5th Youth Scientific Session

"BioMedicine and Quality of Life"

4–5 December 2025, IBPhBME-BAS

BMQL '2025

Book of Abstracts

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Foreword

Dear young researchers – students, doctoral candidates, postdoctoral researchers,
Dear colleagues,

It is a true pleasure for me to welcome you to the opening of the Fifth Youth Scientific Session *"Biomedicine and Quality of Life"*, organized by the Institute of Biophysics and Biomedical Engineering – one of the leading research institutes within the scientific field "Biomedicine and Quality of Life" at the Bulgarian Academy of Sciences. With this edition, we mark our first anniversary, and the full auditorium gives me every reason to define this session as a highly anticipated event for you, one that is making a strong statement toward becoming a traditional celebration of youth and knowledge.

In the current edition of the Youth Session, we once again observe an increase in the number of young scientists who have applied and been accepted for participation – students, doctoral candidates, and postdoctoral researchers. We are proud to share that more than 130 participants will take part in the Fifth Youth Scientific Session *"Biomedicine and Quality of Life"*, with their research achievements presented by over 25 young scientists through oral or poster presentations.

We warmly welcome young scientists from numerous institutes of the Bulgarian Academy of Sciences that traditionally participate in the scientific forums organized by our Institute. With great pleasure, I share that young scientists from 5 out of the 6 institutes within our scientific field will take part in the Youth Scientific Session "*Biomedicine and Quality of Life*", including: the Institute of Molecular Biology "Acad. Rumen Tsanev", Institute of Microbiology "Stephan Angeloff", the Institute of Neurobiology, the Institute of Experimental Morphology, Pathology and Anthropology with Museum, the Institute of Plant Physiology and Genetics, the Institute of Organic Chemistry with Centre of Phytochemistry, the Institute of General and Inorganic Chemistry, the Institute of Polymers, the Institute of Physical Chemistry "Acad. Rostislaw Kaischew", the Institute of Optical Materials and Technologies, and the Institute of Solid State Physics.

Young scientists from the most prestigious universities will also present their scientific achievements – Sofia University "St. Kliment Ohridski", Medical University – Sofia, the University of Chemical Technology and Metallurgy, the Technical University, the University of National and World Economy, New Bulgarian University, as well as colleagues from Plovdiv University "Paisii Hilendarski", Burgas State University "Prof. Dr Assen Zlatarov", South-West University "Neofit Rilski" – Blagoevgrad, and Trakia University – Stara Zagora. This reflects a significant expansion of the geographical reach of those wishing to participate in the Youth Scientific Session "*Biomedicine and Quality of Life*". We also welcome young researchers from the First Municipal Hospital – Sofia, Vistamed Medical Center, *Medical Complex "D-r Shterev",* Medical Center Markovs, as well as a representative of VMware.

All young scientists participating in the Session, together with their scientific supervisors, will have the opportunity to share the pleasure of attending the eagerly anticipated lectures delivered by the guest speakers invited by the Program and Organizing Committees. On behalf of the Session organizers, I would

like to express our deep gratitude to the distinguished scientists from Bulgaria and abroad who wholeheartedly accepted our invitation to share their invaluable experience and achievements with the new generation of Bulgarian scientists in the field of "*Biomedicine and Quality of Life*".

Within the scientific program of the Fifth Youth Session, we will have the pleasure of hearing lectures by established researchers such as Prof. Ivanka Dimova from the Medical University – Sofia; Assoc. Prof. Yordan Georgiev from Burgas State University "Prof. Dr. Assen Zlatarov"; Assoc. Prof. Maya M. Zaharieva from the Institute of Microbiology "Stephan Angeloff" – BAS; Assoc. Prof. Tonya Andreeva from the Institute of Biophysics and Biomedical Engineering – BAS and Reutlingen University, Germany; Sen. Assist. Prof. Kolyo Dankov, who completed his doctoral studies at our Institute and is currently at Sofia University "St. Kliment Ohridski"; Sen. Assist. Prof. Nia Z. Petrova from the Institute of Biophysics and Biomedical Engineering – BAS and the Institute of Plant Biology at the HUN-REN Biological Research Centre in Szeged, Hungary; as well as Assoc. Prof. Vassia Atanassova from the Institute of Biophysics and Biomedical Engineering – BAS, Assoc. Prof. Justine Toms from New Bulgarian University, and Sen. Assist. Prof. Ana Lazarova from Sofia University "St. Kliment Ohridski" and the Digital Republic Association, who will serve as panelists in the highly topical discussion "AI in Science".

The main organizer of the Fifth Youth Session is the Institute of Biophysics and Biomedical Engineering; however, the Session would not have been possible without the kind support of the Union of Scientists in Bulgaria and the companies LabPrim Ltd., Labco Ltd., and FOT Ltd., with whom we share long-standing and fruitful cooperation.

With this edition of the Youth Session, another tradition is being firmly established – namely, the organization of this Session being entrusted to an Organizing Committee composed primarily of young scientists. Allow me to express my sincere gratitude to the Chair of the Organizing Committee, Assoc. Prof. Simeon Ribagin, and to share my satisfaction with the work of all young scientists in the Organizing Committee. Working with such enthusiastic, energetic, and creative young people is extremely inspiring and rejuvenating. In the event of any minor shortcomings in preparation or unforeseen challenges during the conference days, we kindly ask for your understanding, as these are related to our efforts to create a distinctive and genuinely youth-focused scientific session.

I most sincerely wish you highly productive conference days!

Best wishes for success to the Fifth Youth Scientific Session *"Biomedicine and Quality of Life"*!

Prof. Tania Pencheva,PhD
Chair of the BMQL'2025 Programme Committee

Invited Speakers

Influence of Adsorbed Small Bioactive Molecules on the *in vitro* Immunomodulatory Effects of Herbal Polysaccharides

Yordan Georgiev[1,2*], Manol Ognyanov[1], Vesselin Kussovski[3], Daniela Antonova[1], Petko Denev[1], Desislava Teneva[1], Daniela Pencheva[1], Vasil Georgiev[3]

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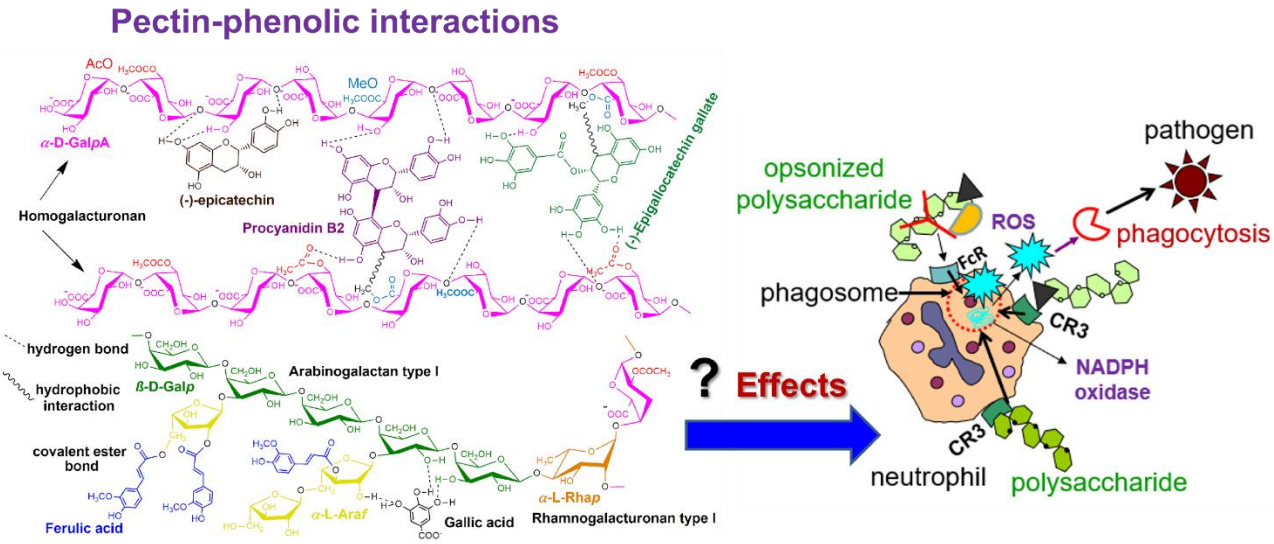
The study aimed to identify noncarbohydrate compounds adsorbed to structurally characterized PS complexes (PSCs) from *Tilia tomentosa* L., *Lavandula angustifolia* Mill., *Portulaca oleracea* L. and *Haberlea rhodopensis* Friv., and to investigate their influence on the *in vitro* antioxidant and complement-fixing activities of the initial PS samples. Combining in pairs of the PSCs from linden, lavender and purslane led to synergism in the complement-fixing activity via the alternative pathway ($IC_{50} \leq 45$ µg/mL). The activity of the derived PS fractions was increased through both pathways. The PSCs contained acetylated and methylesterified pectins with a total carbohydrate content between 56 and 89.4%. Linden and lavender pectins adsorbed during extraction of hydrocarbons, fatty acids, smaller sugars, phytosterols, triterpenic acids, phenolic acids, flavonoids, phenylpropanoids, amino acids, etc. Phenolics contributed positively and fatty acids negatively to the expression of a complement-fixing activity by the initial PSCs through the classical pathway. Lavender pectins formed antioxidant complexes with catechins. *Haberlea* pectins adsorbed 3,4-dihydroxybenzoic, vanillic acids, quercetin, naringin, and kaempferol in very small quantities, but myconoside was found in the largest quantity (179.5 mg/100 g). *Haberlea* PSs and myconoside contributed 9.1% and 58.3% to the obtained total ORAC antioxidant activity of the PSC (1304.3 ± 3.6 TE/g). The identified herbal complexes could serve as natural complement regulators in conditions of compromised immune health and oxidative stress.



Acknowledgement

Project BG161PO003-1.1.05-0024-C0001, Grant №DFNP-17-62/July 26, 2017, and Bilateral grant agreement between the BAS and CAS (2020-2022).

Curriculum Vitae

Assoc. Prof. Yordan Georgiev, PhD, is a lecturer in Biochemistry at the Medical Faculty of the "Prof. Dr. Assen Zlatarov" State University of Burgas and Associated member at the Bulgarian Academy of Sciences. He has defended his PhD degree in Chemistry in 2018 at the Institute of Organic Chemistry with Centre of Phytochemistry. In 2022, Dr. Georgiev was honored with the Young Scientist Award "Prof. Marin Drinov" in "Biomedicine and quality of life" at the Bulgarian Academy of Sciences. In 2023, he was awarded the Pythagoras Young Scientist Grand Prize in the field of Natural sciences and Engineering by the Ministry of Education and Science in Bulgaria. His research interests are focused in studying of the biochemical mechanisms of immunomodulation with polysaccharides and their anti-inflammatory effects, isolation and characterization of antioxidant metabolites from natural origin and their application in functional and dietary nutrition, as well as regulation of enzymes with clinical significance. His scientific papers in co-authorships have been cited more than 618 times with h-index=14, according to Scopus (November 2025). Dr. Georgiev has specialized in Germany, Japan, Czech Republic and Norway.

The Way to the Next Generation Reproductive Genetics

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Reproductive genetics is a field that connects reproductive and genetic technologies, using all the achievements of genetics, with the aim of diagnosing and choosing the most appropriate treatment for infertility, as well as preventing the birth of a child with congenital anomalies and genetic diseases. The Human Genome Project was launched as a massive scientific effort to create a reference map of the human genome. Thanks to technological advances, genetic tests are becoming increasingly relevant in reproductive medicine, where they have three main purposes: identifying the causes of infertility; identification of genetic diseases transmitted to offspring; optimizing assisted reproductive technology (ART). The standard genetic testing algorithm for infertility research currently includes chromosomal analysis, microdeletions of the Y-chromosome, and molecular genetic studies of certain mutations, such as congenital thrombophilias and CFTR. Strategies based on NGS (next-generation sequencing) offer the opportunity not only to optimize genetic testing in reproductive medicine (since in one step it may be possible to analyse potential causes of infertility, carry out carrier screening and to support ART), but also to adapt the therapeutic solution to the specific genomic characteristics of the patients. The challenge for future medicine is to move from a population-based approach to an individual-based approach. New technologies are driving this revolution. In recent years, new single-cell genomics methods have emerged that have revolutionized our ability to identify and characterize the cells that make up complex tissues. The Human Cell Atlas (HCA) project was launched as an international collaborative effort to create comprehensive reference maps of all human cells – the basic units of life – as a basis for both understanding human health and diagnosing, monitoring and treatment of diseases. Using advances in sequencing technologies, this project has the ambitious goal of profiling cellular transcriptomes, along with their spatial determination, to map the identified cell types onto the tissue architecture of the human body. This information will give an unprecedented impetus to the development of all medicine.

Acknowledgement

Grant No 9546/26.11.2024, Council of Medical Science, Medical University of Sofia.

Curriculum Vitae

Prof. Ivanka Dimova has been working at the Department of Medical Genetics at the Medical University of Sofia since 2001. She obtained her PhD in Medicine in the field of genetics in 2006 after successfully defending a dissertation entitled “Genetic Characterization of the Different Types of Ovarian Tumors“.

Prof. Dimova has specialized in a number of leading international centers, including the University of Montpellier (France), the University of Cambridge (United Kingdom), Wiesbaden (Germany), and Istanbul Medical University (Türkiye). She has worked as a researcher at the University of Fribourg and the University of Bern (Switzerland). She has more than 100 publications with over 500 citations in prestigious international scientific journals and has participated in more than 20 research projects. The main areas of Prof. Dimova's scientific interests are focused on oncogenetics, congenital malformations, reproductive genetics, and the genetic basis of complex diseases. She introduced for the first time in Bulgaria the DNA microarray analysis method, which is an indispensable tool in the diagnosis of children with developmental abnormalities.

Surface Adaptation, Characterization and Modeling of Patient Specific Additively Manufactured Permanent and Bioresorbable Implants Based on *in vivo*, *in vitro*, and *in silico* Methods

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The primary objective of our Intelligent Surfaces group within the DFG Research Unit 5250 is the development and application of advanced surface coatings aimed at functionalizing and enhancing the biocompatibility of additively manufactured implants. Our work contributes to the overarching goal of Research Unit 5250, which is to establish and validate an innovative, integrated strategy for the manufacturing, characterization, and simulation-based design of customized, patient-specific implants produced by additive manufacturing.

During the first funding period, the research focused on permanent Ti6Al4V implants for dental applications. The work began with the development of gyroid structures designed to minimize stress shielding using novel triply periodic minimal surface (TPMS) architectures and topology optimization. Since additively manufactured surfaces typically exhibit high process-induced roughness and porosity, particularly within gyroid architectures, a dedicated surface optimization protocol was established, including sand-blasting and acid etching. Subsequently, uniform surface coatings were applied in order to enhance biocompatibility and promote effective interactions with surrounding tissues. Optimizing the implant surface is essential to improving early-stage osseointegration and ensuring long-term implant stability. In this context, the cytocompatibility of various additively manufactured titanium alloys, including those with innovative coatings, was evaluated using standard and extended *in vitro* analysis techniques as well as *in vivo* biocompatibility assessments in accordance with the 3Rs principle.

In the second funding period, the same integrative methodology is being transferred to the development of an innovative bioresorbable implant based on magnesium alloy. The overarching vision is to unlock the clinical potential of bioresorbable additively manufactured magnesium implants. To this end, essential findings on TPMS structures from the first funding period are being translated to the magnesium alloy WE43. A particular focus lies on tailoring the degradation behaviour in relation to mechanical stability, biomechanical development and validation in biological model systems, as well as *in silico* modelling to predict implant performance. By addressing existing research gaps in degradation control, mechanical robustness, surface functionalization, and *in vivo* compatibility, the project aims to pave the way toward the clinical translation of bioresorbable implant systems.

Acknowledgement

The authors gratefully acknowledge the funding by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) for the Research Unit 5250 “Mechanism-based characterization and modeling of permanent and bioresorbable implants with tailored functionality based on innovative *in vivo*,

in vitro and *in silico* methods" (project no. 449916462). All subprojects are deeply acknowledged for the manufacturing, coating, testing, and modeling of the implant materials and structures within the framework of an excellent scientific collaboration.

Curriculum Vitae

Assoc. Prof. Tonya Andreeva, PhD, is a specialist in materials science with a focus on biomaterials, surface characterization and modification, and interactions at the material–tissue interface. She obtained her PhD in biophysics at the Institute of Biophysics and Biomedical Engineering, Bulgarian Academy of Sciences (BAS), where she subsequently continued her academic career. In 2016, she was appointed Associate Professor at the same institute of BAS. Over the past seven years, she has been working as a researcher and project leader at Reutlingen University, Germany. Her research interests are centered on the design and characterization of functional thin films, polymer-based coatings, and surface modification strategies for metallic and polymeric biomaterials. A significant part of her work is dedicated to investigating cell-material interactions, platelet adhesion and activation, as well as protein adsorption processes on biomaterials. Assoc. Prof. Andreeva has participated in numerous national and international research projects, as well as projects carried out in direct collaboration with medical device manufacturing companies, within which she has developed innovative coatings to improve implant biocompatibility. She supervises PhD and MSc students and is actively involved in teaching courses in biomaterials and biocompatible coatings.

Bioelectricity Production and Photosynthetic Characterization of the Highly Exoelectrogenic Green Alga *Parachlorella kessleri* MACC-38

Nia Z. Petrova[1], Soujanya Kuntam[1], Milán Szabó[1], Kashif Shaikh Mohd[1], Gyula Kajner[2], Gábor Galbács[2], Szilvia Z. Tóth[1]

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Exoelectrogenesis is a term denoting the electron export out of living cells. Algae inherently combine exoelectrogenesis with photosynthesis which makes them an excellent choice as a living partner in bio-hybrid devices for transformation of light into electric current in biophotovoltaics or for electrosynthesis.

We recently identified a green algal strain Parachlorella kessleri MACC-38 with exceptional exoelectrogenic properties. MACC-38 is capable of producing up to 10 times higher ferricyanide-mediated electric current than model green alga Chlamydomonas reinhardtii. In our current work, we aim to reveal particular photosynthetic characteristics of this strain that sustain such massive electron export and possibly mitigate its effect on cellular redox state.

We found that, in MACC-38, light-induced current is sustained not only by the photosynthetic electron transport chain (PETC), but also by the oxidative pentose phosphate pathway (OPPP). Together PETC and OPPP provide reducing power for electron export in the form of NADPH. However, the activation of OPPP leads to over-saturation of PETC. Interestingly, we found that another specific trait of MACC-38 is its heavy reliance on chlororespiration (mediated by the plastid terminal oxidase, PTOX) to mitigate the oversaturation of PETC.

Our work provides the first insights into the physiological mechanisms of increased light-induced electric current production in green algae and paves the way towards new strategies to maximize solar energy capture.

Curriculum Vitae

Dr. Nia Petrova is a researcher at the Institute of Plant Biology, Centre for Biological Research, Szeged, Hungary. In 2020, she defended her PhD dissertation entitled “Structural Stability and Intermolecular Interactions of the Major Light-Harvesting Complexes in Higher Plants and Cyanobacteria” at the Institute of Biophysics and Biomedical Engineering, Bulgarian Academy of Sciences. Her PhD supervisors were Prof. Sashka Krumova and Prof. Stefka Taneva.

Her research focuses on the study of photosynthesis in higher plants and algae, employing a range of biophysical and biochemical methods. Currently, Dr. Petrova’s scientific interests are centered on the biotechnological applications of photosynthetic microorganisms, with particular emphasis on the use of green microalgae in biohybrid devices for the conversion of light energy into electricity (biophotovoltaics).

Applied Biophysical Methods in Astrobiology

Kolyo Dankov

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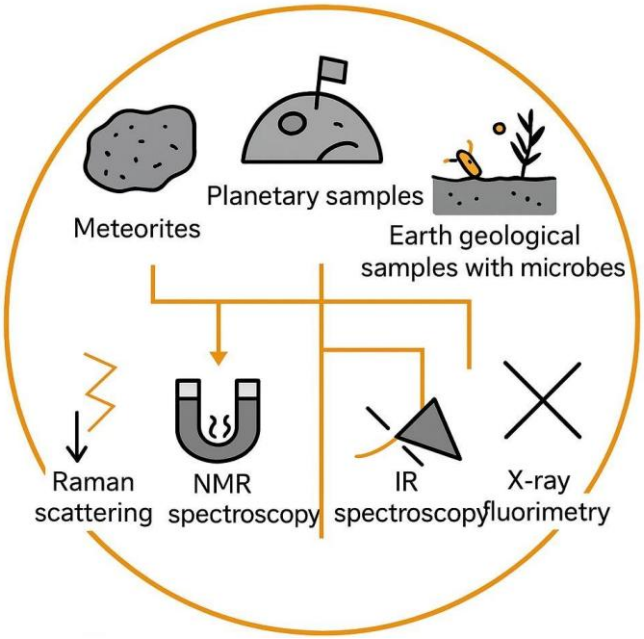
The search for life beyond Earth increasingly relies on biophysical methods capable of detecting subtle chemical and structural signatures associated with extremophile microorganisms and prebiotic organic matter. Among these, Raman spectroscopy has emerged as a core analytical tool due to its non-destructive nature, sensitivity to molecular vibrations, and capacity to identify both inorganic and organic phases in complex geological matrices. In astrobiology, Raman techniques enable the detection of extremophile biosignatures—such as pigment molecules, carotenoids, and cell-wall components—while simultaneously mapping mineralogical contexts that may preserve or enhance these signatures. A promising application is the characterization of carbon phases in meteorites, where Raman spectral parameters provide insight into graphitization, thermal history, and organic matter contributions. Such measurements have been performed extensively in laboratory settings and are now incorporated into modern planetary exploration missions, including rover-based Raman instruments designed to analyze Martian sediments *in situ*.

Complementary biophysical methods further enhance the detection and interpretation of potential extraterrestrial biosignatures. Solid-state and solution NMR spectroscopy allow high-resolution identification of organic compounds in meteorites, including amino acids, polyaromatic structures, and other complex carbonaceous materials whose composition and isotopic characteristics may indicate prebiotic or biogenic origins. X-ray fluorimetry provides elemental mapping critical for assessing mineral microenvironments that could sustain or preserve life-related chemistry, while infrared spectroscopy expands molecular detection capabilities by probing functional groups, hydration states, and mineral–organic interactions relevant to microbial survival strategies. Together, these approaches create a multidimensional analytical framework capable of operating both in controlled laboratory environments and aboard space probes, landers, and rovers.



By integrating Raman spectroscopy with NMR, X-ray–based techniques, IR spectroscopy, and additional biophysical modalities, contemporary astrobiology is increasingly able to detect, validate, and contextualize potential biosignatures. This synergistic use of biophysical tools advances our understanding of extremophile survivability, helps the design of future planetary space missions, and enhances our ability to recognize potential traces of life in extraterrestrial materials.

Curriculum Vitae

Kolyo Dankov is a Senior Assistant Professor in the Department of Biophysics and Radiobiology at the Faculty of Biology of Sofia University "St. Kliment Ohridski." He holds a PhD in the biophysics of photosynthesis from the Institute of Biophysics and Biomedical Engineering of the Bulgarian Academy of Sciences.

His main scientific interests are in the fields of quantum biology and photobiology, the biophysics of photosynthesis, astrobiology and astrochemistry, meteoritics, and planetary geology. He teaches courses in meteorite analysis, biophysical methods in astrobiology, molecular biophysics, and cosmic rays and cosmogenic nuclides in the master's programs in Astrobiology, Biophysics, and Radiobiology at the Faculty of Biology of Sofia University.

Photodynamic Inactivation of Bovine Coronavirus with the Photosensitizer Toluidine Blue O

Maya M. Zaharieva[1,*], Pelagia Foka[2], Eirini Karamichali[2], Alexander D. Kroumov[1], Stanislav Philipov[3], Yana Ilieva[1], Tanya Chan Kim[1], Petar Podlesniy[4], Yordan Manasiev[1], Vesselin Kussovski[1], Urania Georgopoulou[2], Hristo M. Najdenski[1]

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Coronaviruses (CoVs) belong to the group of enveloped positive-sense single-strand RNA viruses and are causative agents of respiratory, gastrointestinal, and central nervous system diseases in many host species, i.e., birds, mammals, and humans. Beta-CoVs revealed a great potential to cross the barrier between species by causing three epidemics/pandemics among humans in the 21st century. Considering the urgent need for powerful antiviral agents for decontamination, prevention, and treatment of BCoV infections, we turned our attention to the possibility of photodynamic inactivation with photosensitizers in combination with light irradiation. In the present study, we evaluated, for the first time, the antiviral activity of toluidine blue O (TBO) against Beta-coronavirus 1 (BCoV) in comparison to methylene blue (MB). First, we determined the *in vitro* cytotoxicity of MB and TBO on the Madin–Darby bovine kidney (MDBK) cell line with ISO10993-5/Annex C. Thereafter, BCoV was propagated in MDBK cells, and the virus titer was measured with digital droplet PCR, $TCID_{50}$ assay and plaque assay. The antiviral activity of non-toxic concentrations of TBO was estimated using the direct inactivation approach. All effects were calculated in MAPLE 15® mathematical software by developing programs for non-linear modeling and response surface analysis. The median inhibitory concentration (IC_{50}) of TBO after 72 h of incubation in MDBK cells was 0.85 µM. The antiviral activity of TBO after the direct inactivation of BCoV (MOI = 1) was significantly stronger than that of MB. The median effective concentration (EC_{50}) of TBO was 0.005 µM. The cytopathic effect decreased in a concentration-dependent manner, from 0.0025 to 0.01 µM, and disappeared fully at concentrations between 0.02 and 0.3 µM of TBO. The number of virus particles also decreased, depending on the concentration applied, as proven by ddPCR analysis. In conclusion, TBO exhibits significant potential for direct inactivation of BCoV *in vitro*, with a very high selectivity index, and should be subjected to further investigation, aiming at its application in veterinary and/or human medicinal praxis

Curriculum Vitae

Assoc. Prof. Maya Zaharieva graduated from the Faculty of Pharmacy at the Medical University of Sofia, Bulgaria, obtaining a Master's degree in Pharmacy. In 2008, she was awarded the educational and scientific degree "Doctor" (PhD) in the scientific specialty "Pharmacology". In 2001, she received a graduate student scholarship and a DAAD doctoral scholarship for specialization at the German Cancer Research Center (DKFZ) in Heidelberg, Germany. She has also completed specialized training at the Institute for Agricultural

and Fisheries Research in Belgium. Prof. Zaharieva is the Head of the Laboratory of Cytotoxicity and Signal Transduction at the Institute of Microbiology "Stephan Angeloff", Bulgarian Academy of Sciences. She is the author of more than 80 scientific publications and has over 1,400 citations in peer-reviewed scientific journals. Assoc. Prof. Zaharieva's main research interests are related to molecular biological identification of foodborne pathogens; antimicrobial resistance; antimicrobial activity and cytotoxicity of compounds of natural and synthetic origin; infections and neoplasms; and bacteria–host interactions. Her work focuses on the development of novel molecular biological methods for the identification of potentially hazardous pathogenic bacteria in drinking and wastewater, river sediments and deposits, as well as on advanced molecular biological techniques for the detection of pathogenic bacteria and fragments of their genome in wastewater, including the identification of antimicrobial resistance genes.

Youth Session: Oral Presentations

Metabolite Profiling of *Rhodiola rosea* L. from Two Different Localities in Bulgaria

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Rhodiola rosea L. is the most popular plant species among family Crassulaceae acting as adaptogen and possessing antidepressant, anti-inflammatory, anti-cancer, cardio- and neuroprotective [1], as well as immune stimulating activities [2]. The most valuable molecules in this plant are the phenylethanoids and phenylpropanoids, found in its rhizomes, which are the principal raw materials widely applied in traditional and contemporary medicine [3]. The compounds in *R. rosea* account for approximately 140 in total. However, in spite of its broad use there is still insufficient knowledge concerning the natural variability in secondary metabolite levels.

The aim of this work was to report the metabolite difference in the rhizomes of *R. rosea* naturally grown in Bulgaria from two different habitats. Nuclear magnetic resonance (NMR) metabolite profiling in combination with high performance liquid chromatography (HPLC) for structural identification and quantification were applied. It was found that the main compounds in the rhizomes were p-tyrosol, salidroside, rosin, rosavin and rosarin. The content of the metabolites (salidroside, p-tyrosol, rosarin, rosavin and rosin) in the dry biomass was as follows: 1.46±0.06 and 1.25±0.00; 0.45±0.06; 0.14±0.01 and 0.44±0.08; 1.78±0.13 and 1.33±0.02; 0.46±0.04 and 0.17±0.01 %, while the total rosavins were 2.39±0.30 and 1.95±0.11%.

The estimated amounts of salidroside and rosavins in our study are high enough to fulfill the requirements of the Russian (0.8-1% salidroside and 3% rosavins) and US Pharmacopoeia (0.08% salidroside and 0.3% of rosarin, rosavin and rosin calculated as rosavin. For that reason, we consider that the plant extracts obtained from *R. rosea* wild collected in Bulgaria are of adequate enough quality and it can be assumed that they are potentially able to manifest health benefits.

Keywords

Golden root, NMR-based metabolomics, High performance liquid chromatography.

Acknowledgements

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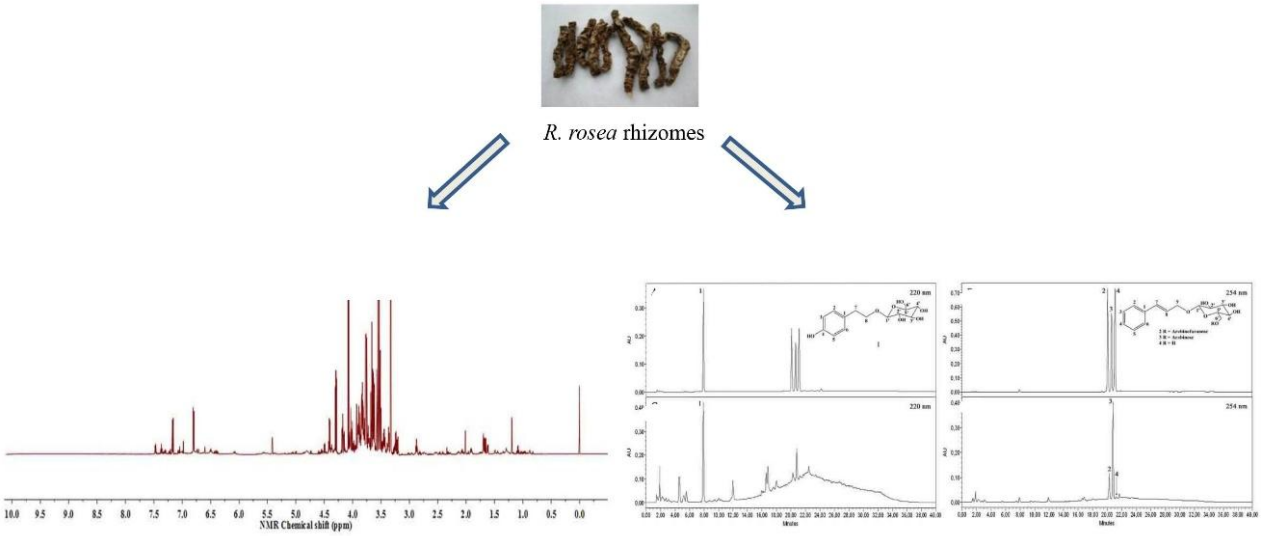

Identification of the main secondary metabolites from *R. rosea* by ^{1}H NMR-based metabolomics and quantitative determination by HPLC

Anti-Coronavirus Activity of Bulgarian Plant Extracts Loaded in Liposomal Nanocarriers Stabilized with Chitosan

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This study explores the potential to encapsulate multi-component plant extracts in liposomes as optimized delivery systems and to verify if they exert inhibitory effects against human seasonal betacoronavirus OC43 (HCoV-OC43) *in vitro*. The BALB 3T3 neutral red uptake (NRU) phototoxicity/cytotoxicity assay was used to estimate compounds' safety. Photo irritation factors (PIFs) of the liposomes containing extracts were < 2 which assigned them as non-phototoxic substances. The antiviral capacities of liposomes containing medicinal plant extracts against HCoV-OC43 were measured by the cytopathic effect inhibition test in susceptible HCT-8 cells. The antiviral activity increased by several times compared to "naked" extracts' activity reported previously. *A. Hippocastanum* extract showed 16 times higher inhibitory properties reaching a selectivity index (SI) of 58.96. Virucidal and virus-adsorption effects were investigated using the endpoint dilution method and Δlgs comparison with infected and untreated controls. The results confirmed that nanoparticles do not directly affect the viral surface or cell membrane, but only serve as carriers of the active substances and the observed protection is due solely to the intracellular action of the extracts.

Keywords

Natural extracts, Chitosan, Liposomes, Encapsulation, Drug release, Coronavirus HcoV-OC43, Antiviral activity, Natural inhibitors of viral replication, Cytotoxicity, Phototoxicity.

Acknowledgements

The authors thank Extractpharma Ltd. and Eng. Marin Penkov, for the provided extracts, which are part of a wide range of products of Extractpharma Ltd. and Mirta-Medicus Ltd. offered commercially. The authors greatly acknowledge Ilina Amer, for the article's linguistic revision.

Funding

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Plant Species		Area of the Collected Material	Biological Activities
Aesculus hippocastanum (horse chestnut)		Seed	Anti-inflammatory, vascular supporting, immunomodulatory, antioxidant, virucidal, antiviral (against RSV, HSV-1, VSV, RSV, Dengue virus) activity.
Allium sativum (garlic)		Bulb	Immunomodulatory activity; prevention of infectious diseases; pronounced antiviral activity through various mechanisms of action: inhibition of virus entry into the cell, inhibition of viral RNA polymerase, reverse transcriptase, DNA synthesis.
Sambucus nigra (elderberry)		Fruit	Anti-inflammatory, immunomodulatory, antiviral activity.
Glycyrrhiza glabra L. (licorice)		Root	Positive effect in gastrointestinal problems (gastritis, peptic ulcer), in respiratory infections, arthritis and tremors. Pronounced anti-inflammatory, antispasmodic, antioxidant, antidiabetic, antimalarial, antifungal, antibacterial, antiviral effect.
Potentilla reptans (creeping cinquefoil)		Stem	Well manifested antidiarrheal, antidiabetic, hepatoprotective, antioxidant, antispasmodic, anti-inflammatory, antitumor, antifungal, antibacterial, antiviral action.

Humic Acid Improves Basil Resilience to Water Deficit, Enhancing the Photosynthetic Efficiency and Antioxidant Activation

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Background: Humic acid, a natural biostimulant derived from organic matter, is increasingly recognized for enhancing plant tolerance to drought by improving nutrient uptake, osmotic regulation, and antioxidant activity.

Methods: Basil plants were exposed to drought stress simulated with 20% PEG 6000 and treated with humic acid at 1, 3, or 5 mg/ml. Photosynthetic efficiency was assessed via chlorophyll fluorescence (PAM and JIP test). Pigment composition, phenolic metabolites, relative water content (RWC), electrolyte leakage, malondialdehyde (MDA), and hydrogen peroxide were quantified to evaluate stress responses.

Results: Humic acid significantly improved photosynthetic performance under drought, with the strongest effect at 5 mg/ml. Treated plants maintained higher pigment stability, reduced oxidative damage, and greater water retention compared to controls. Lower concentrations conferred moderate protection.

Discussion: Enhanced resilience was linked to strengthened antioxidant defences, particularly phenolics and carotenoids, which limited ROS accumulation. Stabilization of photosynthesis was further supported by increased cyclic electron transport around PSI, sustaining energy balance under stress.

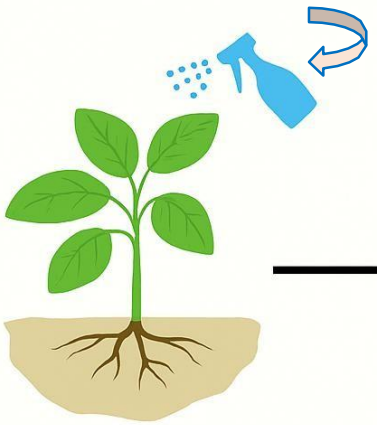
Conclusions: Humic acid mitigates drought-induced damage in basil by reinforcing antioxidant systems and maintaining photosynthetic function. These findings highlight its potential as a sustainable biostimulant to improve crop tolerance in water-limited environments, with broader implications for stress-tolerant agriculture.

Significance statement: Humic acid enhances drought resistance in basil by stabilizing photosynthesis and strengthening antioxidant defences, underscoring its potential as a sustainable biostimulant for water-limited agriculture.

Acknowledgements

This work was financially supported by Bulgarian National Science Fund under project КП-06-М 76/3.

Humic acid improves basil resilience to water deficit, enhancing the photosynthetic efficiency and antioxidant



↑ **Improvement in pigment content**

↑ **Photosynthetic efficiency** *(especially at 5 mg/ml)*

↑ **Antioxidant defense**

- **Phenolic compound** (especially acidic- and flavonoid-derived ones)
- **Carotenoids**
- **Antocyanins**

↑ **Overall Physio-logical Performance**

*Drought induced through **3-day, 20% PEG** protocol, with plant's **roots**, immersed in a ½ Hoagland solution; and **leaves** – treated with **1 / 3 / 5 mg/ml** of **HA***

Eco-friendly resilience

Cyclic Polymer Brushes as Versatile Nanoplatforms for Drug and Gene Delivery

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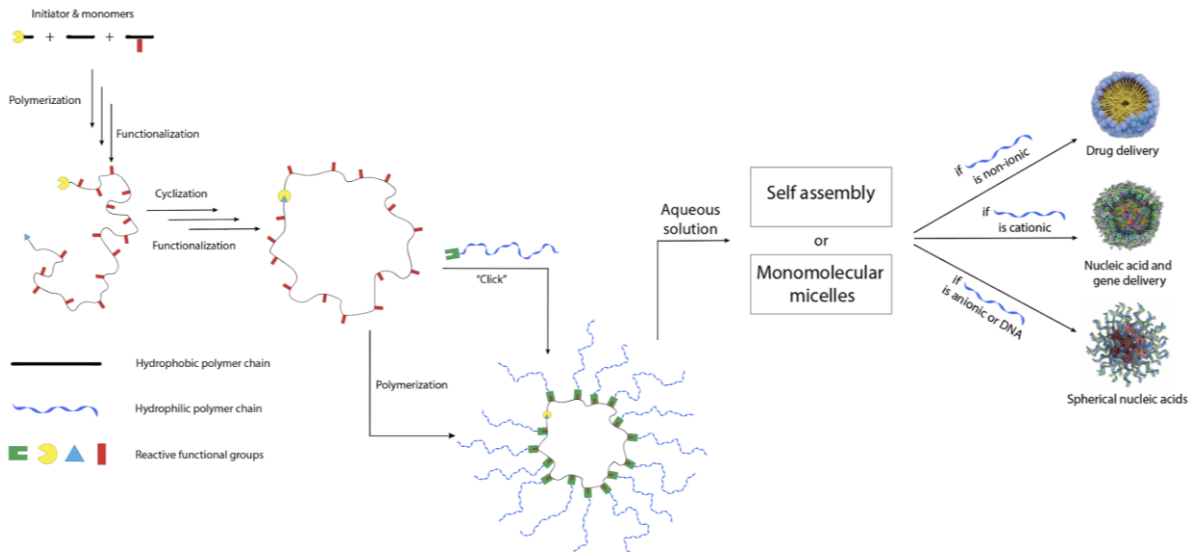
Cyclic polymer brushes represent a novel class of macromolecular architectures with great potential in nanomedicine. Their unique topology—comprising a hydrophobic cyclic backbone densely grafted with hydrophilic side chains—combines structural compactness, enhanced stability, and high functional tunability. This work aims to explore the synthesis, self-assembly, and biomedical applications of amphiphilic cyclic polymer brushes as innovative platforms for drug and nucleic acid delivery, as well as for the construction of a novel type of spherical nucleic acids (SNAs). The polymers are synthesized via controlled radical and ionic polymerizations, followed by efficient "click" coupling reactions to yield well-defined cyclic brush structures with adjustable composition, molecular weight, and grafting density. Their amphiphilic character enables spontaneous formation of nanosized self-assembled structures or unimolecular micelles in aqueous media, suitable for encapsulation or complexation of hydrophobic drugs and/or nucleic acids. The cationic analogues are expected to be able to coordinate DNA/RNA into stable polyplexes with high transfection potential, while direct conjugation of oligonucleotides onto hydrophobic cycles affords organic-core SNAs combining the intrinsic advantages of spherical nucleic acids – such as rapid cellular internalization, nuclease resistance, and non-immunogenicity - with tunable physicochemical properties of polymeric carriers. This interdisciplinary approach, integrating polymer chemistry, supramolecular science, and molecular biology, aims to develop novel biocompatible nanocarriers with improved pharmacokinetics and therapeutic efficacy.



Acknowledgements

This work was supported by a grant from the Bulgarian National Science Fund "Cyclic Polymer Brushes – Innovative Platforms for Drug and Nucleic Acid Delivery Systems and Spherical Nucleic Acids", КП-06-Н89/2. The authors thank the INFRAMAT project (part of the Bulgarian National Roadmap for Research Infrastructures, supported by the Bulgarian Ministry of Education and Science) for the research equipment that was used in this investigation.

Electro-assisted Delivery of Natural Redox-Modulators via Alkali Lignin-Based Biopolymer Formulations for the Treatment of MDA-MB-231 Triple-Negative Breast Cancer Cell Line

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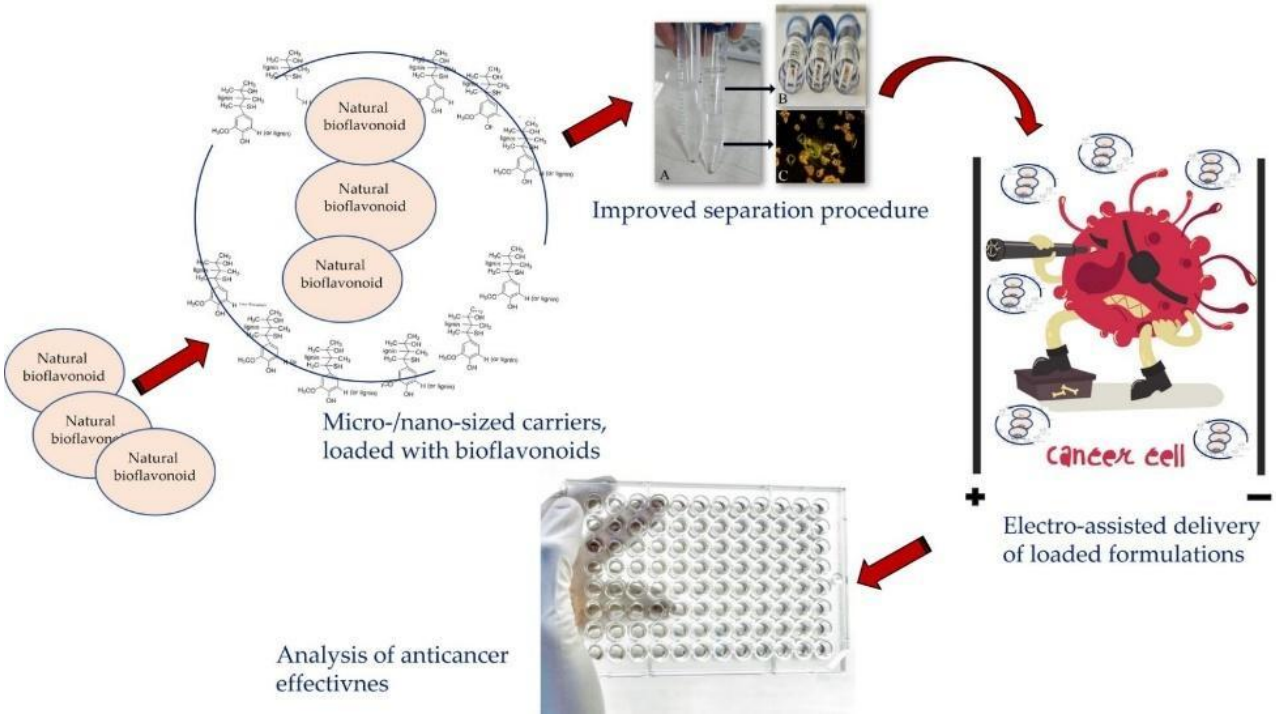
Breast cancer is the most frequently occurring cancer in women in 2022, according to the World Health Organization. The treatment of cancer diseases requires a therapeutic approach with severe side effects. Recently, new sources of non-toxic natural substances with underexplored therapeutic mechanisms of action, a presumed potential for developing advanced therapies for medically challenging diseases and opportunities to overcome multi-drug resistance are under active investigation. Bioflavonoids are an example of such substances, that provide anti-tumor activity, partially through redox-modulation. In particular, lignin, an underestimated waste product, is safe and biodegradable, therefore suitable for the design of micro-/nano-sized carriers, which, loaded with an active ingredient, are expected to deliver a larger amount of it into the cells. On the other hand, the reversible electroporation has been exploited to facilitate the internalization of chemotherapeutic drugs or micro-/nano-formulations into the cells.

The aim of the present *in vitro* study is to investigate the possibility of the application of Alkali Lignin-based micro-/nano-sized bioflavonoid carriers with or without electroporation for the treatment of MDA-MB-231 triple-negative breast cancer cell line.

An improved procedure for size- and charge-unification and the following relative concentration calculation, based on dynamic and electrophoretic light scattering techniques, was studied. Afterwards, the cytotoxicity effect of Alkali Lignin-based micro-/nano-sized formulations alone or bioflavonoid-loaded with or without electroporation was analyzed on the human epithelial breast cancer cell line (MDA-MB-231).

The improved procedure for separation of micro-/nano-sized carriers, based on dynamic and electrophoretic light scattering techniques, was implemented. The effectiveness of Alkali Lignin-based micro-/nano-sized bioflavonoid carriers with or without electroporation was successfully proven against the triple-negative breast cancer cell line (MDA-MB-231).

The results show that Alkali Lignin-based micro-/nano-sized bioflavonoid carriers are a presumable therapeutic opportunity against the triple-negative epithelial human breast cancer cells and electroporation can facilitate their internalization into the cells.



Acknowledgements

This work was supported by the Bulgarian National Science Fund under Grants № KP-06-N59/3 and KP-06-COST30. The authors thank the Bulgarian Ministry of Education and Science for the support, provided via the "National Center for Biomedical Photonics" D01-352/2023 (Zetasizer Nano ZS analyzer, Iprasense technology).

Assessing the Therapeutic Potential of Phytochemicals in Collagen Antibody-Induced Arthritis in Mice

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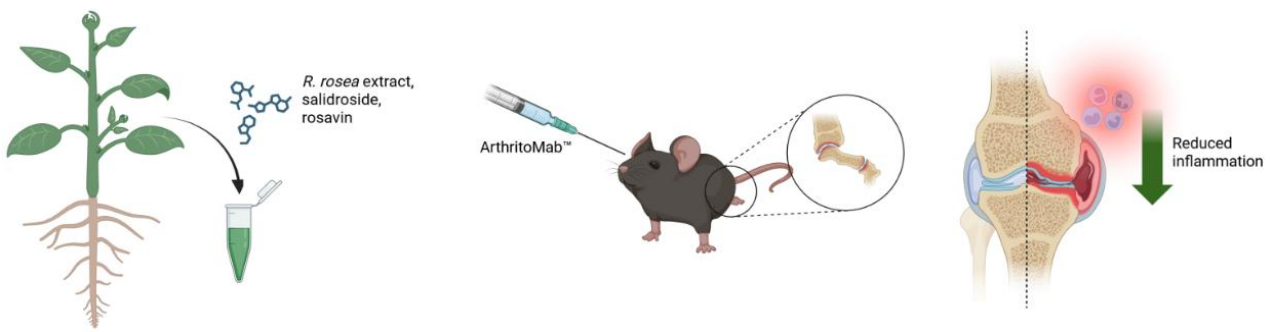
Rheumatoid arthritis (RA) is a complex autoimmune disease, affecting the lining of the synovial joints. It is characterized by chronic inflammation – infiltration of immune cells in the synovial membrane and the joint capsule, formation of hyperplastic synovium and ultimately joint destruction and bone erosion. Serological hallmark of the disease is the presence of autoantibodies towards the Fc region of immunoglobulin G (rheumatoid factor (RF)), as well as autoantibodies against citrullinated proteins (anti-citrullinated proteins antibodies (ACPAs)) [1].

The most common therapeutic agents used in RA treatment are the different classes of disease modifying anti-rheumatic drugs (DMARDs) – conventional synthetic, targeted synthetic and biologic. However, those only manage inflammation and pain, without dealing with the underlining cause of the disease and in most cases cause a range of side effects. This is why it's of high interest to develop new therapeutics that directly target the dysregulated immune networks associated with RA and have minimal negative effect on the patient's wellbeing. Many phytochemicals show promising adjuvant properties that can be further developed into alternatives to current RA treatment.

In the current research, the anti-inflammatory activity of Rhodiola rosea rhizomes extract and two of its characteristic metabolites (salidroside and rosavin) were investigated in collagen antibody-induced arthritis (CAIA) mouse model. Three groups of C57Bl/6 mice were injected with ArthritoMab™ to induce rheumatoid arthritis and were then treated with the aforementioned plant derivatives daily for 2 weeks. Control groups of healthy mice and mice treated with methotrexate were also monitored. At the end of the experimental course the mice were sacrificed, and their synovia and joints were isolated and examined for infiltrate immunophenotype and histopathology. The results showed improvement in the clinical symptoms of the disease in the treated mice – decreased paw swelling, as well as improved synovial inflammation.



Keywords

Golden root, Rheumatoid arthritis, Collagen-antibody induced arthritis, Flow cytometry, Synovial inflammation.

Acknowledgements

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[1] Nikolova-Ganeva, K. A., Mihaylova, N. M., Kechidzhieva, L. A., Ivanova, K. I., Zarkov, A. S., Parzhanov, D. L., Ivanov, M. M., & Marchev, A. S. (2025). The therapeutic potential of phytochemicals unlocks new avenues in the management of rheumatoid arthritis. International Journal of Molecular Sciences, 26(14), 6813. DOI: 10.3390/ijms26146813.

Albumin Thermal Stabilization and Plasma Proteins Aggregation as Diagnostic Markers for Preeclampsia: Impact of Disease Severity

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Preeclampsia (PE) is a pregnancy-related disorder that is associated with abnormal placentation and the development of hypertension accompanied by proteinuria. It can progress to multi-organ damage that can threaten the life of both the fetus and the mother.

PE can be categorized as severe or non-severe, based on the timing of the onset of clinical symptoms, their severity, the disease progression, and/or the presence of fetal growth restriction. It is considered that compromised trophoblast invasion, vascular dysfunction, and maladaptation of the placenta are thought to play a central role in PE pathogenesis. It is also believed to be associated with the oxidative modification of proteins in maternal blood plasma.

We hypothesize that plasma proteins in preeclampsia are altered in concentration, structure, oxidation level, and/or binding interactions and that elucidating these alterations from a thermodynamic point of view will shed new insight into the nature of this disorder. To prove our hypothesis, we combine differential scanning calorimetry (DSC), and atomic force microscopy (AFM) to analyze the changes in the thermodynamic behavior of plasma proteins isolated from PE patients, as compared with those of healthy pregnant controls and healthy non-pregnant women.

Our results demonstrate that the last trimester of pregnancy affects the main calorimetric characteristics of blood plasma from pregnant controls compared to non-pregnant women. DSC analysis reveals significant deviations in the plasma heat capacity profiles of PE patients from those of pregnant controls. These alterations are expressed primarily in: (i) substantial reduction in the amplitude and upshift of the albumin associated transition, (ii) lower total calorimetric enthalpy change, and (iii) reduced ratio of the heat capacity of the albumin/globulin-assigned thermal transitions. The observed changes are more pronounced in severe PE cases (Fig. 1). The *in vitro* oxidation model reveals that the changes in PE thermograms are partly due to protein oxidation. AFM data reveal numerous large amorphous aggregates in the plasma of PE samples and a few small spherical ones in the pregnant controls, which are absent in healthy non-pregnant samples (Fig. 2). Our study justifies further exploration of the role of albumin thermal stabilization and plasma proteins aggregation in PE pathology and its diagnostic potential.

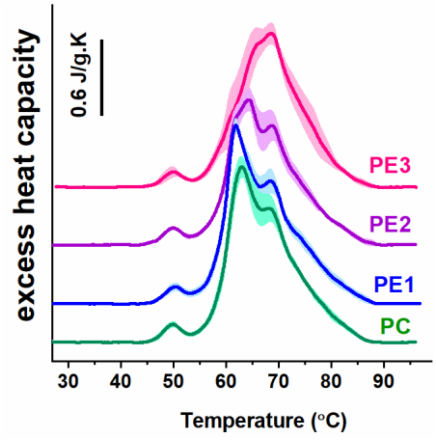

Figure 1. Thermodynamical profiles of the studied groups of patients: PE1 (blue line/ light blue shading), PE2 (violet line/violet shading), and PE3 (red line/pink shading) compared to control pregnant group (PC, green line, light green shading).

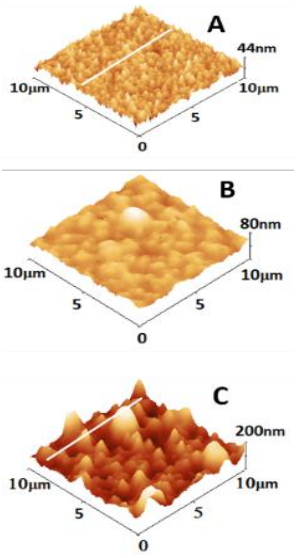

Figure 2. Representative 3D AFM images of blood plasma derived from healthy nonpregnant women (NPC, A), pregnant women (PC) (B), and patients with preeclampsia (PE).

Acknowledgements

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Influence of Silver Nanoparticles on Liposomal Membrane Properties with Relevance to Drug Delivery and Photothermal Therapy

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Silver nanoparticles (AgNPs) have been widely applied in pharmacology, structural biology, and nanomedicine. Given their favorable interactions with lipid membranes, this study investigates how AgNPs affect the physicochemical properties of SOPC-based liposomal bilayers, focusing on elastic and structural properties and phase behavior. Experimental approaches included infrared (IR) spectroscopy, differential scanning calorimetry (DSC), thermally induced shape fluctuation analysis, and laser irradiation at 343, 515, and 1030 nm. FTIR-ATR spectra showed characteristic fructose C–O and C–C stretching bands at 1160, 1101, 1085, 1064, and 1016 cm^{-1}, most intense at 2.5 wt % AgNPs, confirming interactions of fructose-capped nanoparticles with carbonyl and phosphate groups of SOPC. DSC analysis revealed a slight decrease in the main transition temperature from 3.41 °C for pure SOPC to 2.80 °C at 2.5 wt% AgNPs, accompanied by an enthalpy reduction from 0.280 to 0.234 J g^{-1}. The bending modulus decreased from 1.18 × 10^{-19} J to 0.93 × 10^{-19} J, indicating reduced bilayer rigidity. In thermal response tests, the highest temperature rise (Δt ≈ 22 °C) occurred at 515 nm and 0.2W/cm^2, while 1030 nm irradiation produced only 3–5 °C increases. These results demonstrate that AgNPs moderately perturb lipid organization while enabling efficient, controllable photothermal response. Fructose capping further enhances nanoparticle stability via its cryoprotective properties.

Keywords

Silver nanoparticles, Drug delivery, Photothermal therapy, Nanoparticle-membrane inter- actions, Infrared (IR) spectroscopy, Phase transition, Elastic properties, Laser irradiation.

Acknowledgements

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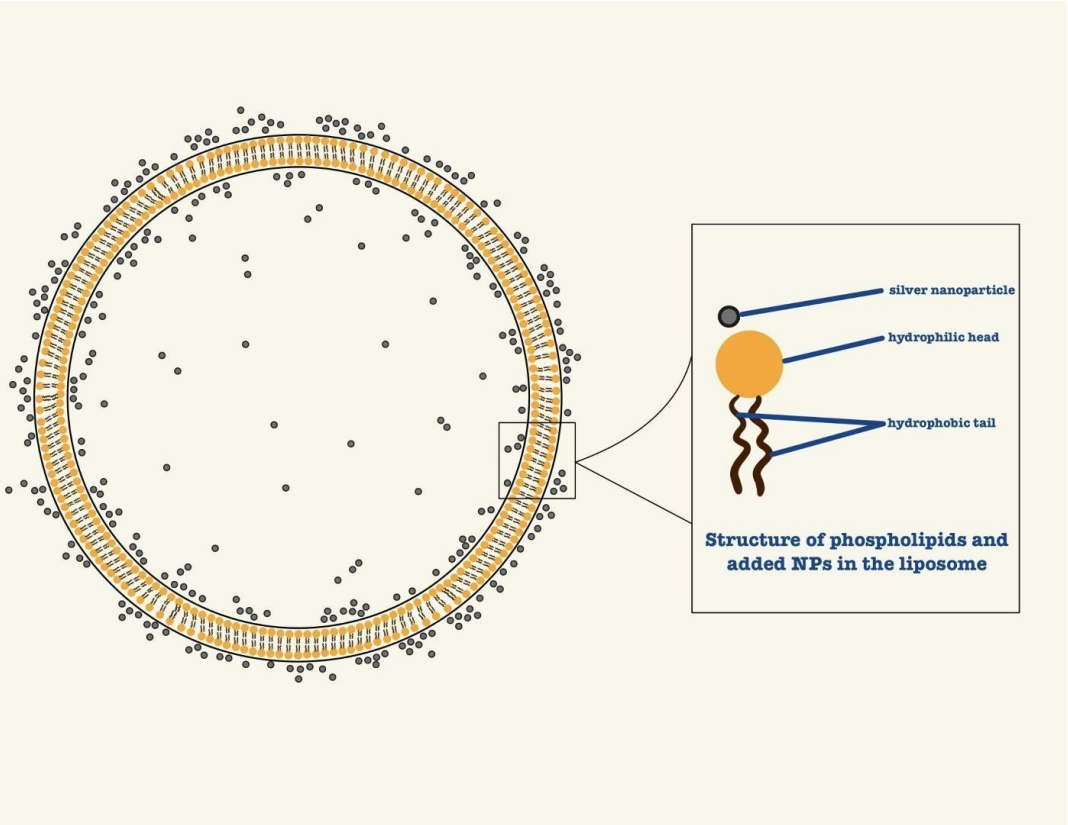

MoS_2 Thin-Film Layers for Antibacterial Applications

Blagovest Napoleonov[1,*], Vladimira Videva[1,2], Dimitrina Petrova[1,3], Dayana Benkova[4], Aneliya Kostadinova[4], Galya Staneva[4], Dimitre Dimitrov[1,5], Vera Marinova[1,6]

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Two-dimensional molybdenum disulfide (MoS_2) has emerged as a promising antibacterial material and coating platform, combining tunable surface chemistry with broad-spectrum activity and generally low cytotoxicity reported *in vitro*. In this work, we grow CVD MoS_2 thin films on UV-ozone-pretreated Si/SiO_2 substrates and evaluate them as antibacterial coatings by correlating film thickness and surface chemistry with the biological response. Raman spectroscopy, AFM and XPS are used to relate crystallinity and thickness to antibacterial performance. We assess cytotoxicity toward normal human skin cells alongside microbiological tests of inhibitory action against pathogenic species to probe selectivity. These complementary studies aim to demonstrate selective suppression of pathogens while preserving skin-cell viability.

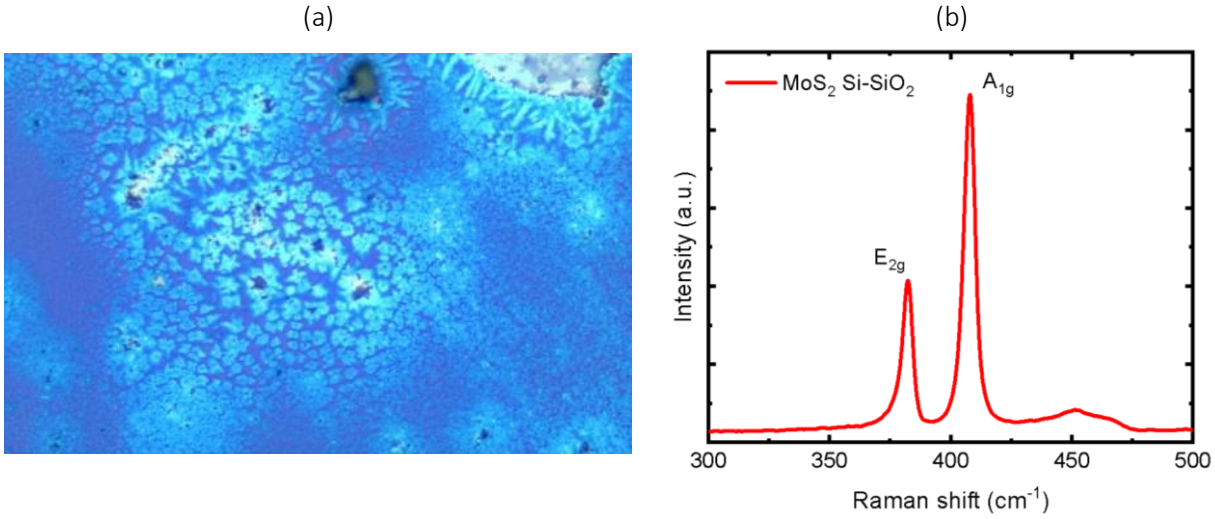

Figure 1. (a) Raman-microscope image of the MoS_2/SiO_2 sample. (b) Raman spectrum showing the characteristic E_{2g} and A_{1g} modes of MoS_2.

Acknowledgements

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Chitosan-Based Nanomaterials: A Systematic Study on Their Multifunctional Applications

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Chitosan is a naturally derived polysaccharide with broad applications in biomedicine, drug-delivery, tissue engineering, and commercial nutraceutical products. Despite the extensive research on chitosan-based nanomaterials, this versatile polymer continues to attract significant scientific interest. Its adaptable chemical structure enables the design of innovative materials for diverse applications.

In this systematic study, we highlight the wide-ranging potential of chitosan as a polymeric platform for nanomaterial formulations. We describe how various synthesis strategies and combinations with organic (plant extracts) and inorganic components (metal oxides) generate distinct nanocomposites with tailored physicochemical properties and morphologies suited to specific functional requirements.

This work includes fundamental investigations into drug-delivery mechanisms, with particular emphasis on the interactions of chitosan–metal oxide nanomaterials with cell-model membranes. The study further evaluates the pesticide-like activities of chitosan–metal oxide nanocomposites, obtained by different synthesis methods, against the globally destructive phytopathogens *Fusarium solani* and *Alternaria solani*. Finally, we explore the therapeutic potential in dermal applications of chitosan-based hybrid systems incorporating feverfew (*Tanacetum parthenium*) extract. Their wound-healing efficacy was evaluated on human skin keratinocytes (HaCaT) under *in vitro* conditions simulating diabetic wounds, while their cytotoxic potential was assessed against human melanoma cells (A375).

Keywords

Chitosan, Nanocomposites, Drug-delivery.

Acknowledgements

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Halophilic and Halotolerant Fungi from the Bulgarian Black Sea Coast – Mechanisms of Adaptation

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Halophilic and halotolerant fungi represent a unique group of microorganisms capable of surviving and developing in environments with high salinity, low water content and increased osmotic pressure, which for most eukaryotes are extreme. Their study provides valuable information on the mechanisms of cellular adaptation to osmotic and oxidative stress, as well as on their potential as sources of biologically active compounds of industrial importance.

In the present study, isolates obtained from the saline ecosystems of the Atanasovsko and Pomorie lakes from the Bulgarian Black Sea region were analyzed. Most strains showed optimal growth at 5% NaCl, with some of them retaining viability at 20% salinity. The dominant genera include *Aspergillus, Penicillium, Cladosporium, Alternaria, Talaromyces,* etc., whose representatives exhibit high enzymatic activity – proteases, lipases and amylases, which help them in their survival strategy in conditions of increased salinity. The study of the adaptive strategy to salt stress includes a model strain *Penicillium chrysogenum* P13 – a broad halotolerant. The increased levels of the antioxidant enzymes superoxide dismutase and catalase confirm their key role in the adaptive mechanisms of filamentous fungi under salt stress.

Conclusion: Salt stress is the cause of increased formation of COP, causing oxidative stress, which leads to damage to cellular macromolecules – lipids, proteins and NC. The high adaptive ability, combined with the resistance of filamentous fungi to oxidative and osmotic stress, provides them with an evolutionary advantage in colonizing environments with extreme conditions and emphasizes their importance as promising objects in modern biotechnological applications.

Acknowledgements

The authors express their gratitude to the Bulgarian National Science Fund, supporting this work with the project Adaptive mechanisms to halotolerance of filamentous fungi from the Bulgarian Black sea region, Grant No КП-06-Н81/12/2025.

Biophysical Insights into Petasin-Mediated Modulation of Mast Cell Model Membranes

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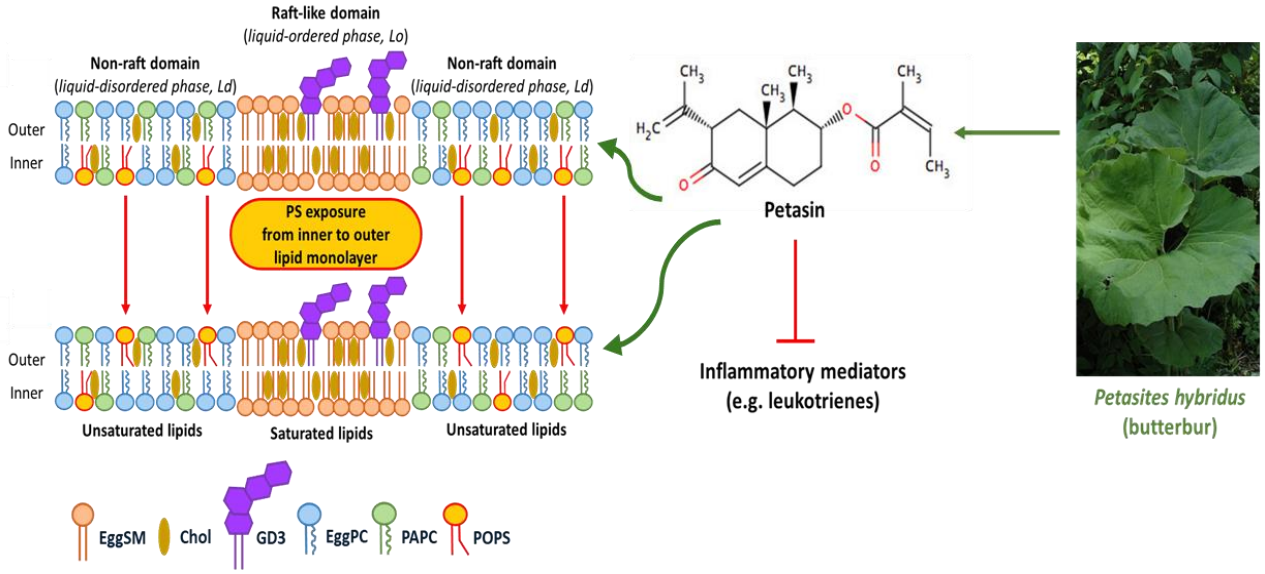
Allergic diseases involve chronic inflammation driven by mast cell activation, a process regulated by the structural organization of their plasma membranes and characterized by non-apoptotic phosphatidylserine (PS) exposure, which reflects dynamic membrane remodeling. Lipid rafts, cholesterol- and sphingolipid-rich nanodomains, facilitate receptor clustering and signaling during degranulation. This study used large unilamellar vesicles (LUVs) mimicking the lipid composition of mast cell membranes in resting and activated states to examine how petasin, a natural anti-inflammatory compound from Petasites hybridus, affects membrane properties. Fluorescence spectroscopy revealed that petasin increased Laurdan GP values, indicating enhanced lipid packing and reduced interfacial hydration. DPH anisotropy showed decreased lipid chain mobility, while DPH-Tempo quenching demonstrated lower quencher accessibility to the bilayer core, suggesting condensation and possible stabilization of raft domains. These findings indicate that petasin promotes a more ordered and less dynamic membrane structure, potentially modulating raft-dependent signaling pathways involved in mast cell activation and mediator release. Overall, petasin appears to exert its anti-allergic and anti-inflammatory effects by reorganizing membrane architecture and influencing the spatial arrangement of signaling components crucial for mast cell function.



Acknowledgements

This study was financially supported by the National Science Fund of Bulgaria, Grant KP-06-M81/3-04.12.2024. The authors thank the Bulgarian Ministry of Education and Science for the support provided via Scientific Infrastructure on Cell Technologies in Biomedicine (SICTB) DO1-361/2023, part of the Bulgarian National Roadmap for Scientific Infrastructures 2020–2027. The authors also acknowledged COST Action CA22153 EuroCurvoBioNet.

CompuToxPredictor: A Computational Platform for Predicting Toxicokinetics and Toxicodynamics of Chemicals

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This presentation outlines the ongoing development of a web-based, free-to-use and open-data software application designed to predict physicochemical and toxicokinetic properties of chemicals. The project addresses the European Chemicals Regulation – REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals), which encourages the use of alternative approaches – such as *in silico* methods – to fill data gaps related to toxicological properties of substances placed on the EU market. The application is intended to provide researchers and regulators with reliable, freely accessible computational predictions to support chemical safety assessments.

The application currently integrates the following models for predicting physicochemical and toxicokinetic properties of molecules:

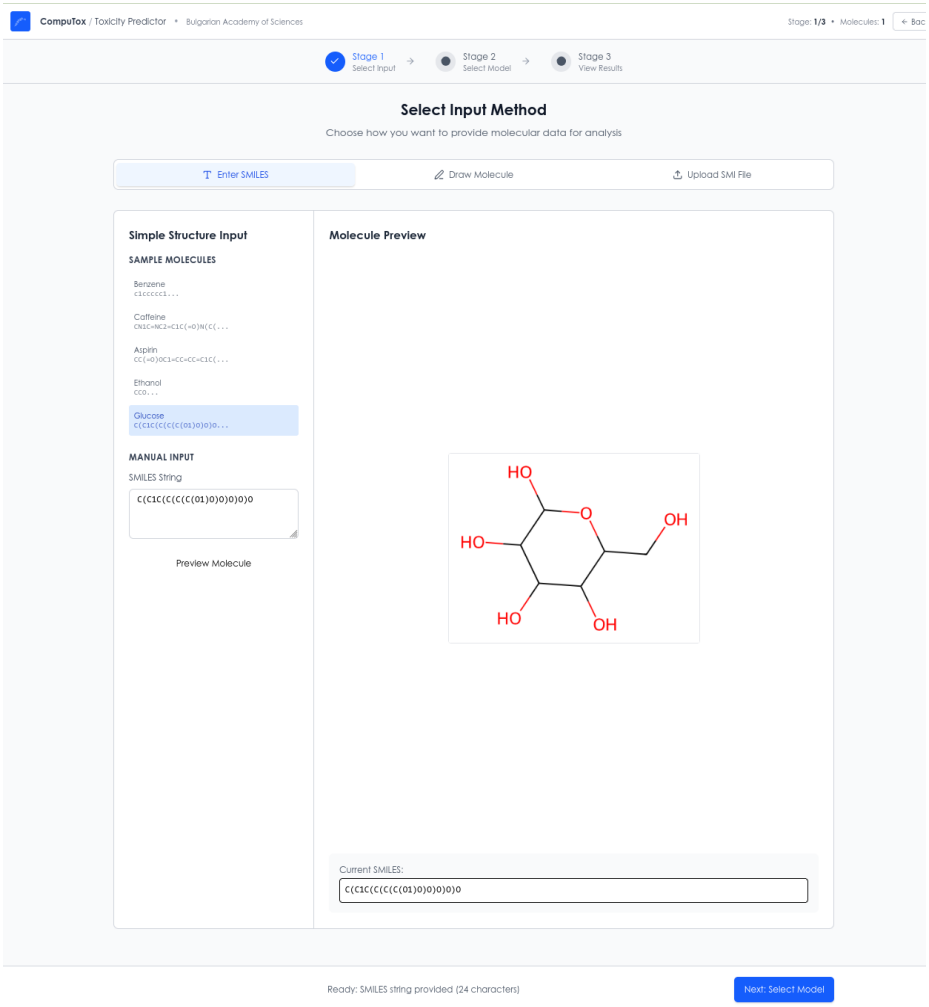
(1) An in-house developed QSAR model for melting point prediction using a GCN (Graph Convolutional Network) implemented via DeepChem. The model was trained on the Bradley melting point dataset containing over 28,000 chemical structures. After preprocessing and validation, the curated dataset included more than 23,000 unique chemical structures. The model achieved a Pearson correlation coefficient of 0.89 on the test set. It utilizes molecular graph representations with convolutional molecular featurization, enabling direct learning from chemical structure.

(2) A refined QSAR model for water solubility prediction adapted from the original model of Lowe et al. [1]. The model employs a random forest regression algorithm and was trained on a dataset of 7,628 unique chemical structures. The molecular descriptors were calculated using the open-source software PaDEL. The model achieved R^2 of 0.80 and an RMSE of 1.04 log(mol/L) on the test set.

(3) An in-house developed QSAR model for PAMPA (Parallel Artificial Membrane Permeation Assay) prediction – designed to screen compounds for passive intestinal absorption [2]. This multiple linear regression model was trained on 277 commercial drugs with experimentally determined permeability constants log P_e. It utilizes three molecular descriptors – logD (apparent distribution coefficient), TPSA (topological polar surface area), and MW (molecular weight). The model achieved R^2 of 0.77 and an SEE of 1.11 log P_e on the test set.

The platform is implemented as a modern web application featuring a React-based frontend, with an emphasis on ease of use, and a Flask-based REST API backend. Users can input chemical structures via SMILES notation (visualized using the RDKitJS library), through a file upload containing multiple structures (SMI format), or by drawing structures in an integrated molecular editor (Ketcher). The application provides a streamlined three-stage workflow: (1) predictive model selection, (2) molecule input and validation, and (3) visualization and export of the results. The platform supports batch prediction for multiple compounds and displays outputs in an interactive results table.

Once completed, the CompuToxPredictor platform will be publicly accessible via the website www.computox.bas.bg.



CompuToxPredictor application

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Acknowledgements

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Analysis of Antibody Repertoires Using IgOme Graph and Molecular Docking

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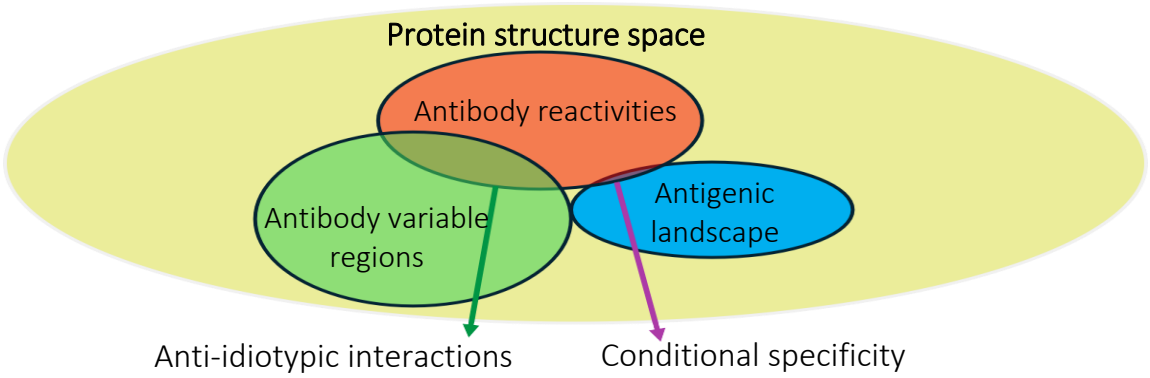
The antibody repertoire can be studied at the systems level through two main approaches: high-throughput B cell receptor (BCR) sequencing and high-throughput binding experiments using phage display random peptide libraries (IgOme) or antigen arrays. The binding-based methods reveal the collective specificity landscape of the antibody ensemble (a repertoire), where the reactivities of individual clones often overlap. Deciphering the complexity of these repertoire profiles starts with the understanding of the individual antibody IgOmes.

Using IgOme data from Ashkenazy *et. al.* [1], we examined the repertoires of four monoclonal antibodies: three anti-Gp120 HIV antibodies and Herceptin. We constructed graphs with 7-mer peptide mimotopes as nodes and shared subsequences of at least five amino acids as edges. By applying spectral embedding and the DBSCAN clustering algorithm, we extracted the specificity spectra of the antibodies and derived sequence motifs. We then used molecular docking to model mimotope–antibody complexes and compared the interactions with the paratope to those of the known epitopes.

We found that each antibody recognizes between 10 and 45 mimotope groups, covering a broad region of the mimotope space. Docking and motif analyses showed that antibodies can bind diverse mimotopes with little sequence and binding similarity to their epitopes. Even clinically established antibodies like Herceptin display this diversity, indicating the necessity of a systemic view of specificity as relative to the antigenic landscape. Finally, our observations suggest that the existence of a network of anti-idiotypically connected antibodies is an inevitable consequence of their polyreactivity and the big sequence diversity of the BCRs. The scope and functions of this network remain to be explored.



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Youth Session: Poster Presentations

Gene Expression in Different Sample Types Among Bulgarian Endometriosis Patients – Challenges and Opportunities

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Introduction: Endometriosis is a chronic, estrogen-dependent inflammatory disease affecting an estimated 2–10% of women of reproductive age. Diagnosis still depends on laparoscopic evaluation with histological confirmation, which contributes to long delays between symptom onset and definitive diagnosis. As a result, there is growing interest in developing non-invasive diagnostic approaches. The aim of this study is to assess the challenges and potential of using menstrual blood for gene expression analysis and endometriosis diagnostics in Bulgarian patients with endometriosis.

Materials and methods: Nine Bulgarian women aged 18–45 participated in the study, divided into a case group (n = 6) with confirmed endometriosis and a control group (n = 3) undergoing hysteroscopy for benign conditions. Tissue samples—including eutopic endometrium from controls, eutopic endometrium from patients, and endometriotic lesions — were collected during scheduled laparoscopic or hysteroscopic procedures. Menstrual blood from patients was self-collected on day 2 of the menstrual cycle from a menstrual pad/cup, using DeltaLab sterile swabs placed into 600 µL DNA/RNA Shield (Zymo Research). Total RNA was isolated using RNAzol® RT. RNA concentration and purity were assessed via NanoDrop spectrophotometry, while RNA integrity was evaluated through BGI internal quality control using Agilent RNA 6000 Pico reagents.

Results: NanoDrop analysis showed that menstrual blood samples had 260/230 ratios below the expected range of 1.8–2.1 (average = 1.23), unlike the tissue samples, which fell within that range. BGI internal quality control indicated an average RNA concentration of 3.94 ng/µL in menstrual blood, compared with 33.2 ng/µL in tissue samples. The menstrual blood samples also demonstrated lower average RIN values (2.6) than the tissue samples (3.4). In addition, tissue samples showed an average alignment rate to GRCh38 reference genome of 97%, whereas menstrual blood dropped to 40%, reflecting bacterial contamination (Figure 1).

Conclusion: Gene expression analysis of menstrual blood shows potential as a non-invasive diagnostic approach for endometriosis; however, several limitations must be addressed. The menstrual blood samples demonstrated low 260/230 ratios, lower RNA concentrations, reduced RIN values, and evidence of bacterial contamination, all of which affect data quality. Future optimization may require modifying the sampling method. Rather than collecting menstrual blood from pads or cups with swabs, obtaining the sample directly from the uterine cavity by a physician using a cannula could reduce contamination and improve RNA integrity.

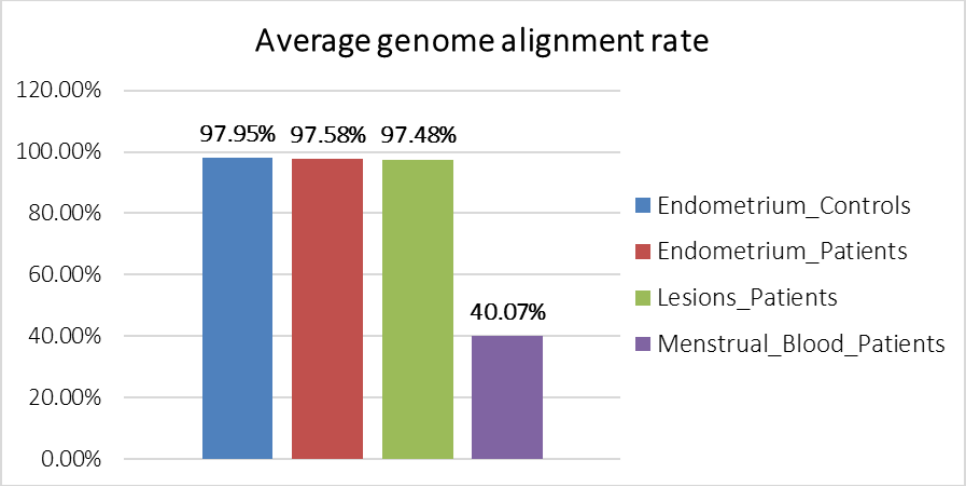

Figure 1. Average alignment rate to reference genome of the different samples.

Acknowledgements

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Study of *CYP2D6* Gene Polymorphisms in Men with Non-Obstructive Azoospermia in the Bulgarian Population

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Introduction: Current studies performed in the genetic field of male infertility reveal a significant correlation between genetic polymorphisms of cytochrome enzymes involved in drug metabolism, generation of reactive oxygen species (ROS) and spermatogenic failure. Reduced-function and loss-of-function polymorphisms may induce oxidative stress, and consequently lipid peroxidation, single- and double-strand DNA breaks, and the activation of apoptosis, leading to male infertility.

Materials and Methods: Nineteen different polymorphic variants in the *CYP2D6* gene were examined in 22 men with non-obstructive azoospermia (NOA) from the Bulgarian population. The polymorphisms were analyzed using PCR amplification followed by reverse hybridization.

Results: The results have revealed high frequencies of the heterozygotes for the polymorphisms *CYP2D6*4* (45%), *CYP2D6*10* (36%), and *CYP2D6*41* (27%) in the group of infertile men (Figure 1). The allele frequencies of *CYP2D6*41* and *CYP2D6*17* were significantly higher among men with azoospermia compared to the European control population – 0.14 and 0.02 versus 0.093 and 0.002, respectively. The only polymorphism established in a homozygous form among azoospermic men was *CYP2D6*4*. The homozygous frequency was relatively low (5%), suggesting the carriership of combined haplotypes in most of the examined patients.

Conclusions: The allele frequencies of *CYP2D6*41* and *CYP2D6*17* established in Bulgarian men with non-obstructive azoospermia, were significantly exceeding European control levels. Homozygosity for *CYP2D6**4 and the prevalence of alleles with reduced or absent enzyme activity suggest a potential contribution to oxidative stress, DNA damage, and impaired spermatogenesis. These results support *CYP2D6* polymorphisms as potential biomarkers for the genetic assessment and personalized management of male infertility.

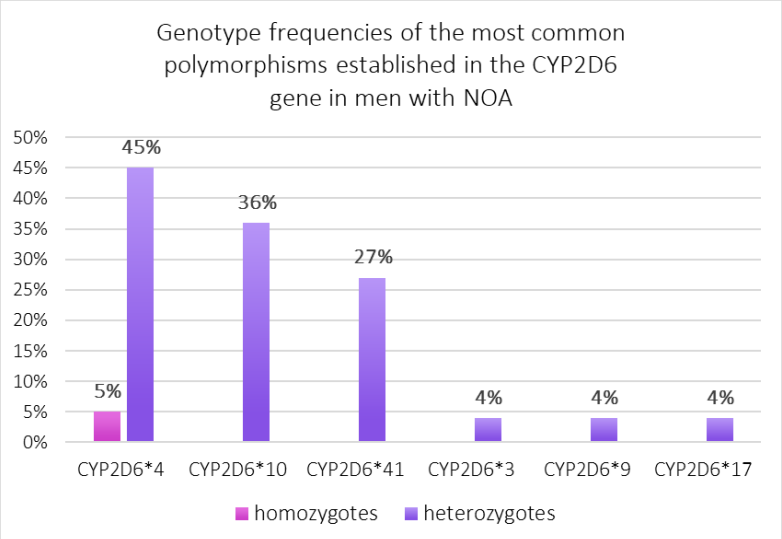

Figure 1. Allele frequencies of *CYP2D6* polymorphisms in men with non-obstructive azoospermia in the Bulgarian population.

Synthesis and Characterization of Zeolite with Bulgarian Herbals Composites

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Bulgarian herbs are distinguished by their healing properties and high antioxidant activity thanks to the content of phenols and other compounds present in them. One of these herbs is Tansy (*Tanacetum parthenium*). It is widely used in folk medicine. This herb is used for asthma, gastrointestinal problems, gynaecological problems and many others. Bay leaf (*Laurus nobilis*) is used for cardiovascular diseases, gastrointestinal problems, helps regulate blood sugar levels, relieves joint pain and neuralgia, is a strong antioxidant and has antitumor properties.

Applying herbal extracts to a carrier allows their delivery to cancer cells. A mechanism has been developed for their slow release, which leads to a prolonged and local effect on tumor cells.

Therefore, the present study is focused on the preparation of composites of zeolite-*T. Parthenium* and zeolite-*L. nobilis*. The obtained samples were characterized by XRD, FTIR, Uv-vis, TEM and SEM. The extract composition was analyzed using combined column chromatography and UHPLC.

Acknowledgements

The authors acknowledge the financial support of the National Science Fund of Ministry of Education and Science of Bulgaria, Project КП-06-М89/5, 2024.

Identifying the Prevalence of *Listeria monocytogenes* in Minced Meat at Different Storage Temperatures Through Artificial Contamination

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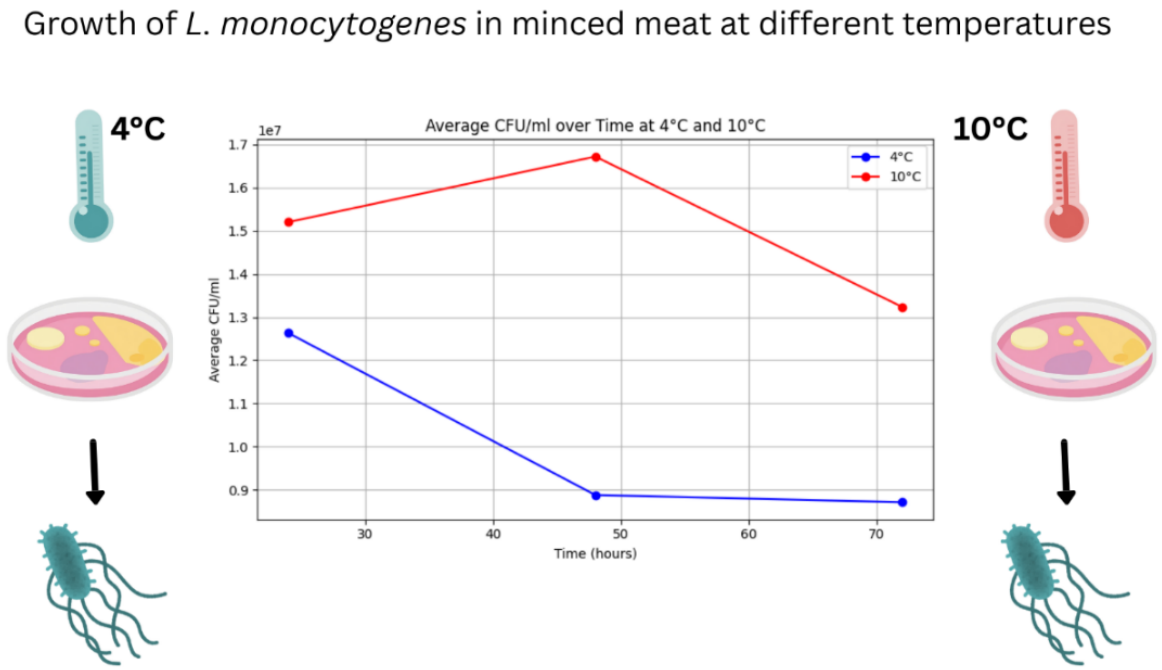
Meat and meat products provide essential nutrients but are prone to contamination by pathogens at various points in production, especially given their nutrient-rich environment. Pathogens such as *Listeria monocytogenes* have become a growing concern, as they can survive in refrigerated, high-salt, and food processing environments, forming resistant biofilms on packaging and contact surfaces, and potentially proliferating in vacuum-sealed or MAP (modified atmosphere packaging) foods. L. monocytogenes can form biofilms on plastic, stainless steel, glass, and even coated paperboard packages. An artificial contamination experiment was conducted using minced meat from a chain store that meets storage standards. The contaminated samples were incubated at 10°C and 4°C to compare *L. monocytogenes* growth at these temperatures. The results obtained from the experiment revealed that *L. monocytogenes* can grow at both temperatures. Higher CFU/ml counts were registered at 10°C compared to 4°C. Bacterial populations increased over time at both temperatures, indicating that the *L. monocytogenes* remained metabolically active during refrigeration. Cultivation at 10°C showed more rapid growth of the bacteria, particularly between 48 and 72 hours, which may indicate that this temperature creates more favorable conditions for proliferation. The obtained results demonstrate the psychrotrophic nature of *L. monocytogenes* and highlight the importance of maintaining food storage temperatures at or even below 4°C to limit bacterial growth and reduce contamination risk.



Biological Active Molecules Synthesized from Antarctic Fungi

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Introduction: Filamentous fungi are a significant part of microbes inhabiting extreme environments. Besides their unique adaptive strategies, they can survive and thrive in such harsh conditions. Extremophilic fungi are considered promising candidates for the isolation of novel bioactive compounds because of their specific characteristics. Several natural products with unusual structural characteristics have already been isolated from such fungi. Approximately 40% of these compounds are new natural products, including, for example, an asterinic acid containing an uncommon nitro group, identified in the Antarctic fungus *Pseudogymnoascus* sp.

Aim: This study was undertaken to discover Antarctic fungal strains for the synthesis of biologically active substances with potential medical and pharmaceutical applications.

Results: The present study used 60 strains of filamentous fungi isolated from soil samples near the Bulgarian scientific base on Livingston Island, Antarctica. Most of the Antarctic fungal strains selected for this study were classified as mesophilic. These isolates were screened for their ability to produce antioxidant enzyme catalase and substances with antibacterial activity against Gram-positive bacteria *Bacillus subtilis* and Gram-negative bacteria *Escherichia coli* and *Pseudomonas aeruginosa*.

The strain with the highest catalase activity and a temperature optimum of 20°C was *Penicillium griseofulfum* P29 (molecular genetic identification of the selected strain was carried out based on sequencing of the ITS rDNA region). The produced catalase is cold cold-active enzyme.

A total of 39 fungal strains exhibited antibacterial activity against Gram-positive bacteria, while 29 strains demonstrated activity against Gram-negative bacteria. Notably, 20 of the tested strains showed inhibitory activity against both bacterial groups.

The culture fluids from *Talaromyces* spp. strain showed the best activity against Gram-negative bacteria *Pseudomonas aeruginosa* and *Escherichia coli* and Gram-positive bacteria *Bacillus subtilis*.

Conclusion: The results of the present study support the suggestion that Antarctic fungi are important producers of novel enzymes. They are promising producers of antimicrobial substances with potential use in medicine. The filamentous fungi from *Penicillium* spp. and *Talaromyces* spp. showed a high ability to produce cold-active enzyme catalase and β-lactam antibiotics along with other antimicrobial metabolites.

Acknowledgements

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Synthesis of Heterocyclic Extended 1,8-Naphthalimides

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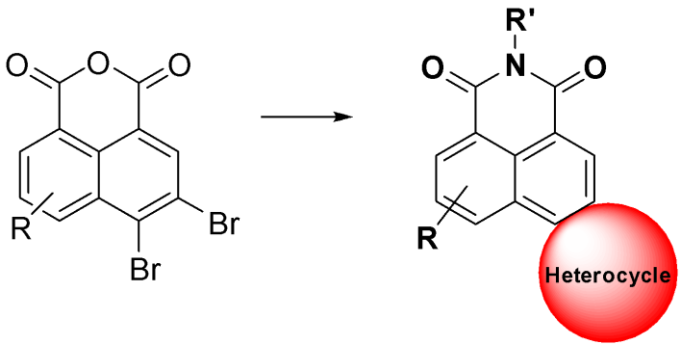
The photophysical properties of 1,8-naphthalimide compounds are governed by the nature of the substituent. In the area of anticancer research, the development of small molecules capable of interacting with deoxyribonucleic acid (DNA) and exhibiting anticancer activities has received enormous attention in recent years. Amongst these, it has been found that 1,8-naphthalimide and its derivatives possess high anticancer activity towards various human and murine cells. Moreover, their absorption and emission spectra can be easily tuned through careful structural modification on either the aromatic 'naphthalene' moiety itself or at the nitrogen of the imide site. In literature, many examples are known where anticancer activities of naphthalimides have been significantly affected via fusing aromatic or heteroaromatic rings or varying the position and size of side chains. Consequently, the 1,8-naphthalimide compounds have been extensively used as strongly absorbing and colorful dyes, building blocks for artificial light harvesting arrays, and fluorescent chemical probes for the sensing of biologically relevant cations and anions.



Acknowledgements

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Peri-Disubstituted Dichalcogenides of Naphthalimides as Promising Anticancer Agent

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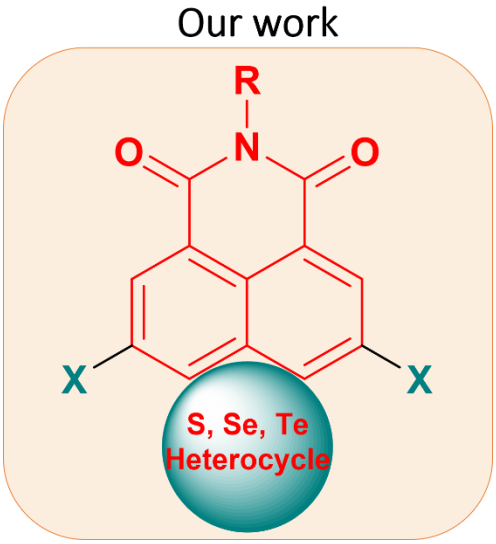
1,8-Naphthalimides are well-established DNA intercalating agents and a diversity of many derivatives were synthesized in order to evaluate both their cytotoxic and antitumor activities, thus finding potential application in anticancer treatment therapies. The amide moiety and the naphthalene core play a crucial role in order for the compound to be biologically active. Two representative examples of this class are mitonafide and amonafide, which even reached clinical trials as topoisomerase II intercalating inhibitors. However, they were interrupted because both compounds exhibited strong central nervous toxicity amongst patients. Since then, many more tuned structures were designed in order to overcome this issue. Subsequently, it was found that adding another heterocycle to the naphthalimide moiety considerably increased its antimutagenic properties.



Acknowledgements

Authors are grateful to the Bulgarian National Science Fund project KP 06-N61/1.

Synthesis and Biological Evaluation of Linear and Star-Shaped Poly(ε-caprolactone)-block-polyglycidol Copolymers as Drug Carriers

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Targeted drug delivery is rapidly advancing, with polymer micelles emerging as versatile nanoscale carriers. Built from amphiphilic copolymers, these systems enable efficient encapsulation, co-delivery of hydrophilic and hydrophobic drugs, and offer excellent biocompatibility, stability, and controlled release. In this work, linear block and star-shaped poly(ε-caprolactone)-block-polyglycidol copolymers were synthesized using click chemistry and fully characterized. Their aqueous solution properties were studied in both unloaded and cannabidiol-loaded forms. Biological evaluation revealed promising performance, underscoring their potential as effective platforms for advanced drug delivery applications.

Keywords

Polymer, Micelles, Nano-carriers, Drug delivery.

Acknowledgements

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Photosynthetic Response of Two Basil Varieties to Drought Stress: The Role of Anthocyanins

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Introduction: Drought stress is a major environmental factor that adversely affects plant growth and inhibits photosynthetic activity. This study aimed to investigate the role of anthocyanins in modulating their physiological responses to water-deficient conditions. The objects of this study were two basil varieties: *Ocimum basilicum* L. Italiano classico (green basil) and *Ocimum basilicum* L. Dark opal (purple basil), which differ in anthocyanin content.

Methods: Photosynthetic performance was evaluated using chlorophyll *a* fluorescence induction (JIP parameters) and pulse-amplitude modulated fluorescence (PAM parameters). Photosynthetic pigment and anthocyanin content, as well as indicators of oxidative stress (malondialdehyde and hydrogen peroxide) were also determined.

Results: The obtained results demonstrated that the chlorophyll fluorescence parameters (PAM and JIP) of purple basil were slightly affected under drought stress compared to green basil. Furthermore, purple basil showed a significantly lower increase in malondialdehyde and hydrogen peroxide levels, indicating higher stress resistance.

Discussion: The increased anthocyanin content in purple basil suggests a potential antioxidant role, contributing to the attenuation of oxidative damage and improved tolerance to drought stress. The different photosynthetic responses observed between the two basil varieties provide valuable insights into their adaptive mechanisms under limited water availability.

Conclusions: This study highlights the important role of anthocyanins in enhancing drought tolerance and advances our understanding of the photosynthetic responses of two basil varieties under water-limited conditions.

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Study of the Mechanism of Dendrimer Penetration into Eukaryotic Cells

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The biological activities of second-generation dendrimers, 4-dimethylamino-1,8-naphthalimide (DAB) and its halogenated analogue 3-bromo-4-dimethylamino-1,8-naphthalimide (DAB-Br), specifically their mechanisms of cellular entry were investigated on eukaryotic cells. Dynamic light scattering measurements revealed that both dendrimers carried strong positive surface charges, +28 mV for DAB and +35 mV for DAB-Br. Their hydrodynamic diameters were determined to be 117 nm and 234 nm, respectively. These nanoscale dimensions, along with their cationic nature, facilitate effective interactions with cellular membranes and promote internalization into target cells.

The treatment of HFF-1 cell line and five fungal strains with the dendrimers tested revealed that DAB dendrimers were more cytotoxic to human cells, whereas DAB-Br exhibited greater antifungal potency. The MTT assay using the HFF-1 cell line showed that DAB had a lower IC_{50} value of 28 µg/mL, indicating stronger cytotoxicity, while DAB-Br was less toxic (IC_{50} = 75 µg/mL). In contrast, antifungal testing using the resazurin method revealed that DAB-Br induced complete growth inhibition of all tested fungal strains at a lower minimum inhibitory concentration.

The TBE assay revealed that both dendrimers enter HFF-1 cells via temporary or permanent membrane permeabilization. At the threshold concentration of 30 µg/mL, dendrimers induced irreversible, time-dependent membrane permeabilization, as higher concentrations accelerated this effect. Microscopic observations and Laurdan fluorescence spectroscopy confirmed compromised membrane integrity, as treated cells exhibited a predominantly blue fluorescence and decreased lipid order, which is indicative of disrupted membrane integrity and permeability. At non-toxic concentrations below 30 µg/mL, dendrimers crossed the cell membrane via temporary permeabilization. Treated cells showed dendrimer accumulation in the cytoplasm, while membrane integrity remained intact, suggesting the formation of transient nanoholes and reversible membrane processes under these conditions.

Keywords

Dendrimers, HFF-1 cell line, Fungi, Cytotoxicity, Antifungal agents.

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Visual Imaging Processing of Abstractionism in Art

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Eye movement research data from which we can obtain useful information about the momentary focus of attention is related to the motor coordination of hand movements. Several studies have provided clear evidence that the two motor systems rely on different adaptive mechanisms [1]. Previous works studying adaptive-reactive saccades found little or no transfer of adaptation from reactive saccades to hand pointing movements, suggesting that the two motor systems rely on different adaptive mechanisms. The study involved 6 individuals aged 55-65 years, with varying professional experience, with lesions and impairments of the anterior superior frontal and posterior parietal cortex, and immobilization of the writing hand for more than a month. Part of the individuals had more than 20 years of driving experience. The participants were given a two-week deadline to complete a task involving observing an abstract watercolor painting form and contouring the images they distinguished. A drawing sheet is divided into an upper and lower half and within 5 minutes, the subjects must draw the figures they see with a pen first in the hand that they draw better with. Only 4 subjects completed the task within 5 days. Between subjects with technical skills and those who are involved in art, a difference is observed in contour depiction such as schematization and separation of individual images. A significant difference was observed in the accuracy of the contour when depicting with the left hand in the form of a curve in people who draw better with the right hand. A significant difference in the accuracy of the contour when depicting with the left hand was observed in the type of curve in people who draw better with the right hand. Two approaches to recognizing details were distinguished: gradual and complete and partial generalized, as well as depicting difficult-to-distinguish details by professional artists and people with drawing experience.

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Chemical Synthesis and Biological Assessment of Multimodal Pressure Sensors with Biocompatible and Antibacterial Properties

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The present work investigates the biocompatibility and functional potential of elastomeric composites designed for the fabrication of flexible force and pressure sensors. The materials are based on polyvinyl silicone (PVS) incorporating different loadings of acetone-treated carbon black (SPHERON 5000) as a conductive filler. A comprehensive characterization, including physical, physicochemical and biological analyses, was conducted to assess the suitability of the developed composites for plantar pressure monitoring in in-shoe measurement systems. The biological evaluation focused on cytotoxicity and antibacterial activity in order to determine their biocompatibility and potential applicability in biomedical and wearable sensor technologies. The obtained results demonstrate that the PVS/carbon black elastomeric composites exhibit low cytotoxicity, good biocompatibility, and pronounced antibacterial properties, thus confirming their suitability for integration into flexible force-sensing platforms.

Keywords

PVS - carbon, Pressure sensors, Biocompatibility, Antibacterial activity, Cytotoxicity.

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