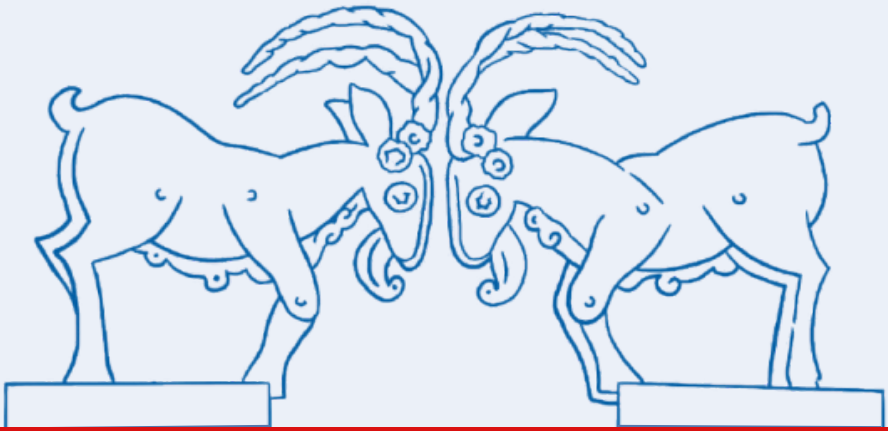
BPCI 2026

7th Symposium on Biotransformations for Pharmaceutical and Cosmetic Industry

Poznań, Poland | 24-26.05.2026



BOOK OF ABSTRACTS

BPCI 2026

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Welcome message

On behalf of the organising committee, we would like to warmly welcome you to the **7th Biotransformations Symposium for the Pharmaceutical and Cosmetics Industry (7BPCI),** which is taking place in **Poznan**, a city with historical charm in the industrial heartland of Poland.

Bringing together **scientists, researchers and industry professionals from around the world,** this international event will explore the latest advancements in biocatalysis, enzymatic processes and sustainable transformations in pharmaceuticals and cosmetics.

The symposium provides an ideal setting for sharing and disseminating scientific knowledge about innovative technologies and best management practices for the **sustainable, large-scale application of biocatalysis.**

We have an **exciting programme of scientific and social events** that will allow delegates to explore some of the most innovative technological developments in the field of biocatalysis, discuss current and future research directions, share their passion for research, renew old friendships and forge new ones, and expand their professional networks.

Join us for a dynamic programme of keynote lectures, oral presentations and networking opportunities, all designed to foster collaboration and innovation in this rapidly evolving field.

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Chairman of the 7BPCI scientific committee,
PUT Rector

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Poznan University of Technology

Programme

DAY 1

24th May 2026, Sunday

BPCI 2026

4:00 p.m. – 5:00 p.m.	**Registration**
5:00 p.m. – 5:30 p.m.	**Conference opening**
5:30 p.m. – 6:30 p.m.	**Christoph Winkler,** University of Graz *Exciting Enzymes: The Potential of Light-Driven Biocatalytic Reactions*
6:30 p.m. – 7:30 p.m.	**Wolfgang Kroutil,** University of Graz *Biocatalysis to Access Bioactive and Flavor Compounds*
7:30 p.m. – 9:30 p.m.	**Welcome reception**

Programme

DAY 2

25th May 2026, Monday

BPCI 2026

8:00 a.m. – 9:00 a.m.	**Registration**

Open session: PUT Sustainable Biotechnology Cluster

9:00 a.m. – 9:45 a.m.	**Amadeo Rodriguez Fernández-Alba,** University of Almería *Importance of Correct Chromatography and its Common Oversights*
9:45 a.m. – 10:30 a.m.	**Piotr Oleśkowicz-Popiel,** Poznan University of Technology *Converting Waste into Valuable Products*
10:30 a.m. – 10:45 a.m.	**Wojciech Smułek,** Poznan University of Technology *Innovations in Environmental Biotechnology*
11:00 a.m. – 11:15 a.m.	**Bogumiła Szubert,** Poznan University of Technology *Using Petri Nets for Modeling and Analysis of Melanoma-Realted Processes*
11:15 a.m. – 11:30 a.m.	**Emilia Krok,** Poznan University of Technology *Engineering Meets Synthetic Biology - Design and Characterization of Minimal Cell Membranes*
11:30 a.m. – 12:30 p.m.	**Poster session and coffee break**

Scientific session 1

12:30 p.m. – 1:00 p.m.	**Marta Ziegler-Borowska,** Nicolaus Copernicus University in Torun *Magnetic Polysaccharide Nanocomposites for Advanced Enzyme Immobilisation and Biocatalysis*
1:00 p.m. – 1:15 p.m.	**Anna Wolny,** Silesian University of Technology *$MgO–SiO_2$ as a Versatile Platform for Lipase Immobilization: Effect of Surface Functionalization on Biocatalytic Performance*

Programme

DAY 2

25th May 2026, Monday

BPCI 2026

1:15 p.m. – 1:30 p.m.	**Olga Grześkowiak** Wrocław University of Science and Technology *Eco-friendly Production of Silica Microparticles: the Role of Culture Conditions in Fusarium Culmorum Bioleaching Activity*
1:30 p.m. – 2:30 p.m.	**Lunch break**
	Scientific session 2
2:30 p.m. – 3:00 p.m.	**Dominik Koszelewski,** Institute of Organic Chemistry Polish Academy of Sciences *Catalytic Promiscuity of Hydrolases: A Platform for Green and Metal-Free Antimicrobial Agents Synthesis*
3:00 p.m. – 3:15 p.m.	**Maciej Szaleniec,** Jerzy Haber Institute of Catalysis and Surface Chemistry PAS *Tungsten Aldehyde Oxidoreductase - H_2-driven reduction of carboxylic acids*
3:15 p.m. – 3:30 p.m.	**Katarzyna Szymańska,** Silesian University of Technology *Structured Microreactors for the Selective Synthesis of Fine Chemicals*
3:30 p.m. – 4:00 p.m.	**Anna Chrobok,** Silesian University of Technology *Tunable Biocatalysts Dedicated for the Synthesis of Fine Chemicals*
7:30 p.m. – 11:00 p.m.	**Dinner party / Barbecue**

Programme

DAY 3

26th May 2026, Tuesday

BPCI 2026

Scientific session 3

9:00 a.m. – 9:30 a.m.	**Paweł Borowiecki,** Warsaw University of Technology *LK-ADH Prince as a "Game-changing Enzyme" in Redox Biocataysis*
9:30 a.m. – 9:45 a.m.	**Anna Szot,** Jerzy Haber Institute of Catalysis and Surface Chemistry PAS *Coupling Hydrogen Oxidation to Carboxylic Acid Reduction for Synthesis of Alcohols or Quinaldic acid – Cascade System Utilizing by Tungsten Aldehyde Oxidoreductase*
9:45 a.m. – 10:00 a.m.	**Martina Bigliardi,** University of Milan *Sustainable Biocatalytic Platforms for the Production of Bioactive Pharmaceutical Compounds*
10:00 a.m. – 10:15 a.m.	**Izabela Ziębińska,** Silesian University of Technology *Innovative Biocatalyst Based on Natural Activated Charcoal and Lipase for Sustainable Esters Production*
10:15 a.m. – 11:00 a.m.	**Coffee break**

Scientific session 4

11:00 a.m. – 11:30 a.m.	**Maciej Guzik,** Institute of Catalysis and Surface Chemistry PAS *Biotransformations of Polyhydroxyalkanoates into Functional Biomaterials and Bioactive Compounds for Pharmaceutical and Cosmetic Applications*
11:30 a.m. – 11:45 a.m.	**Igor Biały,** Silesian University of Technology *Enzymatic Synthesis of Long-chain 2,5-furandicarboxylic Acid Diesters derived from Lignocellulosic Biomass*

Programme

DAY 3

26th May 2026, Tuesday

BPCI 2026

11:45 a.m. – 12:00 p.m.	**Kaja Kowalczuk,** Wroclaw University of Science and Technology *Cyanobacteria as a Tool in Biotransformation and Bioaccumulation*
12:00 p.m. – 12:15 p.m.	**Danuta Gillner,** Silesian University of Technology *Valorization of Plant Biomass Using Green Solvents and Enzymes*
12:15 p.m. – 12:30 p.m.	**Tymoteusz Masłyk,** Jerzy Haber Institute of Catalysis and Surface Chemistry PAS *Toward an AOR-Based Electrochemical Biosensor for Aldehydes*
1:00 p.m. – 1:30 p.m.	**Awards and closing ceremony**
1:30 p.m. – 2:30 p.m.	**Lunch**

Contents

Plenary lectures

EXCITING ENZYMES: THE POTENTIAL OF LIGHT-DRIVEN BIOCATALYTIC REACTIONS

Florian Weissensteiner, Stefan Simić, Valentina Jurkaš, Maria Emilia Iglesias Moncayo, Sara Salehi, Florian Oehlschläger, Isabel Oroz Guinea, Wolfgang Kroutil, Christoph K. Winkler[#*]

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Abstract

Virtually all organic matter can be traced back to light-dependent enzymatic processes of photosynthesis. In this sense, light and the chemistry of life are fundamentally intertwined. Yet from a synthetic chemist's point of view, Nature's photochemical repertoire is surprisingly small: beyond the photosystems, only a handful of light-dependent enzymes are known [1].

Recent advances in photobiocatalysis have changed this picture and revealed a much broader landscape of light-driven enzymatic processes, which can be grouped into subdisciplines: natural photoenzymes and enzymes catalyzing non-natural light-triggered reactions, strategies combining photochemistry and enzymatic steps, and approaches integrating Nature's photosynthetic machinery with downstream reactions [2].

In this lecture, I will follow these themes to present our work: engineering the photoenzyme fatty acid photodecarboxylase to redirect its native reactivity toward C–C bond formation [3], the construction of a photocatalytic-biocatalytic system for cyclic deracemization of sulfoxides [4], and a modular system that taps photosynthetic energy to power enzymatic redox transformations [5]. This will be complemented with discussing our efforts to establish broadly applicable reaction technologies for the field [6, 7].

References:
[1] L. Schmermund, V. Jurkas, F. F. Ozgen, G. D. Barone, H. C. Büchsenschütz, C. K. Winkler, S. Schmidt, R. Kourist, W. Kroutil, ACS Catal. 2019; 9:4115-4144.
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[6] S. Simic, M. Jakstaite, W. T. S. Huck, C. K. Winkler, W. Kroutil, ACS Catal. 2022; 12:14040-14049.
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Biographical note

Christoph Winkler earned his PhD in organic chemistry from the University of Graz. Following experience in the pharmaceutical industry, he returned to the same university and is now a senior scientist and principal investigator, as part of the Biocatalysis group. In 2025, he received his venia docendi in organic chemistry. His research focuses on applying enzymes as complementary tools to synthetic chemistry, advancing the field of radical biocatalysis and photobiocatalysis and developing biocatalytic reaction technology.

BIOCATALYSIS TO ACCESS BIOACTIVE AND FLAVOR COMPOUNDS

Lilla Gal, Jonas Spang, Magdalena Abramiuk, Krisztian Gal, Nathalia Vargas-Valverde, Francesco Mascia, Sara Salehi, Marko Rath, Nikolaus Stadlmann, Aneta Swarovska, Isabel Oroz-Guinea, Jörg Schrittwieser, Christoph Winkler, Wolfgang Kroutil[#*],

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Abstract

Biocatalysis has become a broadly applied tool like for the oxidation of prim-alcohols to acids [1] with still a lot of potential and many more reactions to be addressed. In the presentations various examples will be shown for instance, to use enzymes for oxidative C-C coupling as well as C-C breakage to access bioactive compounds [2,3]. We extended the biocatalytic toolbox by a biocatalytic Friedel-Crafts like reaction allowing alternative protocols for achieving also C-formylation of catechols [4]. Also in the are of amide formation, which is a highly desired reaction for industry to be performed in a sustainable manner, new protocols have been developed [5].

References:
[1] Spang J, Mascia F, Kroutil W. JACS Au 2026; 6:659-677. https://doi.org/10.1021/jacsau.5c01452
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The Acknowledgements:
The Austrian Science Fund (FWF) 10.55776/COE17 within the Cluster of Excellence Circular Bioengineering and the Innovative Health Initiative Joint Undertaking (IHI JU) under grant agreement no 101165889 (PharmEco) are acknowledged. The COMET center acib: Next Generation Bioproduction is funded by BMK, BMAW, SFG, Standortagentur Tirol, Government of Lower Austria, and Vienna Business Agency in the framework of Competence Centers for Excellent Technologies (COMET)

Biographical note

Wolfgang Kroutil is Professor for Biocatalysis at the University of Graz in Austria since 2013 and a Fellow Chemistry Europe. He conducted his PhD-research with Prof. Kurt Faber at TU Graz as well as in Exeter/UK with S. M. Roberts. After his PhD he collected two years experience in industry before he joined the Institute of Chemistry at the University of Graz. He received several awards, like the Biocat award in 2012, the Biotrans award 2015, or the Outstanding Achievements Award 2020 by NIMS, Japan.

IMPORTANCE OF CORRECT CHROMATOGRAPHY AND ITS COMMON OVERSIGHTS

Amadeo R. Fernandez-Alba[#*]

Head of the European Reference Laboratory for Pesticide Residues. University of Almeria
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Abstract

Liquid chromatography coupled to mass spectrometry (LC-MS) has become an essential tool for the determination of contaminants, residues and highly diverse chemical compounds in complex matrices. However, the quality, robustness and efficiency of LC-MS workflows depend not only on the mass spectrometer, but also on the appropriateness of the chromatographic strategy. In many applications, chromatography is still treated as a secondary component of the method, leading to common oversights such as insufficient retention, inadequate separation of matrix interferences, poor peak shape, limited selectivity for polar compounds, and unnecessary consumption of solvents and analysis time.

This presentation highlights the importance of selecting and optimizing the chromatographic approach according to the analytical objective. Dual-channel LC-MS is presented as a powerful strategy to increase laboratory productivity, allowing sample throughput to be improved by up to 70% without compromising analytical performance. Beyond productivity, this configuration can also be used to enhance sensitivity and selectivity while maintaining the same overall analysis time, offering an efficient solution for high-demand routine laboratories.

The role of ion chromatography is also discussed, particularly for the determination of highly polar compounds that are poorly retained under conventional reversed-phase LC conditions. By improving retention and peak shape, ion chromatography can increase sensitivity, reduce matrix effects and broaden the analytical scope of LC-MS methods.

Finally, microflow LC is presented as an emerging alternative for greener and more sensitive analysis. By reducing flow rates and solvent consumption, microflow approaches can significantly decrease the amount of organic waste generated during routine analysis while improving ionization efficiency and sensitivity.

Overall, the presentation emphasizes that correct chromatography is not simply a preliminary separation step, but a key determinant of method performance, sustainability and reliability. Careful chromatographic design can improve throughput, sensitivity, selectivity and environmental impact, making it essential for modern LC-MS laboratories.

The Acknowledgements:
The author gratefully acknowledges the Directorate-General for Health and Food Safety of the European Commission, DG SANTE, for the financial support provided to the European Union Reference Laboratory for Pesticide Residues in Fruit and Vegetables, EURL-FV. The views and opinions expressed in this presentation are those of the author only and do not necessarily reflect those of the European Commission

Biographical note

Prof. Amadeo R. Fernández-Alba is Professor of Analytical Chemistry at the University of Almería and Head of the AGR159 Pesticide Residues Research Group. His research focuses on advanced analytical methods for pesticide residues, emerging contaminants, microplastics and nanoplastics in food and environmental matrices. Since 2006, his group has hosted the European Union Reference Laboratory for Pesticide Residues in Fruits and Vegetables, funded by DG SANTE. He has extensive experience in LC-MS/MS, HRMS, microplastics analysis, regulatory residue control and method harmonisation. He has authored more than 400 scientific publications and has a strong international profile in food safety and quality assurance.

Keynote lectures

CONVERTING WASTE INTO VALUABLE PRODUCTS

Hanna Prusak, Filip Brodowski, Natalia Gutowska, Bartosz Danielewski, Amelia Zagorna, Anna Duber, Jan Maćkowski, Tomasz Rozmanowski, Mateusz Szczygielda, Mateusz Łężyk, Piotr Oleskowicz-Popiel#*

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Abstract

Due to the scarcity and environmental impact associated with the use of fossil resources there has been a noticeable shift in legislation, research, and commercialization trends toward bio-based products. Sustainable biochemical production focuses on converting waste into value-added chemical intermediates, offering higher resource recovery potential. Biochemical production through mixed culture fermentation (MCF) represents a promising approach for advancing sustainable waste management [1]. One of its key advantages is the ability to process complex, waste-derived organic feedstocks or waste gases without the need for strict sterility [2]. This eliminates one of the most energy intensive requirements of pure-culture fermentation, thereby reducing overall energy demand and considerably lowering the environmental footprint. Moreover, division of labour and metabolic specialization among community members not only expand substrate utilization capacity but also relieve thermodynamic bottlenecks in metabolic pathways through synergistic interactions among microbial species. We have developed and significantly improved MCF for converting abundant waste-origin substrates into valuable carboxylic acids [3]. Moreover, we investigated possible upgrading of those acids into alkanes. The produced carboxylic acids and alkanes after Kolbe electrolysis can serve as platform chemicals for wide use in fragrance & flavor, cosmetics, lubricants and sustainable aviation fuels production.

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The Acknowledgements:
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Biographical note

Prof. Piotr Oleskowicz-Popiel recieved his PhD from Technical University of Denmark in 2010, and then completed a postdoctoral fellowship at the Lawrence Berkeley National Laboratory in California, United States. He has been working at the Poznan University of Technology since 2012 and in 2021 received Full Professor position. His research is focused on a bioeconomy aspects in environmental engineering and development of new technologies for resource recovery from organic waste and wastewater. He is leading Biorefinery Research Group and he is Director of Institute of Environmental Engineering and Building Installations.

MAGNETIC POLYSACCHARIDE NANOCOMPOSITES FOR ADVANCED ENZYME IMMOBILISATION AND BIOCATALYSIS

Marta Ziegler-Borowska[1#*], **Dorota Chełminiak-Dudkiewicz**[1], **Adam Sikora**[2], **Michał P. Marszałł**[2]

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Abstract

Magnetic nanomaterials represent a highly attractive class of supports for biomolecule immobilisation due to their large surface area, tunable porosity, and high ligand loading capacity. However, the intrinsic colloidal instability of bare magnetite, particularly at neutral pH, requires surface stabilisation and functional modification.[1-3] In this context, polymeric coatings, especially biopolymers, are widely employed to enhance stability and provide functional groups for efficient immobilisation. Additionally, the superparamagnetic properties of these systems enable facile separation from reaction media and repeated reuse, making them particularly advantageous for catalytic applications.

Herein, we report the synthesis and functionalisation of magnetite nanoparticles coated with natural polysaccharides, including chitosan, aminated chitosan with varying densities of reactive amino groups, and modified starch. Notably, starch functionalisation was achieved via a rapid, solvent-free approach, providing a straightforward, sustainable route to surface modification. The resulting nanomaterials were comprehensively characterised using ATR-FTIR spectroscopy, transmission electron microscopy, X-ray diffraction, dynamic light scattering, and low-temperature nitrogen adsorption analysis.

The obtained magnetic nanocomposites were subsequently applied as supports for lipase immobilisation. Enzyme catalytic performance was evaluated in both model hydrolysis reactions and the kinetic resolution of racemic active substances. The experimental findings were further corroborated by computational studies, providing deeper insight into the structure-activity relationships governing enzyme performance.

References:
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Biographical note

Marta Ziegler-Borowska is Head of the Medicinal Chemistry Research Group at NCU in Torun, Poland. Her research focuses on the design of advanced biopolymer-based nanomaterials for biomedical applications, including drug delivery, enzyme immobilisation, and the development

of functional biomaterials. She has authored over 60 publications, holds multiple patents, and is listed among the world's top 2% scientists. She serves as Senior Executive Editor of the International Journal of Biological Macromolecules and Editor of Applied Biomolecules: Bioactive Materials. She led and participated in numerous nationally funded research projects. Her work bridges chemistry, materials science, and biotechnology to develop innovative healthcare solutions.

CATALYTIC PROMISCUITY OF HYDROLASES: A PLATFORM FOR GREEN AND METAL-FREE ANTIMICROBIAL AGENTS SYNTHESIS

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Abstract

Hydrolases are traditionally recognized for catalyzing hydrolytic reactions; however, increasing evidence highlights their remarkable catalytic promiscuity, enabling them to perform a broad spectrum of nonnative transformations. This promiscuous activity significantly expands their utility in organic synthesis, positioning hydrolases as versatile biocatalysts for the preparation of high value-added compounds. Beyond their natural function, hydrolases can catalyze reactions that involve bond formation rather than cleavage, including carbon-carbon and carbon-phosphorus bond formation [1-3]. Such non-canonical reactivity arises from the inherent flexibility of enzyme active sites and their ability to stabilize diverse transition states. As a result, hydrolases can be repurposed to mediate synthetically valuable transformations under mild and environmentally benign conditions. The exploitation of hydrolase promiscuity opens new avenues in biocatalysis, offering sustainable alternatives to conventional chemical methods. This approach not only broadens the scope of the reaction accessible through enzymatic catalysis, but also contributes to the development of greener synthetic strategies for complex and high-value molecular targets.

References:
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TUNABLE BIOCATALYSTS DEDICATED FOR THE SYNTHESIS OF FINE CHEMICALS

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Abstract

In this contribution, research on the development of new, specialised catalysts required for designing of clean, environmentally friendly technologies dedicated for the production of high-added value organic compounds for chemical industry will be presented. Heterogenization of the catalyst is one of the most widely favoured green approaches to environmentally friendly process. This goal is achieved by designing of catalysts based on innovative nanomaterials and ionic liquids. The resulting hybrid materials, based on nanomaterials, e.g. multiwalled carbon nanotubes (MWCNTs) and silica with unique mechanical, magnetic, thermal and electronic properties, as well as non-volatile ionic liquids as "green" media, combine the unique properties of both materials. The developed catalytic materials are characterized by high activity, selectivity and stability in selected chemical processes: esterification, alkylation, oxidation, cycloaddition including biomass valorisation and others [1-3]. The developed methods, considered within the framework of green chemistry metrics, ensures a balance between the high activity, stability, recyclability, and biodegradability of the catalyst. In summary, ionic liquid-based strategies will be presented as a generic approach to tailoring catalysts for industrially-relevant reactions, to generate both environmentally and economically sustainable processes.

References:
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Biographical note

Professor Anna Chrobok graduated from the Silesian University of Technology (SUT), Poland. After completing her PhD she worked one year as a post-doctoral researcher at the University of Vienna. She then moved to SUT an after she received her habilitation she was promoted to Professor in Chemical Engineering in 2018. Since 2024, she is the Vice Rector for Student Affairs and Education. She is a head of the Ionic Liquids group, the leader of numerous research grants and projects financed by industry, the co-author of 160 publications and over 60 patents. Research interest: designing of heterogeneous and homogeneous (bio)catalysts based on functional ionic liquids for green organic synthesis.

LK-ADH PRINCE AS A ”GAME-CHANGING ENZYME” IN REDOX BIOCATALYSIS

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Abstract

Alcohol dehydrogenases (EC 1.1.1.1-42; ADHs) are among the most widely used enzymes in biocatalysis. Their native catalytic function is the reversible interconversion of carbonyl and hydroxyl compounds using NAD(P)H/NAD(P)$^+$ as redox cofactors. Over the last few decades, numerous engineering campaigns have been undertaken to develop variants with improved biocatalytic and operational properties, usually tailored to a single specific transformation. In contrast, the enzyme presented here demonstrates that a properly redesigned biocatalyst, created through a synergistic remodeling of the substrate-binding pocket and entrance tunnel, can unlock an entire toolbox of redox-driven chemoenzymatic transformations.

In this lecture, I will show how the engineered variant derived from *Lactobacillus kefir* (Lk-ADH Prince) operates as a versatile ”redox bio-hub” across four complementary synthetic manifolds. As an anti-Prelog ADH, Lk-ADH Prince catalyzes the stereoselective reduction of structurally diverse ketones, furnishing optically active (*R*)-alcohols with high conversion and excellent stereoselectivity [1]. Under specific conditions, the same biocatalyst enables hydrogen transfer in the reverse direction, non-selectively oxidizing the corresponding racemic secondary alcohols to ketones [2]. This ambidextrous behavior becomes particularly powerful in the design of biocatalytic cascades. Accordingly, when combined with stereocomplementary transaminases, Lk-ADH Prince drives a concurrent one-pot/two-step oxidation-amination process that provides both enantiomers of valuable primary amines from racemic alcohols with excellent optical purity under mild aqueous conditions [3]. Finally, when coupled with engineered variants of an acyltransferase originating from *Mycobacterium smegmatis*, it enables a fully enzymatic dynamic kinetic resolution (DKR) of *sec*-alcohols in water, transforming racemization from a classical chemocatalytic problem into a biocatalytic opportunity [4].
Collectively, these studies position Lk-ADH Prince not as a single-purpose ADH but as a versatile and potent enzyme for reductive, oxidative, and cascade biocatalysis, offering new opportunities for the synthesis of high-value chiral building blocks relevant to the pharmaceutical industry.

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Biographical note

Paweł Borowiecki graduated with a degree in Biotechnology from the Warsaw University of Technology (WUT) in 2010, received his Ph.D. with Honors from WUT in 2016, and was habilitated in 2026. He currently serves as an Assistant Professor at WUT and is the Founder and Head of the Laboratory of Biocatalysis and Biotransformation (LBB-WUT). Research Interests: Biocatalysis and Medicinal Chemistry.

BIOTRANSFORMATIONS OF POLYHYDROXYALKANOATES INTO FUNCTIONAL BIOMATERIALS AND BIOACTIVE COMPOUNDS FOR PHARMACEUTICAL AND COSMETIC APPLICATIONS

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Abstract

Polyhydroxyalkanoates (PHAs) are a versatile class of microbial polyesters that serve not only as biodegradable and biocompatible materials but also as a promising platform for advanced biotransformations. This presentation gives an outlook on integrated approach combining microbial synthesis, chemical and enzymatic modification, and material processing to generate functional PHA-based systems for pharmaceutical and cosmetic applications. PHAs produced via renewable biorefinery routes can be subjected to targeted transformations, including catalytic depolymerization and enzymatic functionalization, enabling the synthesis of bioactive oligomers and polymer-drug conjugates. In particular, lipase-catalyzed and acid-catalyzed modifications allow incorporation of anti-inflammatory and antimicrobial agents such as diclofenac, ibuprofen, and selected antifungal compounds, resulting in materials with controlled release properties. These systems can be further processed into advanced biomaterials using techniques such as electrospinning, and solvent casting, leading to the development of wound dressings, scaffolds, and composite materials. In vitro and in vivo studies demonstrated enhanced cell colonization, angiogenesis, and therapeutic performance of modified PHA-based materials.

Beyond biomedical applications, the presentation highlights the potential of PHA-derived compounds and ultrafine particles as functional cosmetic ingredients. PHA-based materials can act as biodegradable alternatives to microplastics, as well as bioactive agents influencing cellular pathways, including antioxidant response and epigenetic regulation via 3-hydroxybutyrate derivatives. Overall, the PHAs constitute a unique bridge between biotransformations and functional material design, offering scalable and sustainable routes toward high-value products for the pharmaceutical and cosmetic industries.

Oral presentations

INNOVATIONS IN ENVIRONMENTAL BIOTECHNOLOGY

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Abstract

The rapid escalation of global industrialization and urbanization has introduced a complex suite of pollutants that challenge the limits of conventional waste management. As traditional physical and chemical remediation methods face scrutiny for their high energy demands and secondary waste generation, environmental biotechnology has emerged as a transformative frontier. This presentation explores the latest breakthroughs in leveraging biological systems to restore ecological integrity and transition toward a circular economy. A primary focus of this session will be the escalating crisis of Emerging Contaminants (ECs), specifically pharmaceutical residues and endocrine disruptors. These substances, often resistant to standard wastewater treatment protocols, pose significant risks to aquatic biodiversity and human health. We will examine innovative bio-augmented systems and the use of microorganisms, where specific enzymatic pathways are harnessed to break down stable chemical structures into non-toxic metabolites. Furthermore, the presentation will look beyond simple remediation to the ”valorization of waste”, e.g. Microbial Fuel Cells (MFCs), and the application of synthetic biology in engineering ”designer microbes” capable of sequestering heavy metals or degrading microplastics. By viewing waste streams as nutrient-rich reservoirs, these biotechnological innovations allow for the recovery of valuable bioplastics and phosphorus, aligning environmental protection with economic sustainability.

The Acknowledgements:
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Biographical note

Wojciech Smułek serves as an Assistant Professor at Poznań University of Technology’s Department of Organic Chemistry. He holds a PhD in Chemical Technology, specializing in the biodegradation of organic pollutants. His professional experience is distinguished by international research internships at the University of Copenhagen, University of Aveiro, and Zentiva in Prague. Dr. Smułek’s research focuses on the application of plant-derived surfactants and saponins to enhance antibiotic bioavailability and facilitate the bioremediation of contaminated soils. Furthermore, he investigates natural insecticides’ safety and holds patents for innovative nanoparticle production methods.

USING PETRI NETS FOR MODELING AND ANALYSIS OF MELANOMA-RELATED PROCESSES

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Abstract

Melanoma is one of the most common cancers beyond humans. The process of cancerogenesis is highly complex, and tumor cells acquire a number of characteristic properties to become malignant. Among these features is the ability to avoid apoptosis and proliferate in uncontrolled way. The Hippo/YAP signaling pathway, together with its crosstalk with BMP, TGF-β and BMP signaling pathways, plays an important role in the acquisition of these properties.

Systems biology approaches are particularly useful for studying signaling and metabolic pathways. Among them, Petri nets, in addition to their mathematical formalism, provide a user-friendly graphical representation of complex biological systems.

In this study, we developed a Petri net model describing the above-mentioned signaling pathways. The constructed model enabled the identification and characterization of key subprocesses within the modeled system. Minimal cut sets (MCSs) were generated for transitions associated with pro-cancerous activities in the analyzed net. An MCS for a base transition, understood as a target elementary process, is a set of transitions whose simultaneous knockout leads to the knockout of that transition. Based on the analysis of the generated MCSs and available literature data, four potentially feasible therapeutic scenarios were proposed. Simulations of those scenarios allowed us to estimate their impact on the modeled system.

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Biographical note

I hold a bachelor's degree in Bioinformatics in the discipline of Biological Sciences, obtained from Poznań University of Technology in collaboration with Adam Mickiewicz University in Poznań. I also received a master's degree in Bioinformatics in the discipline of Information and Communication Technology from Poznań University of Technology. Currently, I am a PhD candidate at the Institute of Computing Science. My research interests focus on the application of systems biology methods to cancer research.

ENGINEERING MEETS SYNTHETIC BIOLOGY - DESIGN AND CHARACTERIZATION OF MINIMAL CELL MEMBRANES

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Abstract

Every living cell, whether part of a simple bacterium or a complex human, is surrounded by a delicate, yet remarkably dynamic structure known as the cell membrane. Far from being a static barrier, this membrane acts as a living interface, controlling what enters and leaves the cell while maintaining the right conditions for all cellular components located inside. Although cell membranes were once thought to have a uniform bilayer structure, it is now known that they are highly heterogeneous, filled with tiny regions of specific composition, also known as membrane domains or rafts, where certain lipids and proteins gather together. By ensuring proper protein folding they become involved in a variety of processes such as enzymatic reactions, viral entry, or penetration of bacterial toxins to the cell interior. The indisputable importance of raft-like regions in cell activity led to studies on replicating the local membrane heterogeneities in model membrane systems. By recreating cell membranes in the laboratory and systematically varying factors such as lipid composition, temperature, pH, and hydration, we investigate how these conditions affect membrane structure and their dynamic responses to environmental changes. Understanding how membranes interact with their environment not only deepens our knowledge of their self-organization but also opens new avenues for controlling membrane behavior in medicine and biotechnology. Ultimately, our work helps us see the cell membrane not as a simple protective wall, but as a vibrant, adaptable structure, one that holds the key to many of life's most fundamental processes.

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Biographical note

I obtained my Master's degree in Molecular Bioengineering from the Technical University of Dresden (2019) and a PhD from Poznan University of Technology (2024). I employ bottom-up strategies to design minimal cell systems, with the goal of revealing the core principles that drive the structural organization and properties of cellular membranes. I am a DAAD Alumni (DAAD Scholarship for Master Studies), I received the scholarship of the City of Poznań for Young Researchers and The City of Poznan Award for the outstanding PhD thesis. I serve as Principal Investigator of the National Science Centre Poland PRELUDIUM grant (2024-2027).

MGO-SIO₂AS A VERSATILE PLATFORM FOR LIPASE IMMOBILIZATION: EFFECT OF SURFACE FUNCTIONALIZATION ON BIOCATALYTIC PERFORMANCE

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Abstract

MgO-SiO_2 mixed oxides represent a versatile platform for lipase immobilization due to their tunable physicochemical properties, including surface area, porosity, and acid-base characteristics. In this work, MgO-SiO_2 materials were systematically modified to tailor enzyme-support interactions and enhance biocatalytic performance. Different surface functionalization strategies were applied, including modification with hydrophobic alkyl groups or ionic liquids, enabling control over the microenvironment of the immobilized enzyme. Both physical adsorption and covalent immobilization approaches were employed to anchor lipases onto the support, allowing for a comprehensive comparison of immobilization efficiency, catalytic activity, and operational stability.

The obtained biocatalytic systems were successfully applied in selected esterification and transesterification reactions, demonstrating the strong impact of surface properties and immobilization strategy on enzyme performance. Notably, the systems enabled selective synthesis of target products and retained activity under continuous-flow conditions, highlighting their potential for scalable industrial applications relevant to the pharmaceutical sector, cosmetic industry, and bio-based materials, including FDCA-derived esters. Surface modification influenced enzyme conformational stability, and resistance to deactivation, which translated into improved catalytic efficiency and reusability [1,2].

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Biographical note

Dr. Anna Wolny is a researcher at the Faculty of Chemistry, Silesian University of Technology, specializing in heterogeneous catalysis, especially biocatalysis. Her research focuses on the materials functionalization, enzyme immobilization, and green chemistry analyses for sustainable organic synthesis and industrial applications.

ECO-FRIENDLY PRODUCTION OF SILICA MICROPARTICLES: THE ROLE OF CULTURE CONDITIONS IN *FUSARIUM CULMORUM* BIOLEACHING ACTIVITY

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Abstract

Bioleaching is an environmentally friendly and cost-effective method for recovering and synthesising inorganic materials, offering significant potential for sustainable resource extraction, waste valorisation and the production of functional silica biomaterials. Despite this potential, the specific mechanisms underlying fungal bioleaching remain poorly understood, particularly regarding how culture conditions influence on the metabolic pathways responsible for inorganic biotransformation. Therefore, this study aimed to determine the effect of nutritional conditions on the metabolic activity of *Fusarium culmorum* and its capacity to biosynthesise silica particles from sand.

We systematically evaluated the impact of culture medium composition - comparing various mineral and complete media - on silica particle production. Additionally, we investigated the effect of a nutrient starvation period on the metabolic activity of the fungal biomass.

Our findings demonstrate that nutrient availability critically dictates the course of the biotransformation process. Nutrient-limited conditions favoured a shift in the fungal cell towards a state of heightened metabolic readiness, culminating in enhanced bioleaching efficiency. The highest yield of biosynthesised silica particles occurred under strict nutrient limitation or following biomass starvation. Conversely, nutrient-rich environments significantly diminished or completely inhibited this process.

Morphological analysis revealed that the resulting silica particles were spherical with smooth surfaces and exhibited a semi-homogeneous size distribution, with average diameters ranging from 10 to 25 μm. The results underscore that the precise control of cultivation parameters is a crucial factor in regulating the biosynthesis of silica particles by *Fusarium culmorum*.

Ultimately, this research highlights the viability of utilizing *F. culmorum* for the sustainable production of silica microparticles, with promising applications across materials engineering, environmental remediation, and the chemical industry.

Biographical note

Olga Grześkowiak - in 2024, she graduated from the Faculty of Chemistry at Wrocław University of Technology with a Master of Science degree in Biotechnology. In the same year, she began her doctoral studies at the university's Doctoral School in the field of Chemical Sciences. She specializes in research into biotransformation using fungi as biocatalysts, and the biosynthesis of silica particles from various substrates (including agricultural waste).

TUNGSTEN ALDEHYDE OXIDOREDUCTASE - H_2-DRIVEN REDUCTION OF CARBOXYLIC ACIDS

Anna Szot[1], Patrycja Wójcik[1], Marta Olszak-Płachta[1], Victor Baerle[1], Yvonne Gemmecker[2], Dominik Hege[2], Alexander Lisiecki[2], Julien Cotelesage[3], Graham George[3], Johann Heider[2], Maciej Szaleniec[1#*]

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Abstract

Tungsten-dependent aldehyde oxidoreductases (AORs) catalyse oxidation of aldehydes to acids and uniquely reduce non-activated acids using low-redox-potential electron donors such as Eu(II) or Ti(III). We recently showed that AOR from *Aromatoleum aromaticum* ($\mathrm{AOR_{Aa}}$) reduces carboxylic acids, also using H_2 as reductant [1]. Moreover, the enzyme directs electrons from H_2 to NAD^+ at rates comparable to aldehyde oxidation, suggesting that H_2 oxidation is physiologically relevant rather than a side reaction. Similar hydrogenase activity has been reported for W-co model complexes [2].

In the presence of H_2, the enzyme exhibits dual activity: carboxylic acid reduction and NADH recycling. This combination makes it an attractive catalyst for NADH-driven cascades converting acids into valuable chemicals.

In order to understand this unusual enzymatic activity that allows $\mathrm{AOR_{Aa}}$ oxidation of H_2 and utilisation of its electron for carboxylic acid reduction, we have employed kinetic studies, EXAFS spectroscopy, and DFT modelling.

The EXAFS spectra provided insight into the tungsten coordination mode for the oxidised as well as the aldehyde or H_2 reduced cofactor. Kinetic measurements identified the conditions under which the reaction proceeds at the highest rate in the oxidation of aldehyde or H_2 when a natural electron acceptor (NAD^+) is used, as well as the best conditions for the reduction of carboxylic acid and demonstrated hydrogenation of acids by implementation of deutrated reagents. The calculations were conducted on a cluster model of the active site derived from a full protein relaxed in MD/QMMM. They provided the first comprehensive mechanistic hypothesis that combines structural and spectroscopic insight with observed activities toward both aldehydes and hydrogen, suggesting that the reduced form of the cofactor is better suited for H_2 activation than the oxidised one.

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Biographical note

Maciej Szaleniec currently holds a professor position and is head of the Joint Laboratory of Biotechnology and Enzyme Catalysis at the Institute of Catalysis and Surface Chemistry, PAS. In his research, he focuses on both experimental and theoretical studies of enzymes from anaerobic bacteria, especially containing Mo/W-cofactors. His research interest includes kinetic studies of enzymes, development of bioreactor processes, and theoretical modelling of reaction pathways for enzymes catalysing regioselective/enantioselective hydroxylation of hydrocarbons, reduction of ketones, dehydrogenation of sterols, oxidation of aldehydes and reduction of carboxylic acids. He published over 70 papers and chapters, obtained several patents and implemented one biotechnological method in the industry.

STRUCTURED MICROREACTORS FOR THE SELECTIVE SYNTHESIS OF FINE CHEMICALS

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Abstract

Structured microreactors are promising platforms for the selective synthesis of high-value fine chemicals, combining the advantages of continuous processing, efficient heat and mass transfer, and straightforward catalyst integration. In particular, enzyme-functionalised siliceous monolithic microreactors offer a hierarchical macro/mesoporous architecture that supports effective enzyme immobilisation, rapid substrate transport, intensified contact between phases, and improved interaction between the catalytic phase and the flowing reaction medium.

This contribution highlights the use of structured microreactors in representative biotransformations relevant to the pharmaceutical and cosmetics industries, including esterification/transesterification and enantioselective carbon-carbon bond formation. Compared with conventional batch systems, these reactors can, in selected cases, provide higher process selectivity. This results from improved mixing, shorter and better-controlled residence times, reduced diffusional limitations, and suppression of undesired side reactions or non-selective background pathways. Such effects are particularly important in selective and enantioselective synthesis, where reactor design can strongly influence conversion, product distribution, and the final outcome of the process.

In addition to improved selectivity, structured microreactors offer high conversions, short processing times, easier catalyst separation, reduced solvent consumption, improved operational stability, and enhanced process safety. Overall, they represent an attractive route toward more efficient, continuous, and sustainable manufacturing of fine chemicals and advanced molecular building blocks.

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Biographical note

Katarzyna Szymańska is a university professor in the Department of Chemical Engineering and Process Design, Faculty of Chemistry, at the Silesian University of Technology, Poland. Her research focuses on biocatalysis, immobilised enzymes, silica-based supports, and enzymatic microreactors and flow systems for selective synthesis. Her work combines materials engineering with chemical and biochemical process design, particularly in the development of porous silica materials and hierarchical monoliths for catalytic applications.

COUPLING HYDROGEN OXIDATION TO CARBOXYLIC ACID REDUCTION FOR SYNTHESIS OF ALCOHOLS OR QUINALDIC ACID - CASCADE SYSTEM UTILIZING BY TUNGSTEN ALDEHYDE OXIDOREDUCTASE

Anna Szot[1#*], Marta Olszak-Płachta[1], Patrycja Wójcik[1], Yvonne Gemmecker[2], Johann Heider[2], Maciej Szaleniec[1]

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Abstract

Tungsten aldehyde oxidoreductase from *Aromatoleum aromaticum* ($\mathrm{AOR_{Aa}}$) is a $(\alpha\beta)_\mathrm{n}\gamma$ oligomeric enzyme that contains tungsten cofactor in its catalytic a subunit that is connected by a chain of FeS cluster to FAD-containing NAD^+ binding site in g subunit. The enzyme naturally catalyses NAD^+ dependent oxidation of aldehydes to carboxylic acids. Interestingly, we have shown that $\mathrm{AOR_{Aa}}$ can also oxidase H_2 and reduce NAD^+ [1]. Furthermore, in the presence of H_2 the direct reduction of unactivated carboxylic acids to aldehydes becomes feasible. Those two features enables the development of multi-enzyme systems in which both aldehydes and regenerated NADH can serve as substrates for downstream cascade enzymatic reactions.

In order to explore capabilities of the enzyme we designed two cascade schemes starting with H_2-driven $\mathrm{AOR_{Aa}}$ activity. The first cascade system couples the hydrogenase function of $\mathrm{AOR_{Aa}}$ with NADH-dependent alcohol dehydrogenase (e.g. benzyl alcohol dehydrogenase from *A. aromaticum* - BaDH), enabling the reduction of benzoic acid derivatives to the corresponding alcohols. The second scheme utilises $\mathrm{AOR_{Aa}}$ jointly with trans-o-hydroxybenzylidenepyruvate hydratase-aldolase from *P. putida* G7m (NahE) [2] where anthranilic acid is first converted to 2-aminobenzaldehyde, followed by aldol condensation with pyruvate to 2-aminobenzylidenepyruvate, which spontaneously self-condenses to quinaldic acid.

Our studies have shown that the availability of H_2 in the liquid phase is the main limiting factor for the entire cascade system. Under optimised conditions, in the $\mathrm{AOR_{Aa}}$-BaDH coupling system, we achieved a benzyl alcohol concentration of 400 μM in 24 hours. In addition, we evaluated the rate of hydrogen consumption in the glove box atmosphere (97.5:2.5 N2:H2) and implemented an H_2-replenishment strategy by controlled flow of the H_2-containing atmosphere that improves reaction yield while still preserving the enzyme activity and product concentration. Finally, we have demonstrated the formation of quinaldic acid in our reaction system.

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Biographical note

Anna Szot is a first-year PhD student at the Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences in the Theoretical and Experimental Biocatalysis group. She holds a MSc degree in biochemistry. Her research focuses on tungsten oxidoreductase (AOR), including kinetic studies, investigation of its hydrogenase activity, and design of enzymatic cascade processes. She has also gained research experience in industry.

SUSTAINABLE BIOCATALYTIC PLATFORMS FOR THE PRODUCTION OF BIOACTIVE PHARMACEUTICAL COMPOUNDS

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Abstract

This work focuses on the development of sustainable biocatalytic strategies for the production of pharmaceutically relevant compounds, with particular emphasis on process intensification and green chemistry principles.

A continuous enzymatic platform was established for the synthesis of N-acylethanolamines (NAEs), a class of bioactive fatty acid amides with anti-inflammatory and neuroprotective properties.[1] Compared to conventional methods, the process was significantly improved through the use of immobilized *Candida antarctica* lipase B (CaL B). Starting from 100 mM fatty acids, up to 85% yield of ethyl esters was achieved at 50 °C with a residence time of only 20 minutes. Downstream purification using ion-exchange resins enabled efficient removal of unreacted substrates, facilitating process automation and substrate recycling. Subsequent amide formation performed in the green solvent 2,2,5,5-tetramethyloxolane (TMO) afforded yields between 20-90% depending on the substrate. The resulting NAE analogues demonstrated cytocompatibility in SH-SY5Y and BV2 cell lines and are now under investigation for their neuroprotective properties.

In line with circular economy principles, a complementary process was developed based on oleaginous yeasts grown on whey permeate and agro-food industry ressidues. The extracted triacylglycerols were quantitatively transesterified into ethyl esters in a rotating-bed reactor with immobilized CaL B, followed by aminolysis in eucalyptol. This approach yielded a defined mixture of fatty acid amides enriched in oleyl- and palmitoyl-ethanolamide (≥95% yield), eliminating the need for downstream without purification steps.

Additionally, a one-pot multi-enzymatic cascade was developed for the synthesis of chiral aromatic epoxides from biomass-derived phenolic acids. Phenolic acid decarboxylase from *Bacillus pumilus* (*Bp*FDC) generates reactive vinyl phenols, which are directly converted by newly identified two-component flavoprotein styrene monooxygenase (*Gc*StyA) from *Gulosibacter chungangensis*. The implementation of a nicotinamide cofactor biomimetic avoids the need for costly NADH regeneration systems.[2] This cascade afforded chiral p-hydroxy epoxides within 2 hours, reaching up to 95% conversion and complete (S)-selectivity, thus providing a sustainable route to valuable chiral building blocks.

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Biographical note

I am a PhD student in the National PhD Program in Catalysis at the University of Milan, supervised by Prof. Martina Letizia Contente. My research focuses on exploiting wild-type and engineered enzymes to expand substrate scope and develop sustainable, continuous, and intensified biocatalytic processes for the production of bioactive compounds. Supported by a prestigious Italian fellowship (Zegna foundation), I carried out a research period at TU Delft (Netherlands), where I developed an enzymatic cascade for the valorisation of biomass-derived phenolic acids into high-value, non-commercially available compounds while avoiding the isolation of unstable intermediates.

INNOVATIVE BIOCATALYST BASED ON NATURAL ACTIVATED CHARCOAL AND LIPASE FOR FOR SUSTAINABLE ESTERS PRODUCTION

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Abstract

The chemical industry is currently confronting numerous global challenges, including the escalating climate crisis, rising economic international competition, and shifting consumer awareness. These factors direct a chemical industry transition toward green technologies that minimize waste, utilize renewable resources, and rely on non-toxic material cycles. Levulinate esters are widely used in the cosmetic, pharmaceutical, and fuel industries, and as plasticizers. Their synthesis, typically catalyzed by sulfuric acid, is suboptimal. It is characterized by high energy consumption, the generation of hazardous waste requiring neutralization, and the need for specialized, corrosion-resistant reactors.[1]

The primary objective of this research is to develop an innovative biocatalyst composed of natural activated charcoal and an enzyme to synthesize levulinate esters from the biomass-derived substrate α-angelica lactone under significantly milder conditions, aligning with circular economy principles. Enzymes are recognized for their extraordinary catalytic activity and exceptional enantioselectivity, chemoselectivity, and regioselectivity. These unique properties allow the production of levulinate esters with high chemical purity. Furthermore, enzymes are fully biodegradable and environmentally benign. The application of activated carbon as a support material enhances the enzyme's stability and provides an ideal environment for effective immobilization and activation. This configuration also allows the straightforward separation of the catalyst from the post-reaction mixture, promoting recyclability. As a result of this study and the subsequent optimization of process parameters, up to 97% ester yield was achieved with 100% selectivity. This performance was recorded after 5h of reaction time under mild conditions, demonstrating the efficiency of the proposed biocatalytic approach.[2]

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Biographical note

I am a second-year Chemical Technology student at the Silesian University of Technology. My research journey began early in my studies when I joined the Chrobok Group, where I am currently conducting my experimental work. I am a recipient of a research scholarship under the "Uczelnie Przyszłości" program, which supports my scientific development. My academic interests revolve around sustainable chemistry and modern technological solutions.

ENZYMATIC SYNTHESIS OF LONG-CHAIN 2,5-FURANDICARBOXYLIC ACID DIESTERS DERIVED FROM LIGNOCELLULOSIC BIOMASS

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Abstract

Growing environmental concerns in recent decades have significantly contributed to the advancement of sustainable development and green chemistry. These concepts aim to ensure economic development while limiting the negative impact on the natural environment, including the use of raw materials from renewable sources, carrying out catalytic reactions, and waste prevention.
2,5-Furandicarboxylic acid (FDCA) is an example of a compound obtained from lignocellulosic biomass, which may prove crucial for greener polymer production, limiting the use of petrochemical raw materials. Its applications include the production of bio-based and recyclable materials, which are an alternative to conventional polymers, e.g., PET [1]. Furthermore, long-chain FDCA esters serve as biodegradable plasticizers, offering a non-toxic replacement for traditional phthalates [2].
In this study, the enzymatic synthesis of long-chain FDCA diesters was optimized via the transesterification of dimethyl 2,5-furandicarboxylate with octan-1-ol. Initially, the biocatalyst was prepared by immobilization of a lipase on a solid magnesium oxide/silica support. The effect of selected process parameters on the basic technological parameters of the reaction, such as substrate conversion, yield, and selectivity, was then examined. Conducting the process at 45°C resulted in a conversion of 93.74%, and the selectivity for obtaining dioctyl 2,5-furandicarboxylate was 98.43%.
The obtained results provide a basis for further research on the optimization of FDCA derivatives synthesis and scaling the process towards potential industrial applications.

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Biographical note

Igor Biały is a Master's student at the Faculty of Chemistry, Silesian University of Technology. In 2026, he obtained the degree of Engineer with a specialization in chemical organic technology. Throughout his studies, he has been involved in numerous research projects, frequently presenting his findings at both national and international conferences. His research focuses on biocatalysis and green technologies development. Currently, his research involves the investigation of FDCA as an important bio-based alternative to petrochemical feedstocks.

CYANOBACTERIA AS A TOOL IN BIOTRANSORMATION AND BIOACCUMULATION

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Abstract

Application of cyanobacterial biomass for photocatalysis and bioaccumulation is a task that aligns with sustainable development biotechnology, as the biomass will be utilized in subsequent steps and the process will be classified as "zero waste". Starting with the use of cyanobacteria in biotransformation, it is possible to obtain valuable products from inexpensive and widely available substrates. After biomass recovery, it is utilized in bioaccumulation processes. Bioaccumulation allows for the enrichment of biomass and its use to improve soil quality. The presence of exopolysaccharides (EPS) produced by cyanobacteria, which contain functional sides of negatively charged groups, makes it effectively bind positively charged metal ions. Therefore, cyanobacteria can be used for the bioaccumulation of rare earth elements to further utilize them for improving soil quality. Plants and certain microorganisms possess a remarkable ability to manage rare earth elements, and many of them can utilize their unique properties to enhance their metabolic and physiological functions.

Preliminary data has been obtained on the biotransformation of cinnamic acid by chosen cyanobacteria species. Gas chromatography analysis has shown that products of bioconversion are formed but their structures require further analysis. It is the first step of the three-step circular economy approach to the further application of cyanobacterial biomass in biotransformation, bioaccumulation and biostimulation of plants.

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Biographical note

Kaja Kowalczuk - a PhD student in the field of Chemical Sciences, Master of Science in Environmental Biotechnology. Her current research focuses on the use of microorganisms in biotransformation, as well as the reuse of microbial biomass for metal recovery and plant biostimulation.

VALORIZATION OF PLANT BIOMASS USING GREEN SOLVENTS AND ENZYMES

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Abstract

The production of high value-added products from renewable resources is a central goal of global sustainability strategies. Although waste lignocellulosic biomass is abundant and attractive, its utilization is hindered by a complex polymeric structure, rigidity, variability in morphology and composition.

This study presents a direct, efficient conversion of selected lignocellulosic biomass, without pretreatment, into levulinic acid (LA), using deep eutectic solvents (DESs) and low-cost ionic liquids (ILs) with tailored acidity.

Different waste biomass types were tested, and yields of LA depended on their structure and composition. The highest levulinic acid yield was achieved from mixed wood sawmill chips at 70 °C, using [Hmim][(HSO4)(H2SO4)2] (64 mol%). The ionic liquids were recovered and reused without significant loss of performance.

Selected DESs were also applied for biomass delignification, and their effect on subsequent enzymatic hydrolysis to glucose was evaluated. Delignification efficiencies for soft and hard biomass were compared using a novel StatBioChem reactor, a stirred tank reactor, and a commercial SpinChem® reactor. The highest delignification degree, especially for hard biomass, was obtained in the StatBioChem reactor, while no comparable effect was observed in the SpinChem® system. A greater degree of delignification resulted in higher glucose yields in subsequent enzymatic hydrolysis.

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Biographical note

Danuta Gillner, PhD, DSc, is a university professor at the Faculty of Chemistry at the Silesian University of Technology. Her work focuses on biotransformation processes and the valorization of biomass using ionic liquids, deep eutectic solvents, and enzymes. Other research areas concern selected plant enzymes and their role in defense mechanisms against both biotic and abiotic stresses as well as bacterial enzymes as molecular target for antibiotics. She collaborates with the food, cosmetic, and chemical industries, as well as with academic institutions. She is a co-author of patents, industrial implementations, publications and book chapters.

TOWARD NA AOR-BASED ELECTROCHEMICAL BIOSENSOR FOR ALDEHYDES

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Abstract

AOR_{Aa} from *Aromatoleum aromaticum* is a promising biocatalyst for electrochemical aldehyde detection because it combines broad aldehyde reactivity with compatibility with redox mediators. The enzyme exhibits activity with a wide range of aldehydes, such as aromatic, heterocyclic, alkylaromatic and aliphatic ones. These features make AOR_{Aa} an interesting catalyst for the development of direct detection and quantitation methods of markers of oxidative stress in biofluids, such as 4-hydroxynonenal [1,2].

This work presents preliminary results on the development of a detection assay capable of quantifying aldehydes in solution. First, the enzymatic oxidation of 4-hydroxynonenal was confirmed in a UV-vis-based activity assay. However, the assay turned out to be insufficiently sensitive to detect even elevated levels of 4-hydroxynonenal encountered in patients' blood plasma. In the next step, we decided to test an electrochemical biosensor. Electrochemical experiments were performed with recombinant AOR_{Aa}, produced in the *A. evansii* expression system, using benzaldehyde as a model substrate and DCPIP as a redox mediator. Cyclic voltammetry and chronoamperometry were used to assess mediator behavior and catalytic current responses. Electrochemical measurements were performed on two complementary electrode architectures: a digitally printed electrode (DPE) integrating graphite working and counter electrodes with a silver-paste pseudo-reference electrode, and a conventional three-electrode configuration comprising a calomel reference electrode, Pt-wire counter electrode, and carbon-felt working electrode. Clear current responses were obtained in the model system, confirming that the AOR-DCPIP system can be coupled with electrochemical readout.

A printed DPE produced a detectable but markedly smaller signal, whereas carbon felt gave the strongest response, indicating that electrode architecture and enzyme retention strongly influence the system's performance. These results establish a working model platform for further biosensor development and support the use of AOR as a recognition element for aldehyde detection.

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Acknowledgements: The research was partially funded by the NCN OPUS26 project 2023/51/B/ST4/01224 and NAWA Prom programme FERS.01.05-IP.08-0218/23.

Biographical note

Tymoteusz Maslyk is an MSc student in biomedical engineering at AGH University of Krakow and conducts research at the Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences. His work focuses on tungsten enzymes, enzymatic catalysis, and electrochemical biosensor development for reactive aldehydes, combining enzyme production and purification, activity screening, and bioelectrochemical characterization of mediator-based systems.

BPCI 2026

Poster presentations

ONE-POT PHOTO-BIOCATALYTIC CASCADE FOR THE SYNTHESIS OF OPTICALLY ENRICHED PRIMARY AMINES

Natalia Antos[1#*], **Julia Skrzypek**[1], **Tamara Reiter**[2], **Wolfgang Kroutil**[2], **Paweł Borowiecki**[2]

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Abstract

Combining photocatalysis with biocatalysis has become an attractive strategy for developing more sustainable and selective synthetic methods, especially for producing optically active amines, which are key chiral building blocks for the synthesis of non-racemic active pharmaceutical ingredients (APIs) [1].
In this work, we developed a one-pot/two-step photo-biocatalytic cascade that enables the direct transformation of 1,1-disubstituted alkenes into enantiomerically enriched primary amines. The process involves visible-light-driven oxidative cleavage of alkenes to generate prochiral ketones, followed by an in situ stereoselective reductive amination step catalyzed by transaminases.
The photo-biocatalytic system was expanded to a broad substrate scope (14 examples), delivering the target amines in good-to-excellent conversions (up to 95%) and excellent enantiomeric excesses (up to >9% ee), respectively. Furthermore, the cascade was successfully scaled up to 1 mmol of α-methylstyrene as a model substrate, allowing the preparation of (R)-1-phenylethylamine in 61% yield and >99% ee. The subsequent functionalization of this amine using a modified Mitsunobu-type reaction furnished (77% yield and 99% ee) [2].
Notably, our approach avoids the use of transition metals, hazardous oxidants, and high-pressure hydrogenation, highlighting its potential for green chemistry applications in pharmaceutical manufacturing and industrial asymmetric synthesis development.

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Biographical note

Natalia Antos obtained her MSc in Biotechnology from the Faculty of Chemistry at Warsaw University of Technology in 2023 and is currently a PhD candidate at WUT. Her research focuses on photobiocatalysis, combining photochemical and enzymatic approaches for sustainable

synthesis. She received the ”Most Innovative Poster” award at BPCI 2024. Research Interests: Stereoselective reduction of carbonyl compounds; Asymmetric reductive amination of ketones; Photo-biocatalytic cascades; Photo-chemoenzymatic syntheses of non-racemic APIs intermediates.

REDOX-CONTROLLED CRYO-EM OF A TUNGSTEN ALDEHYDE OXIDOREDUCTASE/HYDROGENASE

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Abstract

Aldehyde oxidoreductase from *Aromatoleum aromaticum* ($\mathrm{AOR_{Aa}}$) is an enzyme of $(\alpha\beta)_{\mathrm{n}\gamma}$ oligomeric structure involved in the cellular detoxification of bacterial cells through the $\mathrm{NAD^+}$ - dependent oxidation of aldehydes to carboxylic acids. Meanwhile, the reverse process, i.e., the reduction of carboxylic acids, is of great interest to the pharmaceutical and perfume industries. Importantly, in addition to aldehyde oxidation, $\mathrm{AOR_{Aa}}$ also catalyzes $\mathrm{H_2}$ oxidation, which can be coupled to the reduction of acids to valuable aldehydes or of $\mathrm{NAD^+}$ to NADH, enabling clean coenzyme recycling.
An important bottleneck in the study of this enzyme is the absence of high-resolution structures that can be used to discern details on its W-cofactor. Up to date, only a medium-resolution (3.5Å) of AOR is available, and the shape of the electron density at the W-cofactor does not allow for unambiguous determination of the coordination mode. Traditional structural methods, such as XRD, require preliminary crystallization of the protein, which is challenging due to the oligomeric nature of $\mathrm{AOR_{Aa}}$. Moreover, X-ray-induced photoreduction of the active sites of metalloenzymes frequently impacts the structure of the tungsten cofactor.
Cryo-EM is a method that can provide comparable resolution while lacking the bottlenecks mentioned above. Cryo-EM studies of AOR allow the investigation of multiple protein oligomers. Since cryo-EM examines the protein in solution, the structures obtained provide additional insight into its real behavior.
This work describes the cryo-EM study of ($\mathrm{AOR_{Aa}}$), aiming to improve upon the results obtained in previous work. The enzyme is studied in both oxidized and reduced states, with the aim of extensively exploring the catalytically relevant conformations.

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Biographical note

Victor Baerle completed his B.Sc. in Biochemistry and an M.Sc. in Bioinformatics at the West University of Timisoara, Romania. His interests lie in expanding the enzymatic toolbox available to chemists through rational and de novo enzyme design, using non-standard amino acids, unique metals, and cofactors. He is a PhD student at ICSC PAN, where he focuses on mechanistic and spectroscopic studies of a tungsten aldehyde oxidoreductase/hydrogenase. His work, supervised by Prof. Dr. Hab. Maciej Szaleniec, attempts to elucidate how tungstoenzymes enable low-potential reactions and to provide a framework for their study.

TEXTILE WASTE VALORIZATION WITH THE USE OF A *ASPERGILLUS NIGER* IAFB 2301 STRAIN

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Abstract

The increasing accumulation of textile waste is one of the major environmental challenges associated with the modern textile industry. This is particularly significant in the case of blended materials, such as cotton-polyester fabrics, which are difficult to recycle using conventional methods. Therefore, the development of efficient and environmentally sustainable recycling technologies is urgently required. One of the most promising solutions is the biotechnological approach based on the use of cellulolytic enzymes. This study aimed to evaluate the feasibility of using textile waste as a substrate for cellulase production by *Aspergillus niger* IAFB 2301. The microorganism was cultivated under solid-state and submerged fermentation conditions in order to compare the efficiency of these two production methods. Pretreatment methods were applied to make cellulose fibres more susceptible to enzymatic degradation. These included thermal pretreatment by autoclaving as well as alkaline treatment. Both were used on textile materials characterized by varying cotton-to-polyester ratios. Sterilized jeans and microcrystalline cellulose proved to be the most effective cellulase inducers. Furthermore, several nutrient medium compositions were tested in order to determine the conditions that most effectively stimulate fungal growth and maximize cellulase biosynthesis. The Mandels-Weber medium [1] was established as the most efficient for cellulolytic enzymes production. After cultivation, the enzymes were extracted and their activity was subsequently evaluated. They were then applied to the enzymatic hydrolysis of textile waste. This process resulted in the degradation of the cellulose component into simple sugars. These products can be used as substrates in subsequent biotechnological processes. Meanwhile, the selective degradation of the cotton fraction enabled polyester fibres to be recovered. Therefore, this approach contributes to the valorisation of textile waste and supports the principles of sustainable development and the circular economy.

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Biographical note

Małgorzata Brzezińska-Rodak, PhD, DSc, Eng., is a researcher at the Faculty of Chemistry, Wrocław University of Science and Technology, where she has been employed since 1998. She earned her PhD in Biotechnology in 2007 and received her DSc (Habilitation) in Biological Sciences in 2019. Her scientific expertise lies in utilizing the enzymatic potential of fungi for the synthesis of biologically active compounds, including optically pure phosphonates and antioxidants. Her recent research projects focus on the valorization of various textile wastes, aiming to develop sustainable recycling solutions.

BIOCATALYTIC TECHNIQUES FOR SYNTHESIS OF ACTIVE PHARMACEUTICAL INGREDIENTS

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Abstract

The rising demand for efficient and sustainable synthesis of pharmaceutically active compounds has intensified interest in biocatalytic approaches.[1] Enzymes, as highly selective and efficient catalysts, offer significant advantages over conventional chemical methods. However, their practical application is limited by low stability and lack of reusability.[2,3]

The main objective of this study was to develop and evaluate biocatalytic systems based on immobilized enzymes for the synthesis of active pharmaceutical ingredients (APIs) as a strategy to enhance catalytic performance and improve long-term stability. The research focused on assessing the effect of different silica-based supports and surface modification methods on the immobilization efficiency and catalytic activity of ω-transaminase.

The obtained results demonstrated that the type of silica support and the applied surface modification significantly affected the properties of the immobilized enzyme. Surface functionalization, achieved through the use of polyethylenimine or 3-Aminopropyltriethoxysilane/glutaraldehyde system, resulted in substantial alterations to the material's morphology and enhanced enzyme binding. Furthermore, immobilized systems demonstrated retention of high catalytic activity, thereby substantiating the efficacy of the immobilization process.

In summary, the study demonstrates that by employing suitable immobilization strategies, the stability and applicability of enzymatic systems can be enhanced. The developed biocatalytic systems demonstrate potential for future application in multi-enzyme cascade processes, thereby enabling more efficient and streamlined synthesis pathways for pharmaceutical compounds.

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Biographical note

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TECHNO-ECONOMIC ANALYSIS OF A CLOSE-LOOP COSMETICS MANUFACTURING APPROACH USING MEMBRANE FILTRATION TECHNIQUES: A CASE STUDY

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Abstract

Increasing regulatory constraints and water footprint reduction targets are driving the cosmetics industry toward advanced circular water management solutions [1, 2]. This study presents a techno-economic assessment of alternative process configurations for cosmetic manufacturing, with particular emphasis on process integration and water reuse strategies [3, 4].

Three scenarios were comparatively evaluated. The baseline system represents a conventional batch production process including complete rinsing, cleaning and disinfection of the mixing vessel after each cycle, typical for hygiene-critical industries such as cosmetics and personal care manufacturing [1]. A modified configuration introduces partial process intensification through vessel reuse following rinsing with demineralised water [5]. The proposed alternative is based on process integration principles and incorporates membrane separation (microfiltration - MF and nanofiltration - NF) for the treatment and recirculation of post-rinsing streams [3][6].

The analysis demonstrates that the membrane-integrated configuration offers the highest potential for water recovery and wastewater minimisation among the considered options [3, 6]. The recirculation of treated streams significantly reduces in freshwater demand and effluent volume, while maintaining process continuity [2, 6]. From an economic perspective, the proposed solution shows favourable long-term performance due to decreased operating costs related to water supply and wastewater treatment, offsetting the increased capital expenditure associated with membrane installation [4].

The results highlight the feasibility of combining membrane technologies with existing production systems to achieve closed-loop water management [2, 6]. This approach supports improved environmental performance and aligns with circular economy principles, offering a viable pathway for sustainable process intensification in the cosmetics industry [1, 2].

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Biographical note

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SAPONIN-RICH PLANT EXTRACTS AS CONDITIONAL ADJUVANTS OF CIPROFLOXACIN: EFFECTS ON BACTERIAL INHIBITION AND MEMBRANE PERMEABILITY

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Abstract

The increasing prevalence of antibiotic resistance highlights the urgent need for strategies that enhance the efficacy of existing antimicrobial drugs. One promising approach is the use of natural compounds as adjuvants. Plant-derived saponins are of particular interest due to their amphiphilic structure and ability to interact with biological membranes, potentially facilitating antibiotic penetration into bacterial cells. However, it remains unclear whether such membrane activity consistently translates into improved antibacterial performance. The increasing prevalence of antibiotic resistance highlights the urgent need for strategies that enhance the efficacy of existing antimicrobial drugs. One promising approach is the use of natural compounds as adjuvants. Plant-derived saponins are of particular interest due to their amphiphilic structure and ability to interact with biological membranes, potentially facilitating antibiotic penetration into bacterial cells. However, it remains unclear whether such membrane activity consistently translates into improved antibacterial performance. This study investigated the interaction between selected saponin-rich plant extracts and ciprofloxacin against *Pseudomonas aeruginosa*, a clinically relevant Gram-negative pathogen characterized by intrinsic resistance and low membrane permeability. The aim was to evaluate the effects of these combinations on key surface-related properties of bacterial cells, including membrane permeability, surface modification, and metabolic activity. By integrating these parameters, the study assessed whether increased membrane permeability corresponds with enhanced antibiotic efficacy. The results indicate that the adjuvant effect of saponins is not universal but depends on factors such as extract type or antibiotic concentration.

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Biographical note

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environment. She has contributed to numerous scientific publications and has been actively involved in research projects. Her achievements include advancing the understanding of microbial processes in contaminated environments and promoting sustainable biotechnological solutions for pollution mitigation.

NATURAL DELIVERY SYSTEMS FOR PLANT-DERIVED BIOACTIVE COMPOUNDS

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Abstract

Plant-derived bioactive compounds have gained increasing attention in pharmaceutical and cosmetic applications due to their broad spectrum of biological activity and natural origin [1]. However, their practical use is often limited by poor water solubility, low stability, and reduced bioavailability, which significantly affect their therapeutic efficiency [2,3]. The aim of this study was to develop a hybrid supramolecular delivery system to improve the physicochemical properties and biological activity of selected plant-derived compounds. The obtained systems were characterized using ^{1}H NMR spectroscopy as well as particle size and zeta potential analysis. The developed systems exhibited improved dispersion stability and enhanced physicochemical properties compared to unformulated compounds. The results demonstrate that such hierarchical delivery systems represent a promising strategy for enhancing the performance of plant-derived compounds. Such approaches are consistent with green chemistry principles and offer significant potential for pharmaceutical and cosmetic applications.

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Biographical note

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M_XO_Y/FUCOIDAN HYBRID SYSTEMS AS ACTIVE ENZYME SUPPORT

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Abstract

Inorganic-bioorganic hybrid materials (in this case, M_XO_Y/fucoidan) exhibit significant potential as enzyme carriers due to their high stability and mechanical strength. They also demonstrate a strong affinity for enzymes, attributed to the presence of organic components containing functional groups capable of interacting with those found in protein structures [1,2]. The results presented here concern the preparation of innovative inorganic-bioorganic hybrid systems based on a sulfated polysaccharide (fucoidan) and inorganic oxides (ZrO_2, MgO, SiO_2). These materials were fabricated either through surface functionalization of the oxides with a fucoidan solution or via in-situ incorporation of fucoidan during oxide synthesis. Comprehensive spectroscopic analyses (infrared spectroscopy, nuclear magnetic resonance, and X-ray photoelectron spectroscopy) confirmed the effective modification of the oxide materials with fucoidan. A central aspect of this study was the application of the proposed M_XO_Y/fucoidan hybrid materials for enzyme immobilization. Enzymatic activity, evaluated using selected model reactions, enabled a quantitative assessment of immobilization efficiency. The utilization of such hybrid platforms as enzyme carriers offers significant potential for the development of advanced biocatalytic systems with broad applicability. Moreover, preliminary findings suggest that the resulting biocatalytic system holds considerable promise for the degradation of a wide range of environmentally hazardous organic pollutants in wastewater.

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Biographical note

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STEREOCONVERGENT PHOTO-BIOCATALYTIC CASCADE TO OPTICALLY ENRICHED AMINES FROM RACEMIC CARBOXYLIC ACIDS

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Abstract

Optically active amines are common structural motifs found in a wide range of natural products and active pharmaceutical ingredients (APIs) [1]. Classical methods for their synthesis are mostly inefficient in terms of yield and optical purity, as well as rely on toxic reagents and volatile organic solvents, posing a significant threat to both the environment and human health [2]. Accordingly, the development of efficient, highly selective, and sustainable processes for producing optically enriched amines represents an important research direction.

In this work, we present a new method for the synthesis of optically active amines from racemic carboxylic acids, employing a two-step, sequential photo-biocatalytic cascade carried out in a ”one-pot” mode that eliminates the need for isolation and purification of the intermediates.

In general, the process utilizes sodium anthraquinone-1-sulfonate (SAS) as a water-soluble, metal-free photo-organocatalyst to achieve quantitative decarboxylative oxidation of racemic aryl-alkyl carboxylic acids under blue LED irradiation (427 nm), employing molecular oxygen as the terminal oxidant. The subsequent step employs stereocomplementary transaminases (*E. coli*/TA), which catalyze the asymmetric reductive amination of the *in situ*-generated ketones. This photo-biocatalytic strategy enabled the preparation of optically active amines with enantiomeric excesses ranging from 93% to 99.9% and conversions up to >99%.

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Biographical note

Aleksandra Madej obtained her MSc in Biotechnology in 2025 from the Faculty of Chemistry at Warsaw University of Technology. She is currently pursuing her PhD at the same institution, Research Interests: evolution of enzymes; chemoenzymatic strategies in the synthesis of chiral building blocks of APIs; expanding the range of novel applications for oxidoreductases.

SELECTIVE ANTIBACTERIAL EFFECTS AND PRELIMINARY INTESTINAL SAFETY PROFILE OF SAPONIN-RICH PLANT EXTRACTS AGAINST GRAM-NEGATIVE BACTERIA

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Abstract

Plant-derived saponins are increasingly discussed as membrane-active excipients and resistance-modifying agents, yet their direct antibacterial effects and host-cell tolerance remain insufficiently differentiated across extracts. This study compared several saponin-rich botanical extracts, including materials derived from *Glycyrrhiza glabra*, *Trigonella foenum-graecum*, *Saponaria officinalis* and *Sapindus mukorossi*, to assess their effects on bacterial metabolic activity and to obtain an initial estimate of intestinal epithelial compatibility. The aim was to identify extracts that combine measurable anti-bacterial activity with an acceptable preliminary safety profile.

In *Pseudomonas aeruginosa*, all tested extracts reduced metabolic activity relative to untreated control cells, with decreases of approximately 20-25%, indicating that the effect was not confined to a single botanical source. In *Escherichia coli*, the response depended on both extract identity and environmental pH. Licorice-derived extract and filtrate produced the most pronounced effect under near-neutral conditions, where bacterial metabolic activity decreased by about 50%. By contrast, *Calendula officinalis*-derived extracts showed a weaker and more pH-dependent response. Preliminary Caco-2 assays further indicated that tolerability varied substantially across tested saponin-rich formulations. At 1 mg/L, *S. officinalis* extract retained high apparent cell viability with minimal LDH release, whereas *S. mukorossi* filtrate displayed poor compatibility across all tested concentrations, with low viability and marked membrane damage.

Taken together, the results support the view that saponin-rich plant formulations should not be considered functionally interchangeable. Some extracts show a more favorable balance between antibacterial activity and epithelial tolerance, while others appear too damaging for straightforward translational use. These differences warrant extract-specific optimization rather than class-level generalization.

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Biographical note

Aleksandra Makiej is a PhD researcher in chemical sciences whose work focuses on advanced drug delivery systems, antimicrobial therapies, and sustainable biomaterials. Her research explores plant-derived surfactants as bio-adjuvants for antibiotics and the development of smart hydrogels for controlled drug release. She has gained international research experience through collaborations and internships at institutions in Spain, Austria, and Australia, with further research activity in Switzerland. Her work combines microbiology, materials science, and chemical technology to develop innovative solutions with potential practical application in modern therapy.

ENZYMATIC CATALYSIS IN API SYNTHESIS

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Abstract

Key components of medicinal products are Active Pharmaceutical Ingredients (APIs), which are responsible for the therapeutic effect in patients. They are meticulously synthesized to meet stringent purity standards, as the quality of an API has a direct impact on the safety and therapeutic efficacy of medicinal products [1]. Biocatalysis and chemoenzymatic reactions are currently among the most innovative and rapidly developing areas in the pharmaceutical sector. Enzymatic catalysis responds to the growing demand for sustainable industrial development by combining high process efficiency with environmental responsibility. Biocatalysis has now become a mature, reliable, and efficient technology for the synthesis of APIs. Enzymes enable reactions to be carried out under mild conditions, which translates into lower energy consumption and reduced formation of undesirable by-products. Biocatalytic reactions can be performed in both aqueous and non-aqueous environments, significantly facilitating the integration of complex, multi-step synthetic procedures. An important advantage of enzymes is their adaptability to specific process requirements. They allow reactions to be conducted at high substrate loadings while maintaining excellent chemo-, regio-, and enantioselectivity. Moreover, they fully align with the fundamental principles of green chemistry, as they are derived from renewable and relatively inexpensive biological sources. Their production is characterized by cost stability and economic predictability, which simplifies process scaling and industrial modeling [2]. Despite their many advantages, enzymatic technologies still require further research and development to fully optimize their efficiency, expand their industrial applicability, and improve process robustness for large-scale pharmaceutical manufacturing.

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Biographical note

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CASCADE REDUCTION OF CARBOXYLIC ACIDS TO ALCOHOLS BY ALDEHYDE OXIDOREDUCTASE AND BENZYL ALCOHOL DEHYDROGENASE - OPTIMIZATION OF REACTION CONDITIONS

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Abstract

The efficient conversion of carboxylic acids to alcohols via enzymatic cascades represents a promising approach in green chemistry, offering high selectivity toward carboxylic/carbonyl group and mild reaction conditions. This study focuses on the optimization of reaction conditions for a two-step enzymatic cascade involving two enzymes from *Aromatoleum aromaticum*: tungsten aldehyde oxidoreductase ($\mathrm{AOR_{Aa}}$) and benzyl alcohol dehydrogenase (BaDH). In this system, the first enzyme catalyzes the reduction of carboxylic acids to aldehydes, while the second enzyme further reduces the aldehydes to their corresponding alcohols. The feasibility of this cascade arises from the dual catalytic capability of $\mathrm{AOR_{Aa}}$ to oxidize hydrogen and reduce NAD^+, as demonstrated in previous studies [1].

In a cascade reaction involving $\mathrm{AOR_{Aa}}$ and BaDH enzymes, the appropriate selection of pH is crucial, as it directly affects enzyme activity and stability. Equally important is ensuring adequate substrate solubility, which enables efficient interaction with the enzymes' active sites. In addition, maintaining a constant supply of hydrogen as a source of electrons is essential for the proper progression of the entire reaction. However, the reaction progress cannot be enforced by too high H_2 content due to substrate inhibition effect [1].

Our research focused mainly on the way H_2 is provided to the reactor system. The reactions were performed with sodium benzoate under strictly anaerobic conditions (O_2 < 35 ppm) in a nitrogen atmosphere containing 2.5% hydrogen in reactors fitted with the control flow of ambient gas. This work highlights the influence of gas flow rate and gas availability on reaction yield. Several internally developed methods for supplying hydrogen to the reaction environment were applied, which led to the production of 0.4 mM of benzyl alcohol during 24 h reaction. Finally, we will highlight potential pitfalls associated with such reactor construction which may impact future strategy of reaction upscaling.

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Biographical note

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CLOSING THE LOOP: INTEGRATION OF BIOTECHNOLOGICAL AND OLEOCHEMICAL PROCESS IN A BIOREFINERY CONCEPT - CASE STUDY

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Abstract

The transformation of the chemical industry towards biorefineries requires not only the implementation of individual biotechnological processes, but also their integration within a unified production system, as widely emphasized in the literature on biorefinery concepts. This work presents a concept for integrating process streams from three installations based on renewable feedstocks from the ORLEN Południe portfolio: second-generation bioethanol production from lignocellulosic biomass (straw), fermentative lactic acid production from sugar beet molasses, and rapeseed oil processing.

The study focuses on the potential for synergies between these processes, including both the valorization of side streams and increased feedstock flexibility. Rapeseed meal is considered as a promising nitrogen source for lactic acid fermentation, either alone or in combination with other nutrients, in line with existing research on the use of agro-industrial residues in bioprocesses. Yeast biomass generated during bioethanol production is identified as a valuable supplement for fermentation media, supporting efforts to replace costly components such as yeast extract. In addition, fermentable sugars derived from second-generation bioethanol processing can serve as an alternative carbon source for lactic acid production, enhancing process flexibility. Furthermore, bacterial biomass generated during lactic acid fermentation can be utilized as a feed additive or blended with rapeseed meal. An important aspect of process integration is also the utilization of lignin fractions from bioethanol production, either as an energy source or as a feedstock for further valorization.

The proposed concept demonstrates that a system-level approach based on circular use of raw materials and side streams can significantly reduce waste generation, optimize operational costs, and improve overall resource efficiency. Biotechnology, as a complement to conventional chemical processes, plays a key role in the development of modern, integrated biorefineries.

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Biographical note

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Adam Szeligowski is a MSc Eng. in Biotechnology. Research interests focus on fermentation processes and industrial biotechnology. Earlier scientific and professional activity included participation in a research project on the fermentative production of biopolymers. Current work at ORLEN Południe R&D is dedicated to the development of technologies for bioproducts manufacturing. Doctoral research conducted within an industrial PhD programme focuses on enzyme production by filamentous fungi and their application in biomass hydrolysis to generate simple sugars as feedstocks for bioprocesses. Experience combines academic research with industrial implementation, with a particular focus on sustainable biotechnological solutions for modern biorefinery systems.

PHA-DERIVED CHIRAL MONOMERS AS VERSATILE BUILDING BLOCKS FOR BIOCATALYTIC SYNTHESIS OF FUNCTIONAL BIOACTIVE COMPOUNDS

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Abstract

Polyhydroxyalkanoates (PHA) are biodegradable microbial polyesters that constitute an attractive renewable source of enantiomerically pure hydroxyacids. Following depolymerization, medium-chain-length PHA (mcl-PHA) yield chiral monomers with high synthetic potential, offering a sustainable alternative to petrochemical-derived intermediates for the development of biologically active compounds. Despite their structural diversity, the application potential of PHA-derived monomers in biocatalytic synthesis remains insufficiently explored. The aim of this study was to evaluate mcl-PHA-derived monomers as versatile chiral building blocks for the synthesis and modification of functional compounds with pharmaceutical and cosmetic relevance.

The obtained monomers were successfully applied in lipase-catalyzed transformations for the synthesis of novel semi-synthetic β-lactam antibiotics and sugar esters. The resulting antibiotic derivatives exhibited antibacterial activity against both Gram-positive and Gram-negative bacteria, confirming the utility of PHA monomers as side-chain precursors for β-lactam modification. In parallel, PHA-based sugar esters demonstrated significant antiproliferative activity against selected cancer cell lines, highlighting their therapeutic potential. Moreover, esterification of PHA-derived hydroxyacids resulted in compounds with pleasant floral and fruity aroma profiles, indicating additional applicability in cosmetic formulations.

These findings demonstrate that PHA-derived monomers represent versatile renewable chiral synthons for biocatalytic synthesis and functionalization of bioactive molecules. Their broad applicability in pharmaceutical and cosmetic sectors highlights the untapped potential of microbial polyesters as sustainable sources of high-value functional compounds.

Biographical note

Justyna Prajsnar holds a PhD in chemical sciences and is a researcher at Jerzy Haber Institute of Catalysis and Surface Chemistry Polish Academy of Sciences in Kraków, Poland. Her scientific background combines microbiology, microbial biotechnology, and biocatalysis, with particular focus on bacterial fermentation processes, bioprocess scale-up, and the synthesis of biologically active compounds. Her expertise includes the development and optimization of laboratory and semi-industrial fermentation processes, enzymatic synthesis, and advanced analytical techniques. She has co-authored 13 scientific publications, holds two patents, and actively participates in industrial and international research projects focused on sustainable biomaterials and bioactive compounds.

INNOVATIVE HETEROGENEOUS BIOCATALYST IN THE SYNTHESIS OF CYCLIC LACTONES

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Abstract

The Baeyer-Villiger reaction is an important oxidation process that converts ketones into esters and lactones, which are widely used as intermediates in the synthesis of fine chemicals, including applications in the pharmaceutical, materials, and fragrance industries. Conventional methods usually employ peracids or other strong oxidizing agents, which may pose limitations related to safety, selectivity, and the generation of chemical waste. Therefore, in accordance with the principles of green chemistry, increasing attention has been directed toward the development of more sustainable oxidation systems based on biocatalysis.

The aim of this work was to investigate the possibility of using filamentous fungal biomass as a heterogeneous biocatalyst in the Baeyer-Villiger oxidation of 2-adamantanone to the corresponding lactone in the presence of 30 wt% hydrogen peroxide. The proposed chemoenzymatic system enabled a one-pot process in which the oxidizing agent was generated in situ in the presence of the biocatalyst, followed by the subsequent transformation of ketones into lactones, providing an alternative approach to conventional oxidation methods. [1-3]

The obtained results demonstrated that the applied system effectively promoted the oxidation process. Very high substrate conversions, approaching 100%, along with 100% selectivity under mild conditions, were achieved in the studied chemoenzymatic system. These findings indicate that filamentous fungal biomass can act as an efficient heterogeneous biocatalyst and may provide a promising and more environmentally friendly alternative to conventional methods of lactone synthesis.

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Biographical note

Anita Procek is a graduate of chemistry at the Silesian University of Technology. In 2025, she obtained the degree of Engineer with a specialization in pharmaceutical and cosmetic chemistry. Her research interests focus on biocatalysis, green chemistry, and the application of enzymatic

systems in organic synthesis. She is an active member of the Chemistry Students Research Society. Her research activity focuses on the development of more sustainable and environmentally friendly chemical processes.

THE USE OF ENZYMATIC REDOX REACTIONS CATALYSED BY A VARIANT OF ALCOHOL DEHYDROGENASE FROM *LACTOBACILLUS KEFIR* IN THE BIOCATALYTIC SYNTHESIS OF OPTICALLY ACTIVE COMPOUNDS

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Abstract

Alcohol dehydrogenases (ADHs) are a well-known class of oxidoreductases that utilize electron-transferring cofactors (NAD(P)H/NAD(P)$^+$) to catalyze oxidation and reduction reactions of carbonyl compounds and alcohols. Owing to their high chemo-, regio-, and stereoselectivity, they represent one of the most widely applied enzymes in modern organic synthesis, particularly in the preparation of ketones and/or optically active alcohols [1].

This study aimed to develop new biocatalytic methodologies for the asymmetric syntheses of optically active products, employing a variant of ADH derived from *Lactobacillus kefir* (Lk-ADH E145F-F147L-Y190C, Lk-ADH Prince) [2]. In our group, this enzyme was applied as a lyophilized *E. coli*-based preparation in various chemoenzymatic campaigns, including the stereoselective reduction of prochiral ketones, non-stereoselective oxidation of secondary alcohols, and biocatalytic dynamic kinetic resolution in water [3].

The results highlight the significant potential of the modified Lk-ADH variant as a versatile whole-cell biocatalyst for the synthesis of optically active compounds and demonstrate its applicability in designing sustainable, selective, and efficient biotransformation processes.

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Biographical note

Aleksandra Rudzka received B.Sc. and M.Sc. degrees from the Faculty of Chemistry at Warsaw University of Technology (WUT), Warsaw, Poland, in 2020 and 2021, respectively. Ms. Rudzka is a Ph.D. student at the Doctoral School WUT, where she conducts her research at the Faculty

of Chemistry as a member of the research group led by Dr. Paweł Borowiecki (LBB WUT). She is a laureate of the L'Oreal-UNESCO For Women in Science Program. Her research interests focus on the development of chemoenzymatic processes for the synthesis of optically active compounds with high added value, particularly active pharmaceutical ingredients.

MICROPLASTICS AS ENVIRONMENTAL RESERVOIRS: ALTERING THE FATE AND TOXICITY OF CIPROFLOXACIN TOWARDS AQUATIC BACTERIA

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Abstract

The co-occurrence of microplastics and antibiotics in aquatic environments represents a significant challenge to public health by facilitating the spread of antibiotic resistance genes (ARGs) and contributing to antimicrobial resistance (AMR). This study investigates the dynamic interactions between polyurethane (PUR) microplastics and ciprofloxacin (CIP) [1,2]. Physicochemical analysis using LDIR imaging and ATR-FTIR spectroscopy confirmed the chemical identity and broad particle size distribution characteristic of mechanical fragmentation of polymers. Adsorption kinetics studies revealed a rapid decrease in antibiotic concentration in the presence of the polymer matrix. The data were most accurately described by a pseudo-second-order model (PSO) ($R^2 > 0.998$), suggesting a key role for chemical processes in contaminant binding. The determined adsorption capacity ($q_e = 50.000$ μg/g) indicates a high potential for PUR to accumulate ciprofloxacin.

The impact of these interactions on biological processes was assessed using six strains of environmental bacteria isolated from Lake Malta (Poznań, Poland). Studies on living cells showed that polyurethane is not an inert material, but influences bacterial physiology in a strain-specific manner. The key finding is that the adsorption of ciprofloxacin onto the surface of microplastics significantly reduced the antibiotic's toxicity to cellular systems. At the highest concentration tested (500 μg/L), bacterial survival was nearly four times higher in the presence of microplastics than when exposed to the free antibiotic.

These findings highlight the role of polymers as vectors that influence the environmental fate of pharmaceutical pollutants, as well as their impact on the metabolism and survival of microorganisms in contaminated ecological environments.

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Biographical note

Aleksandra Rybak is a PhD student at the Institute of Chemical Technology and Engineering at Poznań University of Technology. Her research is conducted in the field of chemical sciences and focuses on microplastics in the environment and microbiological interactions. Her research interests include the impact of microplastics on microbial communities and environmental processes associated with microplastic pollution.

NANOZYMES AS ALTERNATIVES TO NATURAL ENZYMES IN BIOTRANSFORMATION PROCESSES

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Abstract

Biotransformation processes play a crucial role in modern synthesis of compounds of pharmaceutical and cosmetic relevance, enabling chemical reactions to be carried out under mild conditions and with high selectivity [1]. Traditionally, natural enzymes have been employed in such processes, however, their limited stability, sensitivity to changes in reaction conditions, and relatively high cost restrict their widespread industrial application [2]. In recent years, increasing attention has been devoted to nanozymes, nanomaterials exhibiting enzyme-like catalytic activity which may represent a stable and easily tunable alternative to natural biocatalysts [3].

Within the scope of the study, various types of nanostructures were synthesized, including metallic nanoparticles, metal oxide nanoparticles, and metal-organic framework (MOF) structures containing catalytic centers based on transition metals. In addition, surface functionalization of the obtained nanomaterials with selected ligands was performed, which enabled an increase in both catalytic activity and selectivity.

The obtained nanozymes were subjected to comprehensive physicochemical and morphological characterization using techniques such as scanning electron microscopy (SEM), transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR), energy-dispersive X-ray spectroscopy (EDS), and atomic force microscopy (AFM). The obtained results provide a foundation for further studies on the application of nanozymes as stable and efficient catalysts in biotransformation processes relevant to the pharmaceutical and cosmetic industries.

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Biographical note

Agnieszka Rybarczyk is a PhD student at the Faculty of Chemical Technology at Poznan University of Technology. She is a graduate of the interdisciplinary course Pharmaceutical Engineering, and her main interests are related to pharmaceuticals and the dangers of their release into the environment. She is particularly interested in creating biocatalytic systems for the degradation of pollutants from wastewater, and she is furthering her activities in this area by pursuing her PhD project.

AI-ASSISTED EXPLORATION OF ENZYME CONFORMATION SPACE - CASE STUDY FOR 3-KETOSTEROID DEHYDROGENASE FROM STEROLOBACTERIUM DENITRIFICANS

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Abstract

3-Ketosteroid Δ^1-dehydrogenases are FAD-dependent enzymes involved in steroid 1,2-dehydrogenation. AcmB from *Sterolibacterium denitrificans* is one of two structurally characterised members of this family (PDB 7P18) [1], which exhibits unusually broad substrate specificity. Its putative membrane-associated domain (Y153-R204), located at the active-site entrance, is believed to contribute to substrate recognition. However, crystallography captures only a single geometry, while larger rearrangements affecting steroid binding may be difficult to observe in short conventional molecular dynamics (MD) simulations.

Herein, we evaluated whether BioEmu's AI-generated backbone ensembles can efficiently explore AcmB conformational space, providing stable geometries for downstream MD that differ from those observed in the crystallographic structure. One hundred AcmB backbone conformations were sampled with BioEmu [2]; side chains were reconstructed using H-Packer, FAD was reintroduced from the 7P18 reference; each holo model was minimised by molecular mechanics (MM) in explicit solvent using AMBER24. The structures were assessed using sequence-mapped CαRMSD, radius of gyration, final energy per atom, FAD pose RMSD, and targeted analysis of the Y153-R204 region.

The workflow successfully processed 98/100 models, which mostly remained structurally close to the reference, with median Cα/ FAD RMSDs of 1.19 /0.70 Å. However, one model showed a much larger Cα/ FAD RMSD of 6.53 Å/2.57 Å while preserving the global fold but exhibiting a substantial rearrangement of the FAD-binding/active-site region. Furthermore, domain-level analysis indicated that the Y153-R204 segment was strongly displaced relative to the fitted protein core but remained internally structured, supporting an open-like, hinge-type rearrangement. This observation suggests that BioEmu can generate structurally plausible AcmB conformations that differ substantially from the crystallographic holo state. AI-generated backbone sampling, combined with side-chain reconstruction, cofactor restoration, and MM-based quality control, can provide alternative starting points for MD simulations. In AcmB, the open-like geometry may represent the apo-enzyme structure open for FAD binding.

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Biographical note

Maciej Szaleniec currently holds a professor position and is head of the Joint Laboratory of Biotechnology and Enzyme Catalysis at the Institute of Catalysis and Surface Chemistry, PAS. In his research, he focuses on both experimental and theoretical studies of enzymes from anaerobic bacteria, especially containing Mo/W-cofactors. His research interest includes kinetic studies of enzymes, development of bioreactor processes, and theoretical modelling of reaction pathways for enzymes catalysing regioselective/enantioselective hydroxylation of hydrocarbons, reduction of ketones, dehydrogenation of sterols, oxidation of aldehydes and reduction of carboxylic acids. He published over 70 papers and chapters, obtained several patents and implemented one biotechnological method in the industry.

VALORIZATION OF WASTE APPLE POMACE INTO COSMETIC ACTIVE INGREDIENTS USING MEMBRANE TECHNIQUES

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Abstract

Agri-food waste, particularly residues from fruit and vegetable processing, represents a valuable resource for various industries. It should be noted that fruit and vegetable processing generate both solid by-products and wastewater. In general, waste generated during processing accounts for 10-35% of the raw material [1]. In the case of Poland, which is one of the world's largest producers of concentrated apple juice, an average of 2.5 million tons of waste is generated annually [2]. The largest share of waste generated is apple pomace, which is an unstable material, and its high-water content (up to 73% in apple pomace) can lead to rapid microbiological contamination. Fruit and vegetable pomace is a rich source of many valuable ingredients, such as sugars, proteins, minerals, fiber, lipids, organic acids, vitamins, aldehydes, alcohols, as well as coloring and flavoring substances [3]. Pectin belongs to a group of heterogeneous polysaccharides with a non-uniform structure found in the cell walls of higher plants, especially in fruits. Typically, the technology of obtaining pectin consists of four main stages: preparation of plant material, extraction, separation, and final processing of the product [4]. The pectin precipitation stage is considered the most energy- and emission-intensive step, particularly in terms of CO_2 emissions [4]. Thanks to the use of innovative separation processes belonging to the group of membrane processes, it is possible to effectively pre-concentrate apple extracts and obtain valuable functional ingredients that are the basis of high-class cosmetic raw materials. This study provides an overview of key separation techniques for the recovery of bioactive ingredients, along with the characteristics of the raw materials and selected cosmetic formulations derived from them.

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Biographical note

Mateusz Szczygiełda PhD, since 2022 assistant professor at the faculty of Chemical Technology, Poznan University of Technology. Specialist in membrane technology including bioproduct separation using pressure-, osmotically- and electrically driven membrane processes. His work focuses on developing new membrane bioreactor systems and hybrid processes by the assumptions of the circular economy.

INACTIVATION OF S-SPECYFIC 1-PHENYLETHANOL DEHYDROGENASE FROM *AROMATOLEUM AROMATICUM*

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Abstract

The intricate three-dimensional architecture of enzymes renders them sensitive to environmental factors that can induce structural degradation and progressive loss of catalytic function. Consequently, beyond selectivity, the robustness of biocatalysts under both reaction and storage conditions is a key determinant of their practical applicability. In particular, tolerance to elevated temperatures and non-optimal pH values plays a decisive role.

S-1-phenylethanol dehydrogenase (S-PEDH) from the denitrifying bacterium *Aromatoleum aromaticum* EbN1, a member of the short-chain dehydrogenase/reductase (SDR) family, is a well-established and promising catalyst for the enantioselective synthesis of chiral aromatic alcohols [1]. To better evaluate its applicability, the enzyme's thermal and pH stability were investigated.

Thermal inactivation experiments conducted at pH 9.0 revealed that S-PEDH undergoes a two-step inactivation process. This behavior contrasts with structurally related SDR enzymes, such as S- and R-1-(4-hydroxyphenyl)ethanol dehydrogenases, which follow a simpler "one-step–two-stage" mechanism [2]. Combined analysis of activity loss and aggregation data suggests that conformational changes precede aggregation, indicating that aggregation is a secondary effect rather than the primary cause of enzyme inactivation.

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Biographical note

Patrycja Wójcik is a post-doctoral researcher at the Jerzy Haber Institute of Catalysis and Surface Chemistry of the Polish Academy of Sciences. She obtained her PhD in Chemistry in 2022. Before her current academic position, she gained over 3.5 years of professional experience in the

biotechnology industry. Her research interests include recombinant protein production and purification, protein structural analysis, stability studies, and the investigation of enzyme reaction mechanisms.

ALDEHYDE OXIDOREDUCTASE FROM AROMATOLEUM AROMATICUM - PRODUCTION SCALE UP AND STABILITY ASSESSMENT

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Abstract

Aldehyde oxidoreductases (AORs) are tungsten-containing enzymes that catalyse the oxidation of aldehydes under anaerobic conditions. In *Aromatoleum aromaticum*, $\mathrm{AOR_{Aa}}$ is a complex multi-subunit enzyme composed of a catalytic W-containing subunit, an iron-sulfur cluster-containing subunit, and a FAD-containing subunit. Structural studies have shown that it can assemble into filamentous, nanowire-like structures with catalytic subunits arranged along the protein scaffold [1].

This study aimed to scale up the production of recombinant $\mathrm{AOR_{Aa}}$ in *A. evansii*, improve its stability for crystallisation studies, and evaluate its tolerance to organic solvents.

Optimisation of cultivation and purification processes resulted in a nearly twofold increase in enzyme yield, reaching over 100 mg of purified protein from a 33 L fermentor. This improvement was achieved by shortening the lag phase through inoculation with a high-density preculture, monitoring redox potential as a guide for nitrate feeding, and inducing enzyme overexpression at a higher optical density.

The analysis by nanoDSF revealed two distinct melting transitions under standard conditions, with melting temperatures ($\mathrm{T_m}$) of 43.9°C and 64.9°C. Although AOR is composed of three subunits, only two thermal transitions were observed, which is attributed to overlapping unfolding events of domains with similar thermal stability. The addition of sorbitol and glucose at 10% increased the first $\mathrm{T_m}$ by more than 4°C, indicating enhanced stability of the less thermostable domain. In contrast, aliphatic alcohols markedly decreased thermal stability even at 5%, whereas DMSO was well tolerated with minimal effects up to 10%.

Overall, this work demonstrates the successful scale-up of recombinant $\mathrm{AOR_{Aa}}$ production and provides valuable insights into its stability and solvent compatibility, supporting its further use in crystallographic and biocatalytic studies.

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Biographical note

Patrycja Wójcik is a post-doctoral researcher at the Jerzy Haber Institute of Catalysis and Surface Chemistry of the Polish Academy of Sciences. She obtained her PhD in Chemistry in 2022. Before her current academic position, she gained over 3.5 years of professional experience in the biotechnology industry. Her research interests include recombinant protein production and purification, protein structural analysis, stability studies, and the investigation of enzyme reaction mechanisms.

FORMATION OF BIOINSPIRED CHITIN@SILICA CORE-SHELL CAPSULES FOR CONTROLLED DELIVERY OF RISEDRONATE

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Abstract

Chitin, an abundant and renewable biopolymer largely derived from waste, offers strong potential for biomedical applications [1], though its use is limited by poor solubility [2]. This study aimed to develop chitin and chitosan-based carriers for the controlled delivery of sodium risedronate, a drug used in osteoporosis treatment. Ionic liquids enabled the processing of chitin into composite hydrogels, which were further modified with a biomimetic SiO_2 coating to regulate drug release. The obtained carriers were dried using both conventional and supercritical CO_2 methods, influencing their structural properties. FTIR and SEM analyses confirmed successful material formation and surface modification. The ionic liquid was recovered and evaluated by ^1H NMR and coulometric analysis, demonstrating its reusability. Drug release studies under simulated gastrointestinal conditions showed sustained and pH-dependent release, with release curves obtained via UV spectroscopy. The presence of the SiO_2 layer significantly reduced the release rate. Overall, the system demonstrates a promising, sustainable approach for controlled drug delivery with tunable release behavior.

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BIOMEMBRANE PLATFORMS FOR SIMULTANEOUS SEPARATION AND ENZYMATIC PROCESSING OF MICROPLASTICS

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Abstract

Efficient removal of organic matter without altering polymer particles is required for the analysis of microplastics in complex environmental matrices. In this study, we developed and evaluated biomembrane platforms that enable the simultaneous separation and enzymatic processing of microplastic samples as an integrated tool for sample preparation. Enzymatic digestion is increasingly recognised as a more selective and less destructive alternative to the harsh chemical treatments typically employed in microplastic isolation [1, 2]. This study focuses on fabricating biocatalytic membranes with immobilised enzymes that can degrade lipids, proteins and cellulose while maintaining suitable filtration performance.

Membrane properties before and after enzyme immobilisation were characterised using surface charge measurements (SurPASS 3, Anton Paar), water contact angle analysis (DSA100E, Krüss), scanning electron microscopy (Phenom ProX G6, Thermo Scientific) and atomic force microscopy (Park NX10, Park Systems). Filtration performance, including pure water flux and flux recovery after fouling, was evaluated using a dead-end Amicon 8010 filtration cell operated with synthetic air at pressures of 100-400 mbar.

Morphological and spectrophotometric analyses confirmed successful enzyme immobilisation on the membrane surface while maintaining stable membrane flux. A slightly higher total amount of enzymes was immobilised on the Au-based membrane (166.5 mg) compared to the Al-based membrane (164 mg). Among the analysed enzymes, lipase and laccase exhibited the highest immobilisation levels on both membranes. Similar trends in enzyme loading and immobilisation efficiency for both materials suggest comparable chemical interactions between enzymes and membrane surfaces. The slightly higher enzyme deposition on the gold membrane may result from its lower hydrophilicity, promoting stronger hydrophobic interactions with enzymes.

The developed biocatalytic membranes were further evaluated for microplastic sample preparation using LDIR 8700 (Agilent) and model mixtures containing lipids, proteins and cellulose. The results demonstrate the potential of biomembrane systems as multifunctional platforms enabling combined filtration and enzymatic treatment for improved microplastic sample preparation.

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Biographical note

Dr Agata Zdarta's research focuses on biodegradation processes, microbial interactions with pollutants and the design of functional materials for environmental biotechnology. The focus of her current work is the development of biocatalytic systems, including enzyme-functionalised membranes for applications in microplastic sample preparation and analysis. She is the author of numerous peer-reviewed publications, has received national research grants, and actively leads projects on biomembrane systems for microplastic sample preparation. She is developing advanced enzyme-functionalised membrane systems for catalytic and separation processes, which contribute to improved analytical methods for complex environmental samples and advance the field of applied biocatalysis.

OPTIMIZATION OF THE CHEMICAL SYNTHESIS OF METHYL 3-FORMYL-5-METHYLHEXANOIC ACID AS A PRECURSOR IN PREGABALIN SYNTHESIS

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Abstract

Pregabalin, also known as (S)-3-(aminomethyl)-5-methylhexanoic acid, is a compound classified as an analogue of γ-aminobutyric acid [1]. It works by inhibiting excitatory neurotransmission in the central nervous system. The drug is commonly used to treat epilepsy, neuropathic pain, fibromyalgia, and generalized anxiety disorder. Its therapeutic efficacy is mainly due to its high selectivity, as only the S-enantiomer is responsible for its pharmacological activity [2].

In recent years, biocatalysis, which employs enzymes to carry out chemical reactions, has gained increasing importance in the synthesis of active pharmaceutical ingredients. An example of industrial biocatalysis could be the enantioselective synthesis of (S)-pregabalin using ω-transaminase, which may play a key role in generating the desired stereoisomer.

In this study, the first stage of the synthesis of an intermediate compound used in the subsequent steps of pregabalin production methyl 3-formyl-5-methylhexanoate was carried out. The aim of the study was to analyse the effect of reaction conditions, particularly the molar ratio of 4-methylpentanal to methyl bromoacetate, on the degree of substrate conversion, process yield, and the purity of the obtained product. The obtained results showed that changes in the ratio of reagents have a significant impact on the efficiency of the synthesis. The findings indicate that proper optimization of the conditions in the early stages of synthesis is crucial for the course of subsequent chemical transformations. The quality and purity of the obtained intermediate compound directly affects the efficiency of enzymatic hydrolysis and, consequently, the overall effectiveness of the pregabalin synthesis process.

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PhD in chemical sciences in 2017 and became associate professor in 2021. Completed postdoctoral internships at Technical University of Denmark and research training at University of Technology Sydney. Author of over 140 JCR-indexed publications and 20 book chapters, principal investigator of numerous national research projects, and recipient of the Minister's scholarship for outstanding young scientists.

SCALING UP THE BIOTRANSFORMATION OF EPOXYPHOSPHONATES USING CYANOBACTERIA

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Abstract

Cyanobacteria represent a promising class of biocatalysts due to their unique metabolic pathways and photosynthetic capabilities [1]. Whole cyanobacterial cells were applied in biotransformation of phosphonates, which are a class of compounds with wide applications in the pharmaceutical and agricultural industries. The biosynthesis of phosphonate building blocks remains a challenge, because their inhibitory properties often impede process scale-up.

In this study, a comprehensive screening of various cyanobacterial strains was conducted to evaluate their catalytic activity toward a model epoxyphosphonate [2]. The most potent strains identified during the initial screening were selected for further scale-up investigations. To determine the limits of biocatalytic efficiency, substrate concentrations were incrementally increased to 2 mM, 5 mM, and 10 mM. In parallel, toxicity assays were performed to assess the impact of the substrate on cellular viability. Finally, the process was transitioned to a semi-preparative scale using a 1 L bioreactor. These results demonstrate the differential sensitivity of cyanobacteria strain to phosphonates and the feasibility of using cyanobacteria for the synthesis of organophosphorus compounds on a larger scale. Presented work highlights the potential of cyanobacteria to serve as a sustainable alternative for the production of high-value phosphonates, minimizing the environmental footprint of synthesis.

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