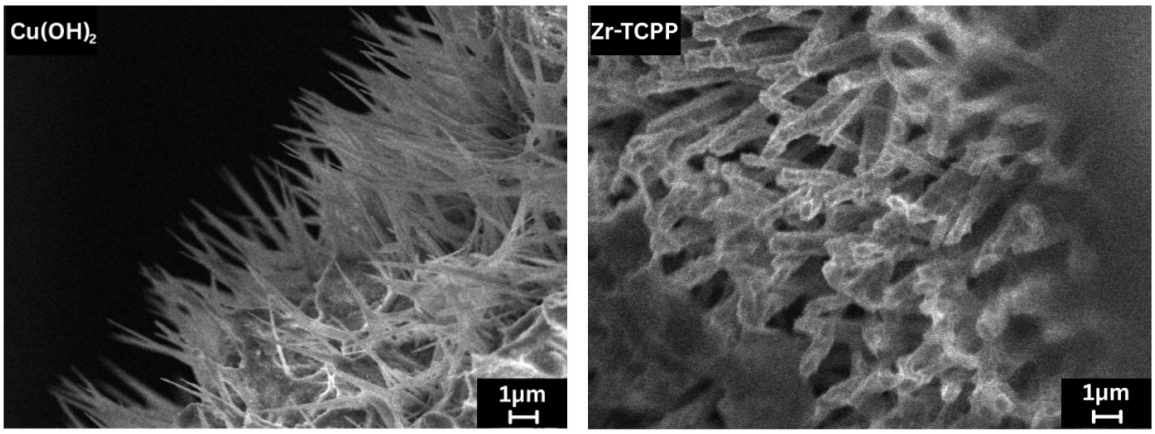

Fig. 1. SEM images for Cu(OH)2 and Zr-TCPP SURMOF

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Glycoconjugation of 8-aminoquinoline derivatives for improving their activity and selectivity towards cancer cells

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Quinoline itself exhibits limited biological activity, however, its skeleton serves as a key structural element in many active compounds with a broad spectrum of action. Quinoline derivatives demonstrate antimicrobial, anticancer, cardiotonic, hypotensive, anti-HIV, anticonvulsant, anti-neurodegenerative, anti-inflammatory, and analgesic activities. There are many drugs on the market that contain this scaffold, and additional derivatives are in various phases of *in vitro* and *in vivo* testing.

In light of the rising incidence of cancer, the antiproliferative activity of quinoline derivatives appears particularly interesting. Their mechanism of action is multifaceted, involving the modulation of signaling pathways, enzyme inhibition, and intercalation into the DNA helix.

A significant limitation of current chemotherapeutics is their low selectivity, which leads to high systemic toxicity. To improve therapeutic safety, targeted drug delivery, involving the covalent linkage between the active molecule and a ligand acting as a transporter with affinity for receptors overexpressed in diseased cells, seems to be a promising strategy. Utilizing sugars as ligands exploits the Warburg effect, a phenomenon of increased glucose demand in cancer cells associated with overexpression of GLUT transporters. Our previous works focused on this strategy in relation to 8-hydroxyquinoline (8-HQ) derivatives, which led to obtaining a series of 8-HQ glycoconjugates using copper(I)-catalyzed azide-alkyne cycloaddition (CuAAC). It was observed that the addition of sugar moiety improved their solubility and bioavailability but did not enhance selectivity toward cancer cells compared to the parent compounds [1,2]. The next goal was to improve glycoconjugates selectivity by simply substituting the 8-HQ moiety with 8-aminoquinoline (8-AQ). The nitrogen atoms in these conjugates allow the formation of complexes with metal ions, such as Cu^{2+} and Zn^{2+}, which play important roles in cancer development. *In vitro* studies on cancer cell lines identified two compounds with higher cytotoxicity and a more favourable selectivity profile toward healthy cells than their oxygen counterparts [3]. These results have encouraged the expansion of the 8-AQ library to include derivatives with unprotected sugar residues and modified linkers between the sugar and quinoline.

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ZINC- AND ZIRCONIUM-BASED BIO-MOFS DERIVED FROM L-GLUTAMIC ACID FOR APPLICATIONS IN CONTROLLED DRUG RELEASE

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Metal–organic frameworks (MOFs) constitute one of the most intensively investigated groups of nanomaterials in recent decades due to their high specific surface area, high porosity, and tunable structure. These properties make them promising candidates for biomedical applications, including controlled drug delivery, detoxification, diagnostic imaging, and modification of titanium implants. A particular subgroup is bio-metal–organic frameworks (bio-MOFs), constructed from linkers of natural origin [1,2].

L-glutamic acid is a natural endogenous amino acid commonly occurring in living organisms and plays an important role in metabolic processes and the functioning of the nervous system. Due to its biocompatibility, low toxicity, and ability to coordinate metal ions, it is an attractive ligand for the synthesis of bio-MOFs. The literature reports the possibility of obtaining L-glutamic-acid-based MOFs with zinc or zirconium ions [3,4].

In this study, such MOF structures were synthesized and used as drug carriers for ciprofloxacin (Cipro), a potent antibiotic with a broad antibacterial spectrum that also exhibits anticancer activity [5]. The obtained materials were subjected to physicochemical characterization. Sorption capacity toward ciprofloxacin was investigated, and the materials were analyzed using scanning electron microscopy (SEM), energy-dispersive spectroscopy (EDS), and Fourier-transform infrared spectroscopy (FT-IR). Particle size and zeta potential were also determined.

Drug release studies were conducted at pH = 7.4 and pH = 5 to simulate physiological conditions and those characteristic of inflammation or the tumor microenvironment. Both materials effectively retained the active substance (Zn-MOF – approximately 194 µg, Zr-MOF – approximately 250 µg) per 20 mg of carrier. Significant differences were observed in the release profiles. The zinc-based material released almost the entire drug amount within 7 hours, whereas the zirconium-based material released only about 35% of the retained amount.

Under acidic conditions, the zinc-based material released the drug almost immediately, while the zirconium-based material released it over a significantly longer period. In summary, the obtained zinc- and zirconium-based bio-MOFs exhibited high ciprofloxacin sorption capacity and distinct metal-dependent drug release profiles, confirming their potential as promising carriers for controlled drug delivery.

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Preparation of Kojic Acid and Study of Its Application in Cosmetics

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Kojic acid (5-hydroxy-2-hydroxymethyl-4H-pyran-4-one) is a widely used skin-brightening agent that inhibits tyrosinase, the key enzyme involved in melanogenesis. Despite its effectiveness, its application is limited by poor stability, restricted skin penetration, and the need for efficient production methods.

The aim of this study was to compare two approaches to kojic acid production: multistep chemical synthesis from glucose and biosynthesis using *Aspergillus oryzae*. The biological activity of the obtained compound was subsequently evaluated after incorporation into an oil-in-water (O/W) nanoemulsion.

Chemically synthesized kojic acid was characterized by NMR spectroscopy. Biosynthetic production was carried out by fermentation of *A. oryzae* in a glucose–yeast medium, followed by spectrophotometric quantification using iron(III) chloride and isolation with isopropanol.

An O/W nanoemulsion containing 1% kojic acid was prepared using heating and ultrasonication. Antioxidant activity assessed by the DPPH assay showed 68% radical inhibition. Skin-brightening efficacy was evaluated in an eight-day in vivo study using a CL 400 colorimeter. Significant increases ($p < 0.05$) in L* and ITA° values confirmed the brightening effect of the formulation.

Chemical synthesis yielded a highly pure product but required complex procedures and environmentally demanding conditions. Biosynthesis represented a greener alternative, although it resulted in lower yield and higher impurity levels. The developed nanoemulsion proved to be an effective carrier system, preserving biological activity and enhancing cosmetic performance.

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Circular Ocean-Bound Plastics: Litter Collected in Pilot Cities and Recycling Pathways

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This work summarizes findings from the COP project, which investigated the types and quantities of plastic litter entering waterways in three South Baltic pilot cities: Aarhus, Rostock, and Gdańsk, and evaluated their potential for circular management. Collection methods included automated systems (SeaProtectorOne), stationary capture devices (PortBins), and citizen driven initiatives (EcoKayak). The litter profiles varied significantly between locations: 30% of all collected litter from Aarhus river was single-use plastic cups, in Rostock cigarette butts made up 25%, while in Gdańsk bottles and can made up almost 50% of all collected litter. Laboratory analyses demonstrated that river collected plastics can be effectively cleaned using alkaline methods without compromising polymer integrity. Mechanical recycling tests showed that recovered PP exhibits properties comparable to virgin materials, while chemical recycling achieved full depolymerisation of polycarbonate and PET, with 70–75% monomer recovery from PET.

These results confirm that ocean bound plastics can be integrated into circular value chains through tailored cleaning, mechanical reprocessing, and chemical recycling technologies.

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Oxidative Stability and Physicochemical Quality of Structured Lipids Obtained by Enzymatic Interesterification of Hemp Oil and MCT

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Oxidative stability is one of the most important factors determining the quality, shelf life, and technological applicability of lipid systems rich in unsaturated fatty acids. Hemp seed oil is characterized by a high content of polyunsaturated fatty acids, which are nutritionally desirable but highly susceptible to oxidation. Medium-chain triglycerides (MCT), in contrast, exhibit relatively high oxidative stability and may improve the stability of lipid systems when combined with unsaturated oils. Enzymatic interesterification enables modification of triacylglycerol structure and may influence oxidative stability and physicochemical quality of the obtained lipids [1,2].

The aim of this study was to evaluate the oxidative stability and selected physicochemical quality parameters of structured lipids obtained by lipase-catalyzed interesterification of hemp seed oil and commercial MCT mixed at a 1:1 ratio. Hemp seed oil was obtained by extraction and subsequently subjected to enzymatic modification with MCT to produce structured lipid systems. Oxidative stability of the obtained lipids was evaluated using pressure differential scanning calorimetry (PDSC). In addition, selected physicochemical quality parameters, including acid value, peroxide value, p-anisidine value, and total oxidation index (TOTOX), were determined in order to assess the quality and oxidative status of the obtained structured lipids.

The obtained results may contribute to a better understanding of the relationship between enzymatic interesterification and oxidative stability of structured lipid systems. Furthermore, the developed lipids may represent promising functional ingredients with improved quality and stability for food and nutraceutical applications.

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Innovative approach to pancreatic cancer treatment: OGF analogs with a dual mechanism of action

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Pancreatic ductal adenocarcinoma (PDAC) is one of the greatest challenges in oncology due to its high mortality rate, limited treatment options, and late diagnosis. Its strong metastatic potential further worsens patient prognosis, with a five-year survival rate of only 5–6%, which has not significantly improved over the past decade.

Both in vitro and in vivo studies have demonstrated that Met-enkephalin, known as the Opioid Growth Factor (OGF), effectively inhibits the proliferation of malignant cells, exhibits broad-spectrum anticancer activity, and possesses a favorable safety profile. OGF regulates the cell cycle by increasing the proportion of cells in the G0/G1 phase while simultaneously reducing the number of cells in the S and G2/M phases. However, its short half-life in human plasma limits its therapeutic potential and clinical applicability.

The aim of the ongoing project is to develop proteolytically stable OGF analog conjugates with topoisomerase II (Top II) inhibitors, enabling simultaneous targeting of two molecular pathways. In the designed constructs, OGF acts as a targeting peptide that binds to the Opioid Growth Factor Receptor (OGFr) located on the nuclear membrane, resulting in the inhibition of cell proliferation and DNA replication processes. Concurrently, the attached Top II inhibitor induces DNA damage and triggers apoptosis in cancer cells.

The results of preliminary studies, including analytical characterization, plasma stability testing, and biological activity assessment in both 2D and 3D cellular models, indicate that OGF–cytostatic agent conjugates represent promising candidates for the development of innovative and more selective therapies for PDAC.

This research was funded by the Young Scientists' Research Project No. BMN 539-T070-B182-25 and the UGrants–start Project No. 533-BG20-GS2A-26

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Sustainable Cosmetics: Upcycling and Microplastic Elimination as Key Directions in Modern Cosmetology and Consumer Expectations

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In recent years, the cosmetic industry has been increasingly focused on sustainable development. Concepts such as *zero waste*, green chemistry, and the circular economy are becoming more important, as they aim to reduce the negative environmental impact of cosmetic production. Manufacturers are more often using natural raw materials, biodegradable ingredients, and solutions that help reduce waste and pollution[1].

One of the important trends in modern cosmetology is *upcycling*, which means giving new value to materials that were previously treated as waste[2]. In the cosmetic industry, this approach allows the use of by-products, such as plant waste or residues from the food industry, as sources of valuable active ingredients, while also reducing the amount of waste generated[3]. This solution supports more responsible use of resources and combines environmental and technological benefits.

At the same time, one of the key challenges in the cosmetic industry is the elimination of microplastics from cosmetic formulations. Microplastics, defined as plastic particles smaller than 5 mm, are very durable and do not biodegrade[4]. They are widely used in cosmetics because of their useful properties, but their accumulation in the environment, especially in water ecosystems, poses a serious threat to living organisms and human health. In response to this problem, new regulations require manufacturers to look for safe and biodegradable alternatives[5].

However, it should be noted that these aspects are only part of a wider range of trends and challenges in modern cosmetology, including the development of natural ingredients and product certification. Consumer expectations also play an important role in shaping the market. The results of the survey indicate that environmental aspects, such as the presence of microplastics and the origin of raw materials, are important factors when choosing cosmetics. This confirms that eco-friendly actions are not just a trend, but a real response to increasing consumer awareness and expectations[1].

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Synthesis of complexes of selected flavonoids with Cu(II)

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Flavonoids constitute a large group of naturally occurring polyphenolic compounds that exhibit a wide range of biological activities. Due to the presence of hydroxyl and carbonyl functional groups, they are capable of coordinating metal ions, which may significantly alter their physicochemical and biological properties.

The aim of this study was to obtain and characterize copper(II) complexes of selected flavonoids: hesperidin, hesperetin, and genistein. The synthesized compounds were characterized by elemental analysis, ATR-IR spectroscopy, and powder X-ray diffraction (XRD).

Elemental analysis confirmed the proposed compositions of the obtained complexes. ATR-IR spectra revealed shifts in characteristic absorption bands associated with hydroxyl and carbonyl groups, indicating their participation in metal coordination. Furthermore, XRD analysis demonstrated substantial differences between the diffraction patterns of the free ligands and their corresponding copper(II) complexes, confirming the formation of new crystalline phases.

The obtained results provide evidence for the successful formation of copper(II)–flavonoid complexes and contribute to a better understanding of metal–flavonoid interactions, which may be relevant for the development of compounds with potential pharmaceutical and biomedical applications.

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Crystallography in Action: Crystal Facet Engineering for Photocatalysis

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Precise control over the atomic arrangement and coordination environment at the photocatalyst's surface is essential for tuning surface energy, geometry, adsorption/desorption behavior, and electronic properties. Among various surface-structure design strategies, crystal facet engineering has emerged as a promising route to obtain materials with tailored physicochemical properties, as the exposure of specific facets directly determines their interaction with the environment.

In heterogeneous photocatalysis, a semiconductor absorbs photons to generate charge carriers that initiate reduction and oxidation reactions at the material's surface. Since these processes occur mainly at the surface, crystal facet engineering has become a key concept in photocatalyst design. By promoting the growth of selected crystal planes, photocatalysts with enhanced reactivity and improved reaction selectivity can be obtained.

The aim of this study is the systematic investigation of crystal facets effect in photocatalytic reactions over shape-controlled titanium(IV) oxide (TiO_2) and bismuth orthovanadate ($BiVO_4$). This approach highlights how crystallography can support the rational design of photocatalysts for environmental technologies.

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Synthesis and Preliminary Characterization of Building Blocks for Redox-Responsive Fluconazole–LDP Peptide Conjugates

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The growing incidence of fungal resistance to clinically used azole drugs necessitates the development of novel delivery strategies capable of improving intracellular drug accumulation and therapeutic efficacy [1]. One promising approach involves the conjugation of antimicrobial agents with cell-penetrating peptides (CPPs), which facilitate transport across biological membranes and may enhance cellular uptake of attached cargo [2].

This work focuses on the development of redox-responsive conjugates composed of fluconazole (FLC), the cell-penetrating peptide named LDP (KWRRKLKKLR), linked via a disulfide linker. The designed constructs are expected to combine the antifungal activity of fluconazole with the membrane-translocating properties of LDP [3, 4], while the disulfide bond serves as a cleavable spacer that may undergo reduction in the intracellular environment, enabling controlled release of active components [5]. Two conjugation strategies are being investigated, employing either cysteine residues or 3-mercaptopropionic acid-derived thiol functionalities for disulfide bond formation.

As part of the preliminary studies, the LDP peptide and its cysteine-functionalized analogue (Cys-LDP) were successfully synthesized by Fmoc-based solid-phase peptide synthesis and characterized by RP-HPLC and mass spectrometry. In parallel, a fluconazole derivative containing a cysteine moiety (FLCpOH–Cys) was obtained. Ongoing studies focus on the preparation of a thiol-functionalized fluconazole derivative through coupling with 3-mercaptopropionic acid. At the current stage, crude reaction mixtures are being monitored by RP-HPLC and mass spectrometry to assess product formation and optimize reaction conditions.

Future work will include purification and full characterization of the obtained fluconazole derivatives, followed by the synthesis of the target fluconazole–LDP conjugates. The conjugation step will primarily rely on selective thiol–disulfide exchange involving Cys(Npys)-functionalized intermediates, providing a controlled and efficient route to disulfide-linked products. Alternative oxidative methods for disulfide bond formation may be investigated for comparison. The obtained results constitute the first stage of a broader project aimed at evaluating the potential of redox-sensitive peptide–drug conjugates with potential application in antifungal therapy.

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Synthesis and Electrochemical Characterization of Aqueous Choline–Phosphate Electrolytes for Energy Storage Applications

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The development of environmentally benign and safe electrolytes remains one of the major challenges in the advancement of electrochemical energy storage systems. Choline-derived salts have emerged as attractive candidates due to their low toxicity, excellent water solubility, and high chemical stability, making them promising alternatives to conventional aqueous and organic electrolyte formulations. Previous studies, including those conducted by Abbas et al. [1–3], have demonstrated the suitability of choline-based electrolytes, particularly choline nitrate, for use in electrochemical capacitors.

Among the available choline salts, choline dihydrogen phosphate (CDHP) represents a promising electrolyte component for electrochemical capacitor applications. Nevertheless, aqueous CDHP solutions are characterized by a mildly acidic pH, which limits the electrochemical stability window to approximately 1.3–1.4 V due to the onset of hydrogen evolution reactions. Earlier reports have indicated that adjusting the pH toward neutral conditions can expand the operating voltage range to approximately 1.5–1.6 V.

To address this limitation, choline hydrogen phosphate (CHP) was introduced as a secondary salt to tailor the electrolyte properties. Incorporation of CHP shifts the electrolyte pH toward neutrality while simultaneously influencing ionic conductivity and ion transport processes, potentially leading to enhanced electrochemical performance.

In the present study, aqueous choline–phosphate electrolytes composed of CDHP and mixed CDHP + CHP systems were synthesized through a neutralization reaction. The resulting electrolytes were systematically investigated including pH, ionic conductivity, temperature-dependent properties, and electrochemical performance

The electrochemical properties of the prepared electrolytes were assessed in electrochemical double-layer capacitors (EDLCs) employing carbon-based electrodes. Comparative analysis of single-component CDHP electrolytes and mixed CDHP + CHP systems revealed differences in electrochemical stability while maintaining similar charge-storage capabilities. The mixed electrolytes demonstrated improved operational stability and more favourable ion transport characteristics, allowing operation within a slightly wider voltage window.

The study confirms that the composition of choline–phosphate electrolytes affects their physicochemical and electrochemical properties. These influences are reflected in variations in conductivity, ion transport behaviour, and overall capacitor performance.

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Electrochemically Driven αC–H Functionalization of Cyclic Tertiary Amines

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In response to the increasing financial costs and extended timelines associated with the discovery of new therapeutic agents, substantial attention has been devoted to the development of alternative synthetic strategies for privileged heterocyclic scaffolds, particularly quinoline derivatives. Quinoline-containing compounds exhibit a broad spectrum of biological and pharmacological activities and are widely investigated for applications in the treatment of malaria, asthma, schizophrenia, neurodegenerative disorders, and various types of cancer. In line with the principles of sustainable and green chemistry, electrochemical synthesis has recently emerged as an efficient and environmentally benign approach for the selective functionalization of organic molecules under mild reaction conditions.

In the present study, an electro-organocatalytic methodology for the synthesis of 2-phenyl-1,2,3,4-tetrahydroisoquinoline derivatives was developed using 2-phenyl-1,2,3,4-tetrahydroisoquinoline and 3-methylbut-2-enal as model substrates. Systematic optimization of key reaction parameters, including applied current, electrolysis time, catalyst, solvent system, and supporting electrolyte, enabled the desired products to be obtained in yields of up to 93%. The results demonstrate the high efficiency of electrochemically induced α-C–H functionalization of cyclic tertiary amines. Furthermore, the developed protocol constitutes a selective, efficient, and sustainable synthetic route toward structurally valuable compounds of potential pharmaceutical significance.

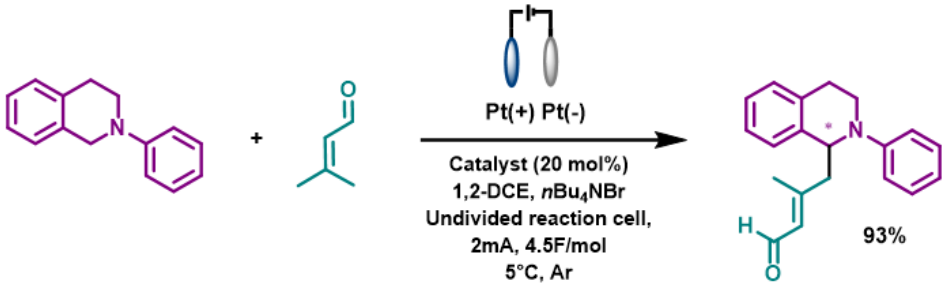

Fig. 1. Scheme of a model electroorganocatalytic reaction.

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Microwave-assisted conversion of oximes to amides

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Amides constitute one of the most important classes of organic compounds due to their widespread acting as pharmaceuticals, polymers or agrochemicals.[1] The amide bond plays a crucial role in numerous biological processes and maintains the structural integrity of biomacromolecules.[2] Among countless examples of specialized amides there are many examples of primary amides utilized in day-to-day life, which could be represented by salicylamide or niacynamide.

Numerous methods for amide synthesis have been developed over the years, including catalytic transformations, classical coupling reactions and modern sustainable approaches.[3] Despite the significant progress achieved in this field, the development of new synthetic methodologies remains highly important, particularly those employing contemporary techniques improving efficiency and environmental compatibility. In order to meet these needs we have developed a new method for amide bond formation utilizing microwaves under basic conditions. Preliminary results, including the optimization of reaction conditions and selected examples of (hetero)aromatic amides obtained using the developed conditions, will be presented in the communication.

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Hydrogen Peroxide Oxidation of Vanillyl Alcohol to Vanillin: A Green and Sustainable Catalytic Route Using Molybdenum Complexes

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Vanillin is one of the most important aromatic aldehydes used in the food, cosmetic, fragrance, and pharmaceutical industries. [1,2] While it can be obtained from natural sources, the increasing demand for vanillin has stimulated the development of efficient synthetic routes based on renewable feedstocks. [3] Among these, the oxidation of vanillyl alcohol represents an attractive approach, as it enables the direct production of vanillin through a relatively simple transformation. However, selective oxidation remains challenging because vanillin is susceptible to further oxidation, resulting in the formation of undesired by-products and a consequent reduction in product yield. Therefore, the design of catalytic systems capable of achieving high conversion while maintaining good selectivity toward vanillin is of considerable scientific and industrial interest.

Molybdenum complexes have attracted significant attention as oxidation catalysts due to their ability to activate environmentally benign oxidants and promote oxygen-transfer reactions under relatively mild conditions. [4,5] In the present work, molybdenum(VI) complexes containing hydrazone-based Schiff base ligands derived from 2-furoic hydrazide and methoxy-substituted salicylaldehyde derivatives were synthesized and investigated as catalysts for the oxidation of vanillyl alcohol. The catalytic studies were performed using hydrogen peroxide as the oxidant, which offers important advantages from a green chemistry perspective because it is inexpensive, readily available, and generates water as the only stoichiometric by-product.

To assess the catalytic potential of the synthesized complexes, oxidation reactions were carried out under optimized reaction conditions, and the influence of catalyst loading on catalytic performance was examined. Particular attention was devoted to evaluating substrate conversion, vanillin selectivity, and catalyst efficiency through turnover parameters. The obtained results demonstrate that the synthesized molybdenum complexes efficiently catalyze the oxidation of vanillyl alcohol and that modifications within the ligand framework influence both catalytic activity and product distribution. These findings provide valuable insight into the structure–activity relationships governing molybdenum-catalyzed oxidation processes and highlight the potential of these systems as sustainable catalysts for the selective production of vanillin.

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Determination of total iron in erythrocytes by RP-HPLC using deferoxamine complexation

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Iron determination in erythrocytes is important for studies of iron metabolism and erythropoiesis. Currently, highly sensitive techniques such as inductively coupled plasma mass spectrometry (ICP-MS) are commonly used for this purpose; however, these methods are expensive and not widely accessible in routine laboratory practice [1,2].

The aim of this study was to develop and validate a simple and cost-effective RP-HPLC method for the determination of total iron in erythrocytes. The proposed method is based on oxidative release of iron from erythrocytes, followed by selective complexation with deferoxamine (DFO) and chromatographic detection of the ferrioxamine complex at 430 nm. Particular emphasis was placed on efficient erythrocyte degradation and purification of the complex biological matrix using extraction-assisted sample preparation [3] .

The developed method demonstrated good selectivity toward Fe(III), with no interference observed from other metal ions. The method showed good linearity in the investigated concentration range (R^2 = 0.9982), satisfactory accuracy and precision, as well as good robustness under varied chromatographic conditions. The Fe(III)-DFO complex remained stable in processed erythrocyte samples for at least 24 h.

Application of the method to human erythrocyte samples resulted in a mean iron concentration of 627.70 ± 40.60 μg mL^{-1}. The proposed RP-HPLC method represents a simple and accessible alternative to ICP-based techniques for routine determination of total iron in erythrocytes.

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Dual-Action Cyclo[18]carbon: A DFT/TD-DFT Study on the Trapping and Optical Sensing of Transition Metals (Fe, Ti)

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Carbon-based rings, from simple benzene to massive fullerenes, are traditionally viewed as rigid structural backbones or passive electron conductors. In most supramolecular architectures, the carbon framework is simply expected to act as an inert scaffold or a silent container for other reactive species. But, is this really true? What if this molecular container is not just a passive host, but a *smart trap* capable of actively signaling the presence of what it captures?

To provide an answer to this intriguing concept, we shifted our focus to one of the newest and most fascinating carbon allotropes: cyclo[18]carbon (C18). Through Density Functional Theory (DFT) and Time-Dependent DFT (TD-DFT) methodologies, we acquired deeper insights into the electronic distribution, spin states, and optical behavior of this highly conjugated ring when encapsulating transition metals.

In this presentation, we intend to showcase two different systems where the captured metal can be designated as the culprit for a drastic change in the properties of the C18 ring. While the cavity traps the metals without suffering major geometric deformations, the response is highly metal-dependent. On one hand, Iron (Fe) acts as a magnetic modulator, forcing the complex into a stable high-spin quintet state and altering the accessible excited states. On the other hand, Titanium (Ti) favors a highly stable low-spin singlet configuration, but drastically reduces the HOMO-LUMO energy gap, triggering a massive optical response—the most intense absorption band in the visible region (480.8 nm).

At the end of this presentation, we intend to respond to questions such as: Which metal is most capable of triggering a visible optical signal? How does a metal's electronic configuration dictate the ring's magnetic structure? Our *takeaway* information for every materials chemist is that highly conjugated carbon rings like C18 should not be overlooked as simple passive hosts; they are active, highly tunable platforms that open a new branch for the design of smart molecular chemosensors and optoelectronic devices.

To my parents and my entire family, for being the fundamental pillar in my life and my greatest motivation. To my friends, for accompanying me and believing in me every step of this path.

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Phytochemical characterization and evaluation of the antimicrobial properties of Ecuadorian sugarcane (Saccharum officinarum) extracts

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Sugarcane (Saccharum officinarum) is an agro-industrial crop of great economic importance worldwide; however, limited information is available regarding the phytochemical and biological potential of its unconventional plant organs, particularly in Ecuadorian ecotypes. In this study, leaves, stems, roots, and flowers of Ecuadorian sugarcane were subjected to exhaustive Soxhlet extraction using solvents of increasing polarity (hexane, ethyl acetate, methanol, 70% ethanol, and water). The extracts were evaluated through phytochemical screening, determination of total phenolic and flavonoid contents, antioxidant activity assays (DPPH and ABTS), Fourier Transform Infrared Spectroscopy (FTIR), High-Performance Liquid Chromatography (HPLC), and antimicrobial assays against (Escherichia coli), (Staphylococcus aureus), (Bacillus cereus), and (Pseudomonas aeruginosa).

Phytochemical screening revealed the presence of phenolic compounds, flavonoids, tannins, alkaloids, saponins, steroids, and triterpenoids. Quantitative analysis showed a heterogeneous distribution of bioactive compounds among plant organs. Flower extracts exhibited the highest flavonoid content, reaching 863.70 ± 29.26 µg QE/mg of dry extract in the aqueous fraction, while root extracts showed the highest phenolic content, with RE70 reaching 158.43 ± 32.75 µg GAE/mg of dry extract. Antioxidant activity was strongly associated with phenolic content, with flower and root extracts presenting the lowest IC50 values in both DPPH and ABTS assays.

FTIR analysis confirmed the presence of hydroxyl, carbonyl, and aromatic functional groups associated with secondary metabolites, whereas HPLC analysis generated characteristic chromatographic fingerprints for each plant organ and extraction solvent. Antimicrobial evaluation demonstrated that polar extracts, particularly those obtained from roots and flowers, exhibited the greatest inhibitory effects. Gram-positive bacteria, especially (B. cereus) and (S. aureus), were the most susceptible microorganisms, while (P. aeruginosa) showed the highest resistance. These findings demonstrate that Ecuadorian sugarcane constitutes a valuable source of bioactive compounds with significant antioxidant and antimicrobial potential, supporting the valorization of underutilized plant organs for future pharmacological and biotechnological applications.

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Surface Metallization of 3D-Printed Electrodes via Copper

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Three-dimensional (3D) printing has recently become an attractive and cost-effective approach for the fabrication of electrochemical devices, including electrodes used in environmental, biological, and medical applications. Among the various additive manufacturing methods, fused deposition modelling (FDM) is one of the most commonly applied techniques due to its accessibility, low operational cost, and capability to produce structures with complex geometries and good reproducibility. In the FDM process, a thermoplastic filament is heated and extruded through a nozzle and deposited layer by layer to build a three-dimensional object. The use of conductive filaments containing carbon-based fillers dispersed in insulating polymers, such as polylactic acid (PLA), enables the direct production of composite electrochemical electrodes by 3D printing.

The electrochemical behavior of these electrodes largely depends on the characteristics of their surface. Parameters such as surface morphology, roughness, and the distribution of conductive sites strongly influence electron transfer processes and the resulting current response. Increased surface roughness may expose additional electroactive carbon sites, particularly edge-plane structures, which can facilitate faster electron transfer and enhance electrochemical performance. Despite these advantages, conductive thermoplastic filaments generally exhibit much lower electrical conductivity compared with metallic materials, which can restrict their practical electrochemical applications.

One approach to overcome this limitation is the metallization of printed structures through electroplating. Electroplating involves the reduction of metal ions from an electrolyte solution onto a conductive substrate under an applied electric current, resulting in the formation of a metallic coating with controllable thickness and properties. In this study, copper electroplating was applied to 3D-printed electrodes in order to improve their electrical conductivity and overall electrochemical characteristics. The integration of additive manufacturing with electroplating offers a promising route for the fabrication of customized electrodes with enhanced performance and potential applications in electrochemical sensing and related fields

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Microplastics in the Baltic Sea Food Web: Implications for Animal Health and Ecosystem Stability

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Microplastic pollution has emerged as a significant environmental challenge in marine ecosystems worldwide, including the Baltic Sea. Due to its semi-enclosed character, limited water exchange and intensive anthropogenic pressure, the Baltic Sea is particularly vulnerable to the accumulation of plastic debris and microplastics. Numerous studies have documented the presence of microplastics in seawater, sediments and a wide range of marine organisms, including zooplankton, bivalves, fish and marine mammals.

This review aims to summarize current knowledge on the occurrence and trophic transfer of microplastics within Baltic Sea food webs and to discuss their potential effects on animal health and ecosystem functioning. Microplastics can be ingested by organisms at different trophic levels and transferred through predator-prey interactions.

Reported adverse effects include gastrointestinal damage, inflammation, altered feeding behaviour, reduced growth and the potential transport of chemical contaminants and pathogens. The presence of microplastics in commercially important fish species from the Baltic Sea raises concerns regarding ecosystem stability and long-term environmental health. Understanding the pathways and consequences of microplastic transfer through food webs is essential for assessing ecological risks and developing effective pollution mitigation strategies in the Baltic region.

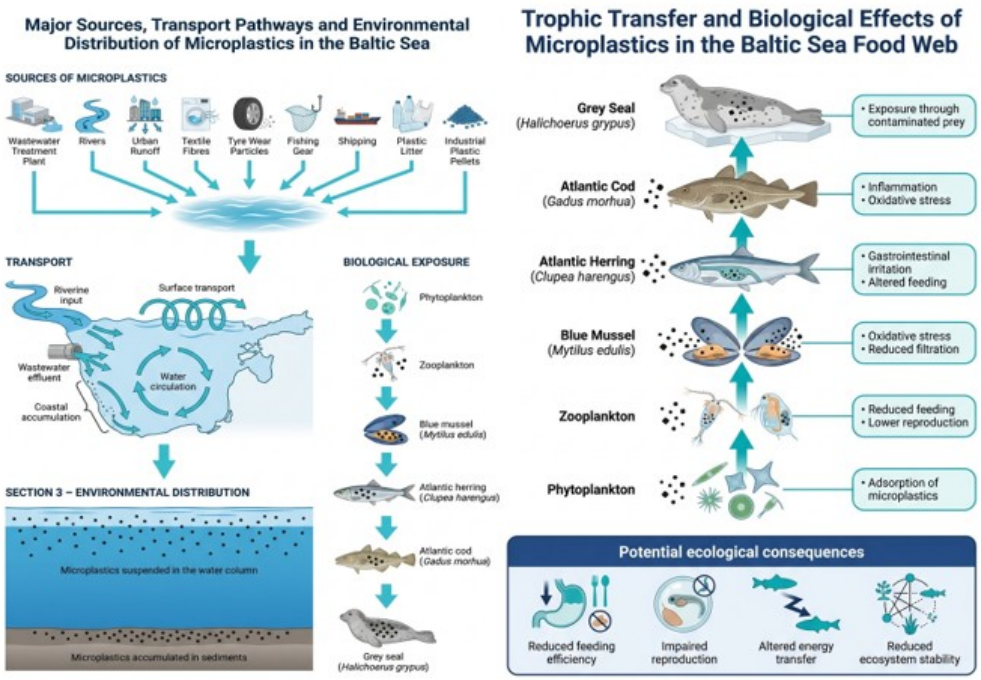

Fig 1. Major sources, transport pathways and environmental distribution of microplastics in the Baltic Sea.
Fig 2. Trophic transfer of microplastics through the Baltic Sea food web and the main biological effects reported for representative marine organisms.

Designing natural deep eutectic solvents (NADESs): component selection and phytotoxic properties.

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Natural deep eutectic solvents (NADESs) are increasingly recognized as ecological alternatives to conventional solvents due to their renewable components, biodegradability, and broad solubilizing properties. NADESs are liquid systems formed by mixing components such as sugars, amino acids, polyols, and carboxylic acids, which interact via hydrogen bonding, resulting in reduced melting points. Due to these properties, NADESs are used in medical applications, extraction processes, nanomaterial synthesis, and in the cosmetic, pharmaceutical, and agricultural industries.

Despite being considered "green" solvents, increasing evidence points to potential toxic effects depending on composition and intermolecular interactions. This study evaluated the impact of selected components (choline chloride, betaine, glucose, lactic acid) on cytotoxicity and phytotoxicity of NADESs. MTT assays and phytotoxicity tests were used to compare individual compounds and their eutectic mixtures.

The results indicate that NADES toxicity does not directly reflect the toxicity of individual components and depends on hydrogen bond donors and acceptors. Cytotoxicity (MTT, A549 cells) varied significantly with composition. Fructose-based systems showed higher toxicity than glucose analogues ($CC50_{,glucose}$ > 10%, $CC50_{,glycerol}$ = 7.63%, $CC50_{,ascorbic\ acid}$ = 0.545%), while acidic systems increased toxicity ($CC50_{,NADESs}$ <0.25%–>10%). Glucose, betaine, glycerol, and proline did not inhibit plant growth (>100%), whereas choline chloride, urea, and ethylene glycol reduced growth (50–90%). Acidic solutions (1–2%) decreased growth by up to 10%. These findings highlight the need for careful NADES design and safety assessment.

The authors thank Olga Długosz for her supervision and significant support provided during the research.

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Effect of Enzymatic Interesterification on Fatty Acid Composition and Nutritional Quality of Structured Lipids Based on Hemp Oil and MCT

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The growing interest in functional lipids has stimulated the development of structured lipid systems with improved nutritional properties. Hemp seed oil is recognized as a valuable source of polyunsaturated fatty acids, particularly linoleic and α-linolenic acids, while medium-chain triglycerides (MCT) are characterized by rapid metabolism and high digestibility. Enzymatic interesterification enables the modification of triacylglycerol structure and may lead to the development of innovative lipids with enhanced nutritional functionality [1,2].

The aim of this study was to evaluate the effect of enzymatic interesterification on fatty acid composition and nutritional quality of structured lipids obtained from hemp seed oil and commercial MCT mixed at a 1:1 ratio. Hemp seed oil was obtained by extraction and subsequently subjected to lipase-catalyzed interesterification with MCT to produce structured lipid systems. Fatty acid composition of the obtained lipids was determined using gas chromatography in order to evaluate changes resulting from enzymatic modification. In addition, positional distribution of fatty acids in triacylglycerols was analyzed to assess structural rearrangements occurring during interesterification. Based on the obtained fatty acid profiles, selected nutritional quality indices of lipids were calculated, including indices related to the atherogenic and thrombogenic potential of the obtained structured lipids.

The obtained results may contribute to a better understanding of the relationship between enzymatic modification and nutritional quality of structured lipids. Furthermore, the developed lipid systems may represent promising functional ingredients for the formulation of health-oriented food products.

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Navigating the challenges of CO_2 upcycling in modern science

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Due to the high atmospheric CO_2 concentrations reaching 422 ppm and annual global emissions of 37 Gt, transforming carbon dioxide from a waste product into a valuable chemical feedstock has become a scientific and industrial imperative. This work reviews the four principal CO_2 conversion pathways - electrocatalytic, photocatalytic, thermocatalytic, and biological - with a critical focus on the barriers that continue to impede their large-scale deployment.

The central challenges identified include the inherent thermodynamic stability of CO_2 ($\Delta Gf° = -394\ kJ \cdot mol^{-1}$), poor selectivity towards multi-carbon products (C_2^+ ~60% FE, C_3 ~10% FE), rapid catalyst deactivation (laboratory stability <100 h vs. industrial requirements of >10,000 h), and a pronounced scalability gap between small laboratory electrodes (<1 cm^2) and industrial-scale systems. It should be noted that the carbon-negativity of any CO_2 conversion process is contingent on a fully renewable energy supply chain, which remains unavailable at the required scale.

Attention was drawn to emerging solutions, including single-atom catalysts achieving >90% CO selectivity, gas-diffusion electrodes enabling current densities above 100 $mA \cdot cm^{-2}$, integrated direct air capture and conversion systems, and photothermal catalysis. A research roadmap is proposed, targeting near-term catalyst lifetimes exceeding 1,000 h, mid-term C_2 Faradaic efficiency above 80% at >200 $mA \cdot cm^{-2}$, and a long-term DAC-to-product system cost below $500 per tonne of CO_2.

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Fast Fourier Transform-Based Vibration Analysis of a Centaur 40 Gas Turbine

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The Fast Fourier Transform (FFT) is a method used to convert vibration signals from the time domain into the frequency domain to identify machine conditions and detect faults. In gas turbines, excessive vibration can lead to operational failures and serious equipment damage, making vibration monitoring essential for maintaining system reliability and performance.

This study analyzes vibration in a CENTAUR 40 gas turbine using the FFT method. Vibration data were transformed into frequency-domain signals and compared with characteristic patterns of mechanical faults. The analysis identified fault indications such as unbalance, looseness, misalignment and bent shaft based on dominant frequency peaks and harmonic patterns in the vibration spectrum. The vibration condition was also evaluated using ISO 10816-3 standards to determine the severity level of the vibration.

The results show that FFT is effective for detecting bearing faults and evaluating turbine operating conditions. This method can support predictive maintenance by identifying early signs of damage, improving machine reliability, reducing maintenance costs, and preventing unexpected turbine failures.

The synopsis of this scientific work is released as an outcome of the partnership between Institut Teknologi Nasional Bandung (ITENAS Bandung), Indonesia, and PT Performa Integritas Indonesia (Fortasindo), Indonesia, an engineering consulting company specializing in risk and integrity management.

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Simulation of photocatalityc properties of staggered MOF-901(M=Ti)

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Metal Organic Frameworks are crystalline structures composed of metal ions or clusters coordinated with organic linkers, creating highly porous materials with large surface areas. In the present work, a computational analysis was performed using theoretical DFT simulations to predict the electronic structure, including the Partial Density of States (PDOS) and band gaps, for three configurations: Honeycomb (HC), Middle (MD) and Overlapped (OV). Density Functional Theory calculations were used to analyze the crystal structure and stability based on the computed total energies.It was found that three structures presented Semiconductor behavior, were HC structure was the most stable one. However, for photocatalytic applications there must be modifications to the band gaps with doping techiques.

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Hybrid system based on xerogel loaded with Carbon quantum dots and Carbon nanotubes for the controlled release of vitamins B6 and B12.

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Vitamins B6 and B12 are essential for physiological processes; however, their oral admin-istration presents challenges due to their high aqueous solubility and rapid renal clearance. In another hand Xerogels, porous solid materials offer effective platforms for catalysis, adsorption, and drug delivery systems. In this work, a hybrid alginate xerogel doped with carbon quantum dots (CQDs) and carbon nanotubes (CNTs) was designed, synthe-sized, and characterized for the controlled release of these vitamins. CQDs were synthesized by thermal treatment of rose stems (200 ◦C, 10 h), while CNTs were obtained by synthesis with nitrate precursors and functionalization with nitric acid. The xerogel was prepared by ionic crosslinking with Ca2+, incorporating 0.01 % w/v of each nanomaterial in a 2 % sodium alginate matrix.

The hybrid xerogel exhibited greater structural stability than the pure control, forming thin sheets and well-defined spheres, with lower swelling capacity (80 % vs 100 %). Flu- orescence spectroscopy confirmed the optical emission of the integrated CQDs. Electrical analysis revealed a conductivity of 10−5 S cm−1 for the hybrid xerogel, superior to the control (10−6 S cm−1) and comparable to materials for electronic applications. FTIR characteriza-tion showed similar spectra between the hybrid xerogel without vitamins B6 and B12 and the one containing them, attributable to the low concentration of vitamins (0.01 % w/v) and confirming the absence of new chemical bonds, which evidences the physical integration of the vitamins into the alginate matrix. In vitro release assays demonstrated that the hybrid xerogel released vitamins B6 and B12 in a prolonged manner over 24 h, in contrast to the pure xerogel which showed complete reabsorption within 60 min. The hybrid system released 47 % less vitamin B6 and 52 % less vitamin B12 than the control, evidencing controlled re-lease kinetics.

These results confirm the potential of the nanocomposite as a dual-functional material for controlled drug delivery systems and bioelectronic applications.

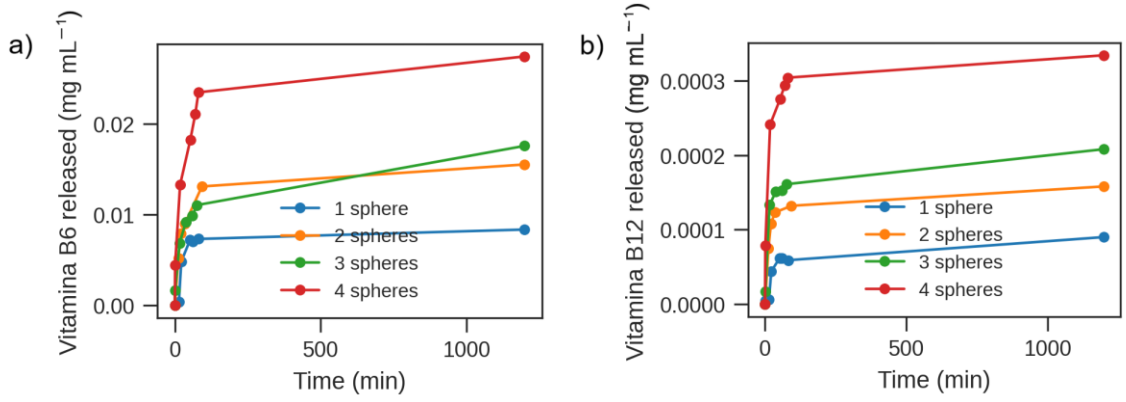

Fig 1. Release behaviour of Alg–CQDs/CNTs beads: (a) B6, (b) B12.

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Electronic and Magnetic Properties of CuO: A DFT Study of NM, FM, and AFM Phases using the LAK Functional

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Cupric Oxide (CuO) is a transition metal oxide with significant applications in catalysis, solar cells, and high-Tc superconductivity. However, standard density-functional theory (DFT) methods systematically fail to describe its electronic ground state, incorrectly predicting a metallic behavior instead of its true insulating nature. To address this issue, this study determines the energetic stability, Equation of State (EOS), and equilibrium lattice parameters of bulk CuO across three distinct magnetic phases: Non-Magnetic (NM), Ferromagnetic (FM), and Antiferromagnetic (AFM), utilizing the advanced, nonempirical meta-GGA LAK functional implemented within the VASP code.

Total energies were fitted using the Birch-Murnaghan Equation of State, unequivocally establishing the AFM phase as the global thermodynamic ground state, which drives the characteristic magnetovolume collapse in bulk CuO. Electronic structure analysis through Partial Density of States (PDOS) demonstrates that while NM and FM phases exhibit false metallic states crossing the Fermi level, the AFM order successfully breaks electronic symmetry, opening a clear Band Gap of 0.35 eV. Orbital hybridization analysis reveals a strong coupling between Cu-3d and O-2p states near the Fermi energy.

In conclusion, the meta-GGA LAK functional successfully corrects the standard DFT metallic misprediction. Furthermore, we demonstrate that magnetostructural coupling in the monoclinic C2/c symmetry is inextricably linked to the electronic gap opening, establishing a rigorous computational baseline to guide and optimize ongoing local experimental semiconductor synthesis.

The authors express their gratitude to Yachay Tech University and the CompNano Research Group for providing the computational infrastructure, resources, and technical support necessary to carry out this simulation work. We also thank our local experimental collaborators for their valuable insights and future joint efforts.

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Automatization of Barkhausen noise measurements for high resolution quality evaluation of steel.

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Understanding the stress distribution on the surface of a welded sample is crucial for evaluating the structural integrity of the product and ensuring the safe operation of industrial components. Measuring stress in such material can be done by utilizing Barkhausen effect phenomenon. During sample magnetization, movement of magnetic domain walls (DW) causes generation of Barkhausen noise (BN) signal. External and residual stresses cause modification of domain wall structure, modifying the BN signal which allows for correlation between signal and stress distribution. [1]

In this work, MagStress BURN measurement set equipment was used. Wedge shaped probe with detecting coil wound on a 1 mm diameter core, was used to test surface of welded sample. Multiparameter BN analysis software, provided 16 descriptors that were derived from different signal features. Robotic arm provided with MagStress BURN allows for movements with 0.1 mm accuracy. This pairing allows for high-resolution testing and imaging of samples. Mesh of points with resolution of 0.5mm over 20x18mm area provides 1440 data points. This covers 3 electron welds and heat-affected zone (HAZ). Chosen descriptor peak values corelate with location of electron welds present in the sample. Values over different welds vary, which can be explained by weld fabrication process. Subsequently placed welds cause relaxation process to occur where the first weld is relaxed by next welds. Analysing obtained values, we can also see that HAZ generated in this process is extremely small compared to traditional welding methods. This combined with small weld surface necessitates usage of high-resolution measurement techniques. Presented system allows for near instant evaluation of ferromagnetic samples thus combining non-destructive evaluation with rapid diagnostics not available with other testing apparatuses.

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Computational Study on the Electronic Properties of Covalent Triazine Frameworks and the Effect of the Pore Size

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We studied the structural and electronic properties of covalent triazine frameworks (CTFs), which are fully covalent, porous and crystalline organic materials with π conjugated networks [1]. We analyze how pore size and dimensionality affect crystalline CTF properties by developing a density-functional theory (DFT) workflow implemented in the Vienna *Ab initio* Simulation Package (*VASP*). The study compares a fully periodic bulk model with slab representations constructed by introducing vacuum along the out of plane direction, as well as stacked layer configurations (e.g., AB bilayers) to capture interlayer effects. A systematic convergence strategy was applied (plane-wave cutoff energy and Brillouin-zone sampling), followed by an equation-of-state (EOS) fit to determine equilibrium structural parameters for each representation. At the optimized geometries, electronic-structure calculations were performed, including total and projected densities of states (DOS and PDOS). The results provide a validated computational procedure and a consistent comparison across models that clarifies how pore size affects the anticipated structural parameters and electronic structure of CTFs.

Special thanks to Henry Pinto for sharing his valuable experience and knowledge, and for his help throughout the calculations and discussions.

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Mapping Peatland Condition from Satellite Sentinel-1 InSAR and UAV Multisensor Fusion

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Peatlands store approximately twice the carbon of all the world's forests combined, yet over 80% of Polish peatlands have been drained, shifting them from carbon sinks to CO_2 sources. Monitoring their condition at landscape scale remains a critical challenge. This study addresses that challenge at Rzecin fen a Natura 2000 protected floating-mat transitional fen in Wielkopolska, Poland, formed approximately 200 years ago as Sphagnum moss colonised Lake Rzecin, growing a floating peat mat over residual lake water that persists beneath it today.

Sentinel-1 satellite radar (InSAR) measures millimetre-scale ground rise and fall over time, encoding information about peatland hydrological condition in the shape of its displacement time series. However, satellite radar alone cannot explain the spatial drivers of displacement. This study fuses Sentinel-1 SBAS InSAR time-series analysis (2022–2024) with a two-year UAV multisensor archive (multispectral, thermal, and photogrammetric data) to spatially attribute displacement patterns to vegetation communities and map where the peatland is losing carbon particularly during the 2024 extreme drought, the hottest year on instrumental record.

Four hypotheses are tested: that subsidence follows the vegetation degradation gradient; that the 2024 drought anomaly is spatially differentiated by condition class; that UAV attribution outperforms satellite optical data alone; and that the shape of the displacement time series alone can classify fen condition using a machine-learning classifier.

Centrifugal Pump Condition Monitoring Through Vibration Analysis

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Centrifugal pumps are widely utilized across numerous industrial sectors, including oil and gas, chemical processing, and fluid distribution systems. A key advantage of these pumps is their capacity to deliver continuous and steady fluid flow. The operating principle relies on converting mechanical energy from the rotating impeller into kinetic and pressure energy within the fluid. Nevertheless, centrifugal pumps frequently encounter vibration-related problems during operation, stemming from causes such as mechanical imbalance, shaft misalignment, bearing deterioration, or cavitation. Uncontrolled vibration can degrade pump performance, accelerate component degradation, and ultimately result in system failure.

To address this challenge, vibration analysis is employed as a predictive maintenance approach, enabling periodic monitoring of machine health. Through spectral analysis of vibration signals, the origins and categories of mechanical failures can be identified from frequency spectrum patterns, allowing early detection of developing faults. These sets activities were initialized by measuring vibration parameters such as displacement and frequency spectra using the CSI Emerson 2130 Machinery Health Analyzer. Furthermore, the pump condition is evaluated in accordance with ISO 10816-3 standards. The findings from this analysis are intended to assist in determining fault sources, the actual operating condition of the pump, and enhancing the overall reliability and operational efficiency of centrifugal pump systems.

The synopsis of this scientific work is released as an outcome of the partnership between Institut Teknologi Nasional Bandung (ITENAS Bandung), Indonesia, and PT Performa Integritas Indonesia (Fortasindo), Indonesia, an engineering consulting company specializing in risk and integrity management.

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