

**The Fourth Annual Conference and Training Program of
Pan-Balkan Alliance of Natural Products and
Drug Discovery Associations
and
International Seminar of UNESCO Regional Network of
Natural Products Chemistry for Safety and
Well-being in Asia and the Pacific**

**“第四届中国-泛巴尔干天然产物和新药发现联盟年会及培训会议” 暨
“联合国教科文组织天然产物化学安全与福祉亚太区域网络”
国际研讨会**

2023. 11. 29-12.2 Parkyard Hotel, Shanghai, China

上海 博雅酒店





PANDA & UNESCO Conference

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2023.11.29-12.2 Shanghai

Directed by

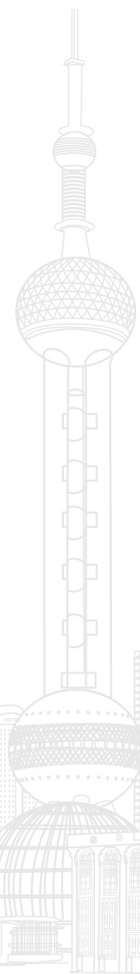
- Bureau of International Cooperation, Chinese Academy of Sciences
- The Alliance of National and International Science Organizations for the Belt and Road Regions (ANSO)
- Chinese Academy of Sciences Shanghai Branch

Organized by

- Shanghai Institute of Materia Medica, Chinese Academy of Sciences (SIMM)
- State Key Laboratory of Drug Research
- China-Serbia “Belt and Road” Joint Laboratory on Natural Products and Drug Discovery
- Institute for Biological Research “Sinisa Stanković, University of Belgrade (IBISS)
- UNESCO Regional Office for East Asia

Supported by

- Shanghai Pharmaceutical Association
- Wuhan Institute of Industrial Innovation and Development
- Shanghai Center of Biomedicine Development
- Vigonvita Life Sciences Co., Ltd.
- Natural Product Research Center, SIMM



INFORMATION





Theme

Natural products and drug discovery innovation and technology transfer

Background

On the occasion of the Third Belt and Road Forum for International Cooperation, Shanghai Institute of Materia Medica (SIMM), Chinese Academy of Sciences (CAS), and Institute for Biological Research “Sinisa Stanković, University of Belgrade (IBISS) are jointly organizing a conference. Nearly 60 scientists from China, the Balkans, including Serbia, North Macedonia, Albania, Bulgaria, Hungary, and Ethiopia, will participate in the conference. The conference will be co-chaired by Prof. Yang Ye, Deputy Director of SIMM, and Dr. Marina Soković, Assistant Minister of Science, Technology Development and Innovation of Serbia, and a researcher at IBISS. The conference will showcase the biomedical research achievements of various countries in the areas of major chronic diseases, newly emerging viral infectious diseases, including the discovery of bioactive compounds derived from natural products and traditional medicines, the discovery of new drugs based on active compounds, the sharing of success stories and practices in knowledge transfer and translation, and the exploration and acceleration of international cooperation in the field of biomedicine to address the unmet clinical needs.

The Southeast Asian Network for Natural Products Chemistry is an academic network in the field of basic sciences supported by UNESCO. It has been strongly supported by representatives from various countries since 1977. The network actively organized regional scientific conferences, training programs, and exchanges among scientists to promote the widespread application of natural product chemistry in the region. It also enhanced academic exchanges and collaboration among scientists, particularly young scientists, and elevated the academic standards of natural product research in the region.

The COVID-19 pandemic has heightened our attention to traditional and herbal medicine. This health crisis has made us realize the complementary and integrative development of modern and traditional healthcare approaches that play a crucial role in safeguarding people's health and well-being.

Following consultations, the UNESCO Beijing Office intends to support the Shanghai Institute of Materia Medica, Chinese Academy of Sciences, in organizing a small-scale symposium. The symposium will invite representatives from member countries of the Southeast Asian Network for Natural Products Chemistry to discuss the resumption of academic



activities of the network supported by UNESCO and further expand it to the entire Asia-Pacific region. It aims to promote inclusive and open scientific dialogue and explore technical approaches for the integration of traditional knowledge and modern science.

The symposium will cover topics such as recent research advances in natural product chemistry in the region, interdisciplinary practices, the construction and sustainable development of ecosystems with active natural product resources, the intersection of emerging disciplines such as synthetic biology and natural product chemistry, and the application of ethnic medicine in response to newly emerging viral infectious diseases. Additionally, we will jointly promote collaborative research on the sustainable application of natural products and integrate it with health, agriculture, food science, biotechnology, and other applications, such as eco-friendly natural dyes.

We sincerely hope to revive and revitalize the Southeast Asian Network for Natural Products Chemistry in the Asia-Pacific region. We also aim to design and plan grants, exchanges, and visit programs for young scientists to engage in international collaborative research, making the network a leading institution for open dialogue and collaborative exchanges between regions. This will pave the way for the development of natural product research in the Asia-Pacific region and actively explore the integration of traditional wisdom, modern research, and open science.

Aim

This conference will discuss topics such as technological innovation progress in the field of natural products and drug discovery, as well as mechanisms for the industrialization of achievements. The presentations will showcase the latest advancements in traditional Chinese medicine and ethnic medicine research, drug discovery, mechanisms for the transformation of achievements, and the construction of laws and regulations. In collaboration with UNESCO Regional Office for East Asia in Beijing, the conference aims to further promote the exchange of scientists from research institutions, universities, and the business community in China, the Pan-Balkan region, and the Asia-Pacific region in the field of natural product research and new drug development. It also aims to promote the construction of an internationally standardized comprehensive innovative drug development system, enhance the research and development capabilities of both parties in new drug development, establish a mechanism for joint talent development and exchange, promote joint training of graduate students, explore new models for the transfer of achievements, and promote cooperation among countries.



Academic committee

Prof. Kaixian Chen, Prof. Jianmin Yue, Prof. Bing Zhou, Prof. Chunhao Yang, Prof. Dehua Yang, Prof. Huixiong Dai, Prof. Haiyan Zhang, Prof. Jingshan Shen, Prof. Likun Gong, Prof. Lijiang Xuan, Prof. Tianyu Zhang, Prof. Wei Tang, Prof. Xin Xie, Prof. Yongzhuo Huang, Prof. Yiming Li, Prof. Yang Ye, Prof. Zhaobing Gao

Organizing committee

Prof. Jian Ding, Prof. Yang Ye, Dr. Marina Soković, Prof. Shahbaz Khan, Dr. Ai Sugiura, Dr. Yongning Chen, Mr. Yongzheng Wu, Ms. Dongying Lu, Ms. Hadžimurtović Nađa, Dr. Bintao Hu, Dr. Chunping Tang, Dr. Yang Wu, Ms. Qing Li, Ms. Yixuan Zhao, Ms. Qinxin Wang



PROGRAM OF EVENTS





Time	Activity	Venue
November 29		
08:00	Registration and check-in	Parkyard Hotel
12:00-13:30	Buffet lunch	Woodside, Parkyard Hotel
15:30-17:00	PANDA Council Meeting	CAS Shanghai Branch
18:00	Buffet dinner	Woodside, Parkyard Hotel
November 30		
09:00-09:30	Registration	Foyer Hall, Parkyard Hotel Host by: Prof. Yang Ye
09:30-09:40	Opening remarks	
09:40-09:48	Introduction of Shanghai Center of Biomedicine Development	
09:48-09:56	Introduction of Zhongshan Institute for Drug Discovery	
09:56-10:04	Introduction of Bohai Rim Advanced Research Institute for Drug Discovery	
10:04-10:12	Introduction of Suzhou Institute of Materia Medica	
10:12-10:20	Introduction of Vigonvita Life Sciences Co., Ltd.	
10:20-10:25	Unveiling Ceremony of China-Serbia "Belt and Road" Joint Laboratory on Natural Products and Drug Discovery	
10:25-10:35	Accession Ceremony and introduction of Wuhan Institute of Industrial Innovation and Development	
10:35-10:45	Accession Ceremony and introduction of OSIC Holding Group Co. Ltd	
10:45-10:50	Awarding Ceremony of Honorary Chair for Dr. Viktor Nedović	
10:50-11:10	Group photo and coffee break	
11:10-11:30	Research progress in screening and evaluating the activities of anti-mycobacterial drugs Speaker: Prof. Tianyu Zhang	Foyer Hall Moderator: Dr. Marina Soković, Prof. Antoaneta Trendafilova
11:30-11:50	Systematic Study of Albania's <i>Salvia Officinalis</i> essential oils composition! Speaker: Prof. Sokol Abazi	
11:50-12:10	Efficient fractionation for the preparative separation of sesquiterpenoids from <i>Tussilago farfara</i> by counter-current chromatography Speaker: Prof. Yeong Shik Kim	

12:10-13:30	Buffet lunch	Woodside
13:30-13:50	Dozen natural products from Ethiopia suitable for drug discovery and innovation Speaker: Prof. Ermias Dagne Haile	Foyer Hall Moderator: Prof. Tibor Kurtán, Prof. Biljana Kukavica
13:50-13:58	Antitumor compounds from <i>Commiphora erlangeriana</i> of Ethiopia Speaker: Dr. Mesfin Getachew Tadesse	
13:58-14:18	Storage condition of medicinal/aromatic plants and use of essential oils and hydrosol as an alternative natural postharvest sanitation mean Speaker: Prof. Nikolaos Tzortzakis	
14:18-14:26	Revealing the antimicrobial potential of <i>Inula extracts</i> : A novel approach to combat bacterial virulence Speaker: Petya Dimitrova Dimitrova	
14:26-14:46	Biosynthetic studies of Bicyclomycin and Leinamycin Speaker: Prof. Song Meng	
14:46-14:54	Potential medicinal properties of the Balkan endemic <i>Scilla litardierei</i> and <i>Scilla lakusicii</i> Speaker: Toda Ignjatović	
14:54-15:14	Olive and olive oil – tradition and use Speaker: Prof. Biljana Lazović	
15:14-15:22	Preliminary results of the research on chemotype diversity of native populations of <i>Helichrysum italicum</i> in Montenegro Speaker: Andreja Komnenić	
15:22-15:30	Herbal medicinal products in Montenegro Speaker: Dr. Svetlana Vujović	
15:30-15:50	Coffee break	
15:50-16:10	Chiroptical analysis of natural and synthetic heterocycles with isolated blocks of chirality Speaker: Prof. Tibor Kurtán	Foyer Hall Moderator: Prof. Tianyu Zhang, Prof. Sokol Abazi
16:10-16:18	Domino synthesis of chiral heterocycles possessing antiproliferative activity Speaker: Dr. Sándor Balázs Király	
16:18-16:26	Domino Knoevenagel-cyclization sequences for preparation of condensed chiral heterocycles with antiproliferative activity Speaker: Mihály Kajtár	
16:26-16:46	New analytical approaches in Silymarin Quantification Speaker: Prof. Gjoshe Stefkov	



16:46-16:54	The importance of quality control for medicinal cannabis Speaker: Dr. Ivana Cvetkovikj Karanfilova	Foyer Hall Moderator: Prof. Tianyu Zhang, Prof. Sokol Abazi
16:54-17:02	Real time monitoring of decarboxylation of cannabinoids in <i>Cannabis sativa</i> L. Speaker: Olga Gigopulu	
17:02-17:22	Dry rose extract, a new product from <i>Rosa damascena</i> Mill – insight into the chemical composition and potential health-related benefits Speaker: Prof. Antoaneta Trendafilova	
17:22-17:30	Study of essential oil composition of <i>Vitex agnus-castus</i> grown in different locations of Albania! Speaker: Doriana Islami	
17:30-17:38	Comparative phytochemical study of two populations of <i>Salvia lanigera</i> from Egypt Speaker: Dr. Viktoria Ivanova	
17:38-17:58	Enzymatic synthesis and biological activity study of non-natural amino acids Speaker: Prof. Cangsong Liao	
18:30	Buffet dinner	Woodside





Time	Activity	Venue
December 1		
09:00-09:20	Secondary metabolites from Hainan marine invertebrates: Chemical diversity, biological function and drugability Speaker: Prof. Yue-Wei Guo	Foyer Hall Moderator: Prof. Biljana Lazović, Prof. Gjoshe Stefkov
09:20-09:28	Bio-based ingredients as alternatives for the food and pharmaceutical industries Speaker: Dr. Filipa Sofia Dinis Reis	
09:28-09:48	A preclinical overview of plant sources in drug discovery Speaker: Prof. Ipek Süntar	
09:48-09:56	Employing apple pomace as a natural and functional ingredient for application in the food and nutraceutical industries Speaker: Liege Aguiar Pascoalino	
09:56-10:16	ErinacinA project – development of GOBA® <i>Hericium erinaceus</i> K food supplement and its effect on cognitive functions and gut microbiota Speaker: Dr. Andrej Gregori	
10:16-10:24	Optimization of cordycepin isolation procedure from <i>Cordyceps militaris</i> Speaker: Mateja Zotler	
10:24-10:44	Coffee break	
10:44-11:04	Medicinal plants and their antioxidant capacity Speaker: Kristina Bratić	Foyer Hall Moderator: Prof. Ipek Süntar, Dr. Andrej Gregori
11:04-11:12	NMR and LC-HRMS based profiling for the quality control of food commodities – Exploitation of statistical tools for markers' identification. Speaker: Dr. Stavros Beteinakis	
11:12-11:32	The freshwater spongy <i>Ephydatia fluviatilis</i> as potential natural antimicrobial agent Speaker: Dr. Ana Čirić	
11:32-11:40	Metabolomic approaches employing LC-MS for the investigation of the role of natural products in different biological platforms Speaker: Dr. Eleni Vaskani Mikropoulou	
11:40-12:00	Myricanol prevents aging-related Sarcopenia by rescuing mitochondrial dysfunction via targeting peroxiredoxin 5 Speaker: Dr. Ligen Lin	



12:00-12:08	Hesperetin's ability to reduce mono- and polymicrobial biofilms Speaker: Tamara Carević	
12:08-12:16	Phytochemical profiling of <i>Cucumis metuliferus</i> E. Mey <i>in vitro</i> plant cultures Speaker: Mladen Rajaković	
12:16-13:30	Buffet lunch	Woodside
13:30-13:45	Greening pharmaceutical and natural product quality control with green analytical chemistry Speaker: Dr. Sysay Palamy	Foyer Hall Moderator: Prof. Viktor Nedović, Prof. Nikolaos Tzortzakis
13:45-14:00	New secondary metabolites from Mongolian plants Speaker: Dr. Sarangerel Oidovsambuu	
14:00-14:15	Biotechnological potential of medicinal important species of Mongolia Speaker: Dr. Bolortuya Ulziibat	
14:15-14:30	Mangrove as the source of natural dyes, opportunities and challenges to kampung laut, cilacap regency Speaker: Prof. Catur Sugiyanto	
14:30-14:45	Introduction of INPC -VAST and some brief results in researching of natural products chemistry Speaker: Prof. Quoc Long Pham	
14:45-15:00	Impact of nature product chemistry in healthcare: challenges and future perspective Speaker: Prof. Avinash Bajaj	
15:00-15:15	Research and Innovation of Indonesian Medicinal Plants Speaker: Dr. Sofa Fajiriah	
15:15-15:30	Searching for lead compounds against SARS-Cov-2 from traditional Chinese medicines Speaker: Prof. Yang Ye	
15:30-16:00	Coffee break	
16:00-16:10	Address by Prof. Shahbaz Khan	
16:10-16:20	Introduction of UNESCO Speaker: Dr. Ai Sugiura	Foyer Hall Host by
16:20-17:00	Panel discussion	
18:00	Conference dinner	

Time	Activity	Venue
December 2		
09:30-11:30	Revival Meeting of UNESCO Regional Network of Natural Products Chemistry for Safety and Well-being in Asia and the Pacific	Yisheng Hall, SIMM
12:00-14:00	Lunch	
09:00-18:00	Departure	



ACADEMIC REPORTS





Name: Tianyu Zhang
Title: Professor
Institution: Guangzhou Institutes of Biomedicine and Health (GIBH),
 Chinese Academy of Sciences (CAS)
Position: Vice Director
Email: 18819181735@163.com

Research Field Discovery and development of antibacterial agents including establishment of rapid, economic high-throughput screening and evaluation antibacterial drugs platform and latent infection model. 2. Mechanisms of action of antibacterial drugs and new compounds.

Report Title **Research progress in screening and evaluating the activities of anti-mycobacterial drugs**

Keywords *Mycobacterium, animal model, latent infection, drug resistance*

Abstract In the report, I will briefly introduce tuberculosis and development of new anti tuberculosis drugs globally, progress in screening and evaluation techniques for anti-tuberculosis drug activity based on mainly our own studies. The techniques include high throughput drug in vitro and in vivo screening methods based on the autoluminescent mycobacteria in vented by us; the new concepts for in vitro screening drugs including negative selection, simulating physiological nutrition condition screening, non-replicating screening; the rapid methods for testing activities of compounds against clinical isolates; the new inhalation administration model developed by us, the latent infection tuberculosis model and so on. I will also introduce the devices developed by us for carrying out the special experiments. Additionally, I will introduce the research and development progress of our team's anti mycobacterial drug TB47.

Short Biography

- 2005.09-2010.08 Post-doctoral fellow, Johns Hopkins University
- 2010.09-Now Professor, PI, Leader of Tuberculosis Lab, State Key Laboratory of Respiratory Disease, Center for Infection and Immunity, Guangzhou Institutes of Biomedicine and Health (GIBH), Chinese Academy of Sciences (CAS)
- 2012.03-2014.12 Selected person of "Introduction of Foreign Outstanding Talents" of the Chinese Academy of Sciences
- 2017.04-2021.06 "Scientific and Technological Innovation Leading Talent" of 2016 Guangdong Special Support Plan
- 2019.01-Now "Excellent Expert" in Guangzhou
- 2020 "Leading Talent in Scientific and Technological Innovation" of China
- 2021.06-now Deputy Director of Center for Infection and Immunity, GIBH
- 2021.06-now "Outstanding Talent" in Huangpu District of Guangzhou



Name: Sokol Abazi
Title: Prof. Dr.
Institution: Canadian Institute of Technology
Position: Rector
Email: sokol.abazi@cit.edu.al

Research Field Natural Product, Organic Synthesis, SFE Extractions

Report Title **Systematic Study of Albania's Salvia Officinalis essential oils composition!**

Keywords *Salvia, essential oil, SFE.*

Abstract Medicinal and Aromatic Plants (MAP), are an endless source of bioactive compound largely used in pharma, cosmetics and food industry. A very well-known plant of Balkan region, salvia officinalis (Lamiaceae), is object of this study. This plant can be found almost all over the country and the metabolite content of essential oil is highly depending on the geographical position, method of extraction, period of the year, cultivated or collected in the nature etc! A systematic study of essential oils obtained from plants of different geographical position, collected in different seasons, showed that the plants collected from the north of Albania have a larger content of Thujons and less Camphor. The plans collected on Central and South of Albania, showed a higher concentration of Camphor and less Thujones! Also high differences in chemical composition were observed between cultivated sage and the one collected in wild!

Short Biography Sokol Abazi graduated as Industrial Chemist in Albania, Tirana University in 1989. In 1997 he obtained his PhD from Fribourg University (Switzerland) in organic synthesis. After a Postdoc in Total Synthesis of Natural Products at Oxford University in 1998, he worked for a couple of companies in the UK and Switzerland and then returned to Albania 2008 working as a Full Professor at Tirana University. Since 2015 he is a Full Professor at CIT, where from 2020 he holds the Rector position. His research interests are mainly focused on natural products, organic synthesis, and supercritical fluid extraction (SFE).



Name: Yeong Shik Kim
Title: Professor & Dr
Institution: Natural Products Research Institute, College of Pharmacy,
Seoul National University
Position: Emeritus Professor
Email: kims@snu.ac.kr

Research Field	Analysis and preparative separation of natural products
Report Title	Efficient fractionation for the preparative separation of sesquiterpenoids from <i>Tussilago farfara</i> by counter-current chromatography
Keywords	<i>Counter-current chromatography, Preparative separation, Sesquiterpenoids, Tussilago farfara</i>
Abstract	<p>A novel application of counter-current chromatography (CCC) to enrich plant extracts using direct and continuous injection (CCC-DCI) was developed to fractionate sesquiterpenoids from the buds of <i>Tussilago farfara</i> L. In this study, an n-hexane-acetonitrile-water (HAcW) solvent system was separately pumped into the CCC column, and an extraction solution (45% acetonitrile) was directly and continuously injected into the CCC column. Finally, 6.8 g of a sesquiterpenoid-enriched (STE) fraction was obtained from the crude extract (315.9 g) of <i>Tussilago farfara</i> (1 kg) in a single CCC run with a separation time of 8.5 hrs. The sample injection capacity of CCC-DCI was greater than 300 grams that could not be handled in conventional CCC or with other fractionation methods for the same separation column size. Moreover, three major sesquiterpenoids (TG: tussilagone, AECN: 14-acetoxy-7β-(3'-ethyl cis-crotonoyloxy)-1α-(2'-methylburyryloxy)-notonipetranone, and ECN: 7β-(3'-ethyl cis-crotonoyloxy)-1α-(2'-methylburyryloxy)-3, 14-dehydro-Z-notonipetranone) were purified from the STE fraction by CCC. The average CCC-DCI recoveries were 96.1% (TG), 96.9% (AECN), and 94.6% (ECN).</p>
Short Biography	<p>Prof. Yeong Shik Kim is the Emeritus Professor of Seoul National University and keeps the joint professorship of Natural Products Research Institute of the same university. He had been engaged in drug discovery and development from the resources of natural products for 30 years. His main research interests had focused on testing anti-inflammatory and antioxidant activities regarding herbal extracts and pure substances isolated from medicinal herbs. He published more than 350 papers in peer-reviewed journals He is currently working as a director of Woori B&B producing porcine heparin.</p>



Name: Ermias Dagne Haile
Title: Emeritus Professor of Chemistry
Institution: Addis Ababa University, Ethiopia
Position: Emeritus Professor
Email: edagne@gmail.com

Research Field

Natural Products Chemistry

Report Title

Dozen Natural Products from Ethiopia Suitable for Drug Discovery and Innovation

Keywords

Aloe, Coffee, Black cumin, Frankincense, Myrrh

Abstract

The use of plants and animal products as medicine and for a wide array of other uses is deeply entrenched in the culture and religions of our people. In this lecture we describe a dozen highly interesting plant products with origin in Ethiopia.

Aloe: Aloe is a genus with origin in Africa comprising over 400 species. Aloe vera is cultivated in different parts of the world for use in the cosmetics industry to make hair and skin care products. About 40 species of Aloe are found in Ethiopia, the most interesting being the endemic plant Aloe pulcherimma. <http://alnapnetwork.com/SpeciesDetail.aspx?input=aloe%20pulcherrima&selectedOption=0>

Coffee: Ethiopia's gift to the world is without doubt one of the most interesting and intriguing natural products. In Ethiopia coffee is not only drunk as a beverage but it is also eaten for the same purpose as the coffee drink. We have recently developed a simple and effective way of eating roasted and powdered coffee to get as good as coffee drink. This new method will be demonstrated in the lecture. <http://alnapnetwork.com/SpeciesDetail.aspx?input=coffea&selectedOption=0>

Black Cumin or Black Seed: Nigella sativa is widely cultivated in the Ethiopian highlands at altitudes above 3000 meters. When pressed the seeds yield up to 40% black medicinal oil. Thymoquinone is the main bioactive component responsible for the hypoglycemic, antioxidant, liver protecting, analgesic, spasmolytic, anti-tumor etc. <http://alnapnetwork.com/SpeciesDetail.aspx?input=nigella&selectedOption=0>

Other topics: Frankincense, myrrh etc.

Short Biography

Ermias Dagne was born on June 8, 1944, got his PhD in the University of California, USA. He is emeritus and leader of a very active research group in Ethiopia. He and his wife run a natural products business: www.arithherbal.com that brings herbs, extracts, and a wide array of value added natural products to local and international markets.

He leads a popular and versatile database: www.alnapnetwork.com



Name: Mesfin Getachew Tadesse
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Research Field

Natural Products Chemistry

Report Title**Antitumor compounds from *Commiphora erlangeriana* of Ethiopia****Keywords***Resin, Commiphora, Myrrh, Antitumor, Podophyllotoxin***Abstract**

The resinous materials from the bark of species of the genus *Commiphora* are important substances in indigenous medicines of many countries in East Africa, Arabia, India and China. The most well-known member of this genus, found in Ethiopia, Kenya, and Somalia, is *C. myrrha*, which yields a culturally and medicinally important gum resin known commercially as myrrh. *C. erlangeriana* resin has been a subject of previous research from our research group, which described the isolation and characterization of four unique podophyllotoxin and polygamatin-type compounds, referred to as Erlangerins A to D.

In our continued efforts to search for additional compounds from *C. erlangeriana*, we have isolated several podophyllotoxin and polygamatin type lignans, the dibenzylbutyrolactone lignans of their precursors, and other types of compounds. The isolated compounds were tested for their cell proliferation inhibition activity against three human cancer cell lines, namely: Daoy (human medulloblastoma), NCI-H1792 (human lung adenocarcinoma) and NCI-H1650 (human lung adenocarcinoma). A number of compounds showed very strong inhibition of cell proliferation against Daoy and NCI-H1792 cell lines at IC₅₀ values of 0.089 - 8.1 μ M and 0.083 - 18.8 μ M, respectively. The structure elucidation of these new compounds and their antitumor activity are presented and discussed.

Short Biography

Mesfin Getachew was born on November 18, 1980, got his Ph.D. in Addis Ababa University, Ethiopia. He is an assistant professor of organic chemistry and research collaborator of Prof. Ermias Dagne research group. He is also active member and coordinator of ALNAP (African Laboratory for Natural Products).



LECTURES L6



Name: Nikolaos TZORTZAKIS
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Position: Associate Professor
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Research Field Horticulture, Vegetable Science, Aromatic/Medicinal Plants, Greenhouse Crops and Hydroponics, Soil and Substrate/Growing Media Evaluation, Abiotic Stress, Post-harvest Science and Preservation

Report Title **Storage condition of medicinal/aromatic plants and use of essential oils and hydrosol as an alternative natural postharvest sanitation mean**

Keywords *Postharvest, natural products, quality and safety, antimicrobial*

Abstract Medicinal and aromatic plants (MAPs) are widely used in many cuisines around the world as well as traditional medicines. MAPs are highly perishable with short shelf life. In an attempt to reduce the use of synthetic fungicides, a turn towards natural products such as essential oils (EOs) and natural compounds has been made, and their use for food preservation is investigated. In one study, Cypriot oregano (*Origanum dubium*) EO and hydrosol, due to their biocidal properties, were tested on fresh spearmint's quality preservation in different concentrations (0, 0.001, 0.01 and 0.1%) and time (0, 1, 5 and 10 min) of dipping application. In another study, new insights presented on the effects of eucalyptus (Euc), rosemary (Ros) EO, their mixture (50:50 v/v) and their common main component (i.e., eucalyptol) on the quality parameters, fruit response and inhibition of blue rot (*Penicillium expansum*) in apple and pear fruits during their shelf life. The results revealed that antifungal activity is not only related to eucalyptol, but to the synergistic effect of other EOs components. High EOs level, increased lipid peroxidation and hydrogen peroxide in fruits through oxidative stress, and optimum application is required for different fresh produce preservation, as alternative natural fungicides.

Short Biography Nikolaos Tzortzakis is Associate Professor at the Department of Agricultural Sciences, Biotechnology & Food Sciences, Cyprus University of Technology. He has extensive research experience on Vegetable Science, Aromatic/Medicinal Plants, Plant Nutrition, Soil, Hydroponics and Substrate determination, Climate Change and Abiotic Stress, Exploitation of Plant Wastes in Greenhouse/field Crops as well as Postharvest Preservation of Fresh Produce. He is involved (coordinator/partner) in EU and national projects. He has published more than 176 papers/book chapters (h-index: 36). For the last 4 years he received a high quality and international recognition as ranked in the Top 2% of researchers in the world.



Name: Petya Dimitrova Dimitrova
Title:
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Research Field microbiology

Report Title **Revealing the antimicrobial potential of Inula extracts: A novel approach to combat bacterial virulence**

Keywords *Biofilm, plant extracts, virulence, antibiotic resistance*

Abstract In today's world, the challenge of treating bacterial infections is growing due to antibiotic resistance. Consequently, it's crucial to seek new methods to reduce microbial virulence. An innovative approach in this regard involves the use of plant metabolites. In recent years, there has been a growing recognition of different phytochemicals as potential inhibitors of this bacterial phenotype. Our study aims to investigate the potential of various extracts from Inula species as natural agents for inhibiting bacterial virulence.

Our research underscores the potential of Inula extracts as natural inhibitors of bacterial virulence. The results indicate that the IBr1 and IBr1-SL extracts were highly effective in reducing biofilm formation in all examined strains. Additionally, the application of the plant extracts led to decreased violacein synthesis, swarming motility, and hemolytic activity. Scanning electron microscopy revealed a reduction in biofilm biomass, changes in biofilm architecture and cell morphology. Moreover, through fluorescence microscopy it was observed metabolically inactive cells suggesting the high activity of the extracts during treatment. These results reveal a promising approach to combat bacterial virulence by targeting key virulent phenotypes, thereby reducing their impact.

Acknowledgement: This work was supported by the National Science Fund at the Ministry of Education and Science, Bulgaria (Research Grant KP-06-H41/8; 30.11.2020).

Short Biography I am assistant Petya Dimitrova. I hold a Master's degree in Microbiology from Sofia University. My research has been centred on investigating the impact of plant extracts on various bacterial virulence factors. Besides this topic, I have interest in Molecular biology, Microscopy, Cell culture and Anti-biofilm activities of nanocomposites. My findings were presented at 20 national and international conferences, I participated in two international summer schools and contributed to the scientific community with my research work. I am an active participant in five national scientific projects related to antibiotic resistance, biofilm formation, application of plant extracts and nanocomposites, probiotic activities.



Name: Song Meng
Title: Professor
Institution: Shanghai Institute of Materia Medica, CAS
Position: Principal Investigator
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Research Field Discovery and Biosynthesis of Microbial Bioactive Natural Products

Report Title **Biosynthetic studies of Bicyclomycin and Leinamycin**

Keywords *Biosynthesis, Natural Products, Pathway, Enzymatic, Bioactivity*

Abstract Natural products with complex structures are one of the most important sources for new drug discovery. By deciphering the biosynthetic pathways of natural products, the mysterious construction from small building block to complex structures by Nature can be elucidated, thus provides opportunities for new enzymes and enzymatic reactions discovery. Many natural products derivatives can be generated through combinatorial biosynthesis and microbial strains engineering and will enrich the natural products library and facilitate drug discovery. The biosynthesis of Bicyclomycin, has been characterized by heterologous biotransformations, in vitro biochemical assays, and one-pot enzymatic synthesis which including regio- and stereoselectively installation of four hydroxy groups and one exo-methylene, as well as forming a medium-sized bridged ring through unactivated C-H bonds functionalization. The sulfur incorporation process for Leinamycin family of natural products has also been investigated, by characterization of an SAM-dependent hydropersulfide methyltransferase for Guangnanmycin biosynthesis, discovery of hydropersulfides as the nascent products of hybrid NRPS-PKS assembly lines and revelation of SH domains as thiocysteine lyases.

Short Biography Dr. Song Meng received his Ph.D. degree in natural products biosynthesis at Shanghai Institute of Organic Chemistry (SIOC), CAS, under the direction of Prof. Gong-Li Tang. Then he conducted his postdoctoral study in Prof. Ben Shen's lab at The Scripps Research Institute, Florida, and learned the emerging sciences and technologies in genome mining and synthetic biology and their applications to natural product biosynthesis. Song joined Shanghai Institute of Materia Medica(Simm), CAS as a professor in July, 2022. Currently, his lab is focusing on discovery and biosynthesis of antimicrobial natural products.



Name: Toda Ignjatović
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Research Field Plant biochemistry

Report Title **Potential medicinal properties of the Balkan endemic *Scilla litardierei* and *Scilla lakusicii***

Keywords *Antioxidative capacity, phenolic compounds, content Cu, content Fe*

Abstract Two Balkan endemic *Scilla* species were examined in the paper: *Scilla litardierei* Breistr. and *Scilla lakusicii* Šilić. Plant material was collected from karst fields and neighboring areas in eastern Herzegovina (B&H). The leaves were analyzed for the total content of phenolic compounds and the antioxidant activity of the extract, measured as Fe chelating ability, Fe and Cu reduction ability, and hydroxyl radical scavenging ability. In addition, the content of Fe and Cu was determined by atomic absorption spectroscopy. The results showed that the two species have a similar content of phenolic compounds and a similar antioxidant capacity. A significantly higher Fe content was measured in the leaves of *S. litardierei*, while an increased Cu content was measured in *S. lakusicii*, but without statistical significance. The possible medical use of the studied species was discussed in the paper.

Short Biography Fourth year Biology student from Banja Luka. Research is based on Antioxidative and Chelation properties of Polyphenolic compounds in plants, especially in medicinal plants of Bosnia and Herzegovina.



Name: Biljana Lazović
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Research Field

Olive growing, fruit breeding, genetic resources

Report Title

Olive and olive oil – tradition and use

Keywords

Olive, olive oil, tradition, quality, health

Abstract

Olive tree is one of the oldest fruit species grown by humans more than 5000 years ago, firstly in the area of Near East and then spread along Mediterranean basin. Main reason for growing olive is production of olive oil. Nowadays olive is grown on five continents but the highest production is still in the Mediterranean area, more than 95% of produced olive oil.

Olive oil, during the development of civilizations in the mentioned area was recognised as important for human nutrition, in trading, and had important role in healing and health. The same understanding of olive and olive oil is today.

Quality of olive oil depends of the olive variety, ecological conditions for the olive growth and production and the processing technology.

Quality of olive oil is regulated by International Olive Council (IOC) and EU standards. For human use the olive oil is classified as 'extra virgin' and 'virgin' olive oil. 'Virgin' olive oil means oil extracted directly from the fruit only by mechanical means - cold pressed. Olive oil is a natural product which used in every day diet has the best impact to the human diet and act as prevention to many diseases.

Short Biography

University degrees have obtained from the Faculty of Agriculture, University of Novi Sad, Serbia: bachelor (1985), master degree (1994) and PhD (1999).

Employed since 1990 at Biotechnical Faculty, Centre for Subtropical cultures in the sector of olive growing - which is a main research interest, and conservation and characterization of genetic resources as well.

Since 2006 involved in teaching.

Involved in realization of international projects with IAEA, IOC (THOC), and with Montenegrin Academy of Science and Art. Published more than 100 papers.

Covering position of Vice Dean for science and international cooperation at Biotechnical Faculty.



Name: Andreja Komnenić
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- Research Field** Bioactive compounds from plants, cultivation of medicinal and aromatic plants
- Report Title** **Preliminary results of the research on chemotype diversity of native populations of *Helichrysum italicum* in Montenegro**
- Keywords** *Helichrysum italicum*, chemotypes, essential oil
- Abstract** Immortelle (*Helichrysum italicum* (Roth) G. Don) is a very popular Mediterranean medicinal plant which is widely known for its valuable essential oil. It is commonly used as an ingredient in various cosmetic products, thanks to its regenerative properties and anti-aging effect. Species belonging to the genus *Helichrysum* are characterized by a high level of polymorphism, which results in numerous genotypes within the same species and subspecies, as well as in chemical variations in the essential oil composition. In order to determine the potential chemotypes of immortelle on the territory of Montenegro, 26 populations were collected in the central and southern parts of the country. All 26 essential oil samples obtained by hydrodistillation were analyzed by GC-MS. The essential oil content varied from 0.12% to 0.48%. The analyzes showed that the ten major compounds present in all essential oils were α -pinene (9.11-45.90%), italidione I (2.97-23.55%), β -acoradiene (2.4-17.83%), neryl acetate (0.04-16.49 %), italidione III (0.23-14.12%), italidione II (2.27-13.86%), β -selinene (0.03-8.78%), linalool (0.19-8.18%), ar-curcumene (2.28-7.09%), and limonene (0.55-6.45%). Hierarchical clustering allowed the grouping of the populations into two main chemotypes. Chemotype A is characterized by the predominance of α -pinene (23.57-45.90%), while Chemotype B is characterized by a high content of β -diketones, especially italidione I (13.61-23.55%).
- Short Biography** Andreja Komnenić was born in Cetinje, Montenegro on June 13th 1996. She graduated from the Biotechnical faculty in Podgorica at the University of Montenegro in 2019, and completed her internship at the Department of Field and Vegetable Crops. She finished her master's studies in 2020 on the same study program and enrolled in doctoral studies as a scholarship holder of the Ministry of Science and Technological Development of Montenegro. During her education path and doctoral studies, she was dedicated to researching medicinal and aromatic plants. She was participating in multiple international conferences, symposiums and student exchanges, and also enrolled in many courses that were relevant for her professional growth.



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Research Field Pharmacognosy

Report Title **Herbal medicinal products in Montenegro**

Keywords *herbal medicinal product, traditional herbal medicinal product, legislation*

Abstract Field of medicines in Montenegro is regulated by Law on Medicines (“Official Gazette of Montenegro”, No. 80/20). Legislation of medicines in Montenegro is quite aligned with European Union legislation. In order for a medicinal product to be placed on the market, it must meet certain criteria in terms of quality, safety and efficacy. According to Law on Medicines (“Official Gazette of Montenegro”, No. 80/20) and Directive 2001/83/EC, herbal medicinal products shall mean any medicinal product exclusively containing as active ingredients one or more herbal substances or one or more such herbal preparations, or one or more such herbal substances in combination with one or more herbal preparations. Traditional herbal medicinal product is a medicinal product, which is based on scientific principles, and it is a result of tradition or other traditional therapeutic approaches. In regardsto the situation in Montenegro, number of herbal medicinal products and traditional herbal medicinal products that have received marketing authorisation issued by the Institute of Medicines and Medical Devices is quite small. They are used to treat mental stress, sleep disorders and temporary insomnia, cough and cold,for the improvement of quality of life in mild dementia and other various conditions.

Short Biography Svetlana Vujović is a Montenegrin pharmacist born on June 22nd, 1996, in Nikšić. She graduated with her doctor of pharmacy (pharmD) degree from University of Montenegro, Faculty of Medicine, Pharmacy Study Program. During her studies, her main interests werepharmacognosy and phytotherapy. Her graduate thesis in the field of pharmacognosy was published as scientific paper. Since 2021, she has been working as pharmacovigilance associate at Institute for Medicines and Medical Devices of Montenegro which is national regulatory authority in the field of medicines. Apart from pharmacognosy and phytotherapy, in future she will focus on pharmacovigilance of herbal and traditional medicines.



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- Research Field** stereochemical analysis of synthetic and natural derivatives, synthesis of heterocycles
- Report Title** **Chiroptical analysis of natural and synthetic heterocycles with isolated blocks of chirality**
- Keywords** *chiroptical spectroscopy, stereochemistry, heterocycles, natural products*
- Abstract** The parallel configurational assignment of central and axial stereogenic elements in axially chiral biaryl natural products is still a challenging task, although the combination of electronic (ECD) and vibrational circular dichroism (VCD), and optical rotation (OR) calculations aided by NMR analysis may offer a solution. Biaryl-type atropodiastereomers usually have near mirror-image ECD spectra when their biaryl chromophore is not symmetrical, which can be used for the assignment of axial chirality with the aid of TDDFT-ECD calculations. Optically active heterodimeric biaryls, containing a stereogenic biaryl axis and up to four chirality centers, were synthesized stereoselectively. Enantiomeric pairs and stereoisomers up to seven derivatives were prepared with different substitution patterns, which enabled to test how OR, ECD and VCD measurements and DFT calculations can be used to determine parallel central and axial chirality elements in three isolated blocks of chirality. In contrast to natural penicisteckins A-D and related biaryls, the ECD spectra and OR data of (aS) and (aR) atropodiastereomers did not reflect the opposite axial chirality but they were characteristic of the central chirality. The atropodiastereomers showed consistently near mirror image VCD curves, allowing the determination of axial chirality with the aid of DFT calculation.
- Short Biography** Tibor Kurtán received his Ph.D. degree in 2001 and currently he is a full professor and department chair at the Department of Organic Chemistry, University of Debrecen, Hungary.
His research interest is the stereoselective synthesis and stereochemical study of flavonoids, related analogues and *O,N*-heterocycles with potential pharmacological activities. He also utilizes chiroptical methods for the stereochemical analysis of isolated and synthetic organic compounds in solution and solid-state.



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Research Field

Synthesis of heterocycles, domino reactions, stereochemistry

Report Title

Domino synthesis of chiral heterocycles possessing antiproliferative activity

Keywords

Domino reaction, heterocycles

Abstract

Synthesis of complex condensed heterocycles, usually requiring a lengthy synthesis, can be achieved using domino reactions. Aryl aldehydes containing a partially unsaturated heterocyclic moiety (2H-chromene, 5,6-dihydro-2H-pyran, 1,2-dihydroquinoline) undergo domino condensation-cyclization reactions with C- or N-nucleophiles (active methylene compounds or primary amines) affording condensed, chiral heterocycles diastereoselectively.^{1,2} The mechanism of the cyclization, and thus the structure of the product, is tuneable by the careful choice of reagent and substrate. Six different cyclization pathways were identified, affording six novel skeletons. Hetero Diels-Alder reactions yield condensed pyrano[4-3,b]pyran derivatives, formal [2+2] cycloadditions give 3-oxabicyclo[4.2.0]octanes, Povarov reactions offer 1,6-naphthrydines. Bridged and spirocyclic ring systems were also prepared by Alder-ene and Prins-type cyclizations, respectively, and a novel multistep cyclization reaction, affording N-hydroxyindoles was identified. Many of the heterocyclic products showed promising antiproliferative effects on different human cancer cell lines.

[1] – S. B. Király, A. Bényei, E. Lisztes, T. Bíró, B. I. Tóth, T. Kurtán; *Eur. J. Org. Chem.*; 2021, 45, 6161-6170.

[2] – S. B. Király, L. Tóth, T. Kovács, A. Bényei, E. Lisztes, B. I. Tóth, T. Bíró, A. Kiss-Szikszai, K. E. Kövér, A. Mándi, T. Kurtán; *Adv. Synth. Catal.*; 2023, 365, 3301.

Short Biography

Sándor Balázs Király received his master's degree from the University of Debrecen in 2015. He continued his research as a PhD. student between 2015 and 2018, under supervision of Prof. Tibor Kurtán, and got his doctorate title in 2023, and is currently working as an assistant lecturer in his group. His research interests focus on the synthesis of novel O-, and O,N-heterocycles using domino reactions, as well as stereochemical and chiroptical studies of both synthetic and natural products possessing potential pharmacological activities.



Name: Mihály Kajtár
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- Research Field** Synthesis of bioactive condensed chiral heterocycles with domino sequences
- Report Title** **Domino Knoevenagel-cyclization sequences for preparation of condensed chiral heterocycles with antiproliferative activity**
- Keywords** *Hetero Diels-Alder, antiproliferative activity, domino reaction, condensed heterocycles*
- Abstract** In our research group, domino Knoevenagel-cyclization sequences are utilized for preparation of the novel chiral condensed O,N-heterocyclic scaffolds. The domino reactions offer a straightforward way to prepare complex molecules starting from simple and readily available starting materials with reduced number of steps, great atom economy and short reaction time. The mechanism of the cyclization step can be tuned with the reaction condition, catalyst, and structure of the substrate and reagent. Chiral tri-, tetra- and pentacyclic N- and O,N-heterocycles were prepared with excellent regio- and diastereoselectivities and yields. Some of our products showed promising antiproliferative activity against human cancer cell lines with low micromolar IC50 values.
- Short Biography** Name: Mihály Kajtár
Date of birth: 1996.05.29
Residence: Mátai street 12. Debrecen, Hungary, HU4063
e-mail.: kajtar.mihaly@science.unideb.hu
Studies:
2014-2018 University of Debrecen, Chemical engineering BSc.
2018-2020 University of Debrecen, Chemical engineering MSc.
2020- University of Debrecen, Doctoral School of Chemistry.
Research work: I have been working in the Synthesis and Stereochemistry of Heterocycles research group since 2015. My research field is the domino cyclization reactions for the preparation of condensed chiral heterocycles with antiproliferative activity.



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Research Field

Pharmacognosy

Report Title

New analytical approaches in Silymarin Quantification

Keywords

Silybum marianum, quantification, PLS model, chromatography, spectrometry

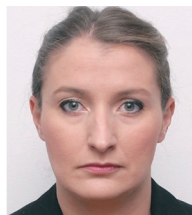
Abstract

Silymarin, mostly found in the fruits of the plant *Silybum marianum* (L.) Gaerth., is a blend of flavonolignans. Studies on *S. marianum* have revealed that it contains hepatoprotective, antihypertensive, antidiabetic, antioxidant, and antiatherosclerotic properties. The European Pharmacopoeia assay involves long and complex sample preparation followed by extensive HPLC analysis requiring at least 1.5% w/w of silymarin in dried seeds. Thus, the purpose of this study was to determine the amount of silymarin present in wild and cultivated milk thistle fruits and extracts, according to the Ph.Eur.11.0. monograph but also to speed up the analysis by applying rapid sample preparation and quantification methods. The obtained HPLC results of the samples of milk thistle fruits, collected throughout several years, showed that silymarin content varied within 0.3–1.8% w/w. The fruits and the extracts were also analyzed using spectroscopic techniques, and the collected spectra were assigned and used for building a partial least-squares (PLS) model for quantification, where HPLC was used as a reference technique. The Ph.Eur sample preparation was substituted with very effective one hour subsequent ultrasonic extraction and the chemometric analysis of the data obtained from FTIR and Raman measurements indicated acceptable statistical indicators for utilization of these methods.

Short Biography

Member of:

- MAP expert group 13 B within the European pharmacopeia
- Commission for Marketing Authorization of Food Supplements within Macedonian Agency for Food and Veterinary
- Commission for Classification of Pharmaceuticals within Macedonian Medicine Agency
- Commission for Marketing Authorization of Traditional Herbal Medicine within Macedonian Medicine Agency
- Commission for GMP within Macedonian Medicine Agency
- Commission for Cannabis cultivation licensing within Ministry of Health
- Commission for the Law on Control of Narcotic Drugs and Psychotropic Substances
- National coordinator for European Cooperative Programme of Plant Genetic Resources Conservation for Medicinal and Aromatic plants.
- Macedonian Pharmaceutical Association
- Macedonian Ecological Society
- AMAPSEEC



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Research Field

Pharmacognosy

Report Title**The Importance of Quality Control for Medicinal cannabis****Keywords***Medicinal cannabis, Quality control, potency, terpenes, pesticides and mycotoxins***Abstract**

The pharmaceutical quality of an herbal drug is ensured if it complies with the requirements of the European Pharmacopoeia or other national pharmacopoeias (e.g., DAB and Ph. Helv.). The abundance of commercialized strains, cannabinoid-containing products, extracts and border line products in North Macedonia, accompanied by the slow implementation of industry standards, GMP and labelling requirements resulted with general perception for the necessity of better quality control (QC). Recently, quality control of medicinal cannabis includes potency test/content of cannabinoids along with loss on drying according to the German Pharmacopoeia 2020 (DAB, 2020) or from 2024 according to the European Pharmacopoeia (Ph.Eur.12.0, 2024), then water content, terpenes and others parameters relevant for reflection of the quality of the product as well as microbiological testing, mycotoxin and pesticides monitoring. Therefore, the Center for Natural Products (CNP), at the Faculty of Pharmacy, UKIM, Skopje has established a Quality system, implementing all required methods for QC (Identification, HPLC method for cannabinoids content determination-DAB 2018), and have been accredited by the ISO 17025 standard in order to respond to the producers demand for QC and to strengthen state capacity to address to the challenges arising from the legal cannabis production.

Short Biography

2008 - Master of Pharmacy from the Faculty of Pharmacy in Skopje.
 2010 - Master's degree in Natural products and Biotechnology, from MAiCh, Crete (CIHEAM).
 2015 - PhD dissertation from the Faculty of Pharmacy in Skopje.
 2016 - Analyst at the Center for Natural Products (CNP), Faculty of Pharmacy in Skopje.
 2021 - Assistant professor at the Institute of Pharmacognosy.
 Responsible for laboratory work (Quality system) in the CPP as accredited laboratory for Cannabis.
 2023 - specialization in Drug Testing and Control from the Faculty of Pharmacy in Skopje.
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Research Field

Vibrational spectroscopy, PAT, chromatography, natural products

Report Title

Real time monitoring of decarboxylation of cannabinoids in *Cannabis sativa* L.

Keywords

Mid-infrared spectroscopy, TG, PCA, cannabis plant

Abstract

The process of decarboxylation of cannabinoids in cannabis plants occurs naturally over time, yet it is commonly employed in the manufacturing of finished cannabis products because it improves the products' bioavailability. The decarboxylation conditions vary significantly throughout manufacturers since there is a lack of information regarding the ideal process settings. As a result, the decarboxylation reaction must be observed and optimized to obtain the necessary crucial quality aspects of the finished product.

In this study, mid-infrared (MIR) spectroscopy in conjunction with HPLC, TG, and DSC analysis are employed in order to provide a better understanding of the THCA and CBDA decarboxylation reaction in real time and to emphasize its importance for the stability and quality of the herbal material.

The MIR spectra collected during the temperature-controlled IR experiments were subjected to principal component analysis. The maximum conversion temperatures for pure THCA and CBDA were outlined at 133°C and 128°C, respectively. However, in plant material the onset temperature and the maximum rate of decarboxylation were determined at significantly lower temperatures. The results from the kinetic studies at fixed temperatures indicate faster THCA than CBDA decarboxylation.

With these results a progress in the development and optimization of efficient and rapid technique for monitoring of decarboxylation reaction was achieved.

Short Biography

Date of birth: September 1, 1993

University education, qualifications and working positions:

2012-2017: Master of Pharmacy, Faculty of Pharmacy, Ss. Cyril and Methodius University, Skopje, R. Macedonia

2017-2018: Master's Degree in Research in and rational use of medicines – Faculty of Pharmacy, University of Valencia, Valencia, Spain

2020-ongoing: PhD student, Faculty of Natural Sciences and Mathematics, University "Ss Cyril and Methodius", Skopje, Field of study: Chemistry Thesis: Employment of vibrational spectroscopic technics and statistical models for quantitative analysis of phytocannabinoids in cannabis (*Cannabis* spp.) and its derivatives

2018-ongoing: Teaching laboratory assistant at the Institute of Applied Chemistry - Department of Organic chemistry, Faculty of pharmacy - Ss. Cyril and Methodius University, Skopje



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Research Field	Chemistry of Natural Compounds
Report Title	Dry rose extract, a new product from <i>Rosa damascena</i> Mill – insight into the chemical composition and potential health-related benefits
Keywords	<i>Rosa damascena</i> Mill, dry rose extract, phenolics, antioxidant activity, antimicrobial activity
Abstract	<p><i>Rosa damascena</i> Mill, commonly known as Damask rose holds a significant and symbolic place in Bulgaria with long-standing uses in culinary and traditional medicine. Nowadays, <i>R. damascena</i> is primarily cultivated in Bulgaria to produce the renowned rose essential oil, water, concrete and absolute. Beside to perfuming effects, many pharmacological properties of different extracts from this plant have been reported in the literature: antispasmodic, cardiovascular preventive, anti-inflammatory, antidepressant, diuretic, anti-HIV, and skin protective effects.</p> <p>Dry rose extract (DRE) obtained industrially by aqueous ethanol extraction from <i>R. damascena</i> flowers was the subject of this study. ¹H NMR allowed the identification and quantitation of fructose and glucose, while HPLC-DAD-ESIMS and HPLC-HRMS showed the presence of flavonoid and galloyl glycosides, phenolic acids and their esters, and ellagitannins. In addition, the structures of 13 flavonoid glycosides were confirmed by ¹H NMR. DRE showed good antioxidant activity (DPPH, ABTS and FRAP) and significant activity against <i>Propionibacterium acnes</i>, <i>Staphylococcus aureus</i>, and <i>S. epidermidis</i>.</p> <p>The obtained results show DRE is a promising source of bioactive compounds and could find innovative applications in the cosmetic, food and pharmaceutical industries.</p> <p>Acknowledgements: We thank Galen-N Ltd. for providing the extract and the Centre of Competence: BG05M2OP001-1.002-0012 for the equipment used.</p>
Short Biography	<p>Graduated from Faculty of Chemistry, Sofia University, 1991; Obtained PhD in 1997 from the Institute of Organic Chemistry with Centre of Phytochemistry, Bulgarian Academy of Sciences (IOCCP-BAS) Work in IOCCP-BAS since 1992.</p> <p>Experience in natural product chemistry - isolation, structural determination and analysis of biologically active natural compounds</p> <p>108 scientific articles with more than 780 citations, H-index 14; Participant in 8 international projects, supported by DFG, UNESCO, SNF, H2020, etc., 8 bilateral projects of BAS and more than 30 national projects (supported by NSF)</p> <p>Coordinator of 2 national projects and 6 bilateral projects of BAS with Serbian and Egyptian Academies of Sciences, TUBITAK.</p>



Name: Doriana Islami
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Research Field

Natural Product, microbiology, food contaminants

Report Title

Study of essential oil composition of *Vitex agnus-castus* grown in different locations of Albania!

Keywords

Vitex agnus-castus, essential oil, SFE.

Abstract

Vitex agnus-castus is a very well-known Mediterranean plant for its biological effects, dedicated to different classes of compounds, but mostly to terpenoids. Different methods of extraction have been used, from which different pure compounds are isolated and tested for their biological effects. This plant is also found in Albania, in its western part near the Adriatic and Ionian Sea! Essential oil analysis showed that the sample collected on the south of Albania have a higher concentration on oxygenated monoterpenes and sesquiterpenes and those from the north of Albania showed a higher concentration on monoterpenes, the cineole being the main component. By analysing the same plant in two different years, it was observed that α -pinene concentration during the year 2018 was 1.5-4 times higher than the year 2017, depending on geographical location. Also, the percentage of essential oil obtained by SFE extraction was much higher than the one obtained by hydrodistillation!

Short Biography

Doriana Islami finished her master studies in chemistry on 2004 from the Faculty of Natural Sciences in Tirana. She has been working in two different accredited laboratories in Albania. She has had in depth training in Italy in microbiology and food analysis. Now she is the Technical Director of Tenuis Laboratories. She specialised on chromatographic analysis of plant material, including nutrients and contaminants like pesticides, heavy metals, mycotoxins etc.



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Research Field	Chemistry of Natural Compounds
Report Title	Comparative phytochemical study of two populations of <i>Salvia lanigera</i> from Egypt
Keywords	<i>Salvia</i> , phenolic compounds, biological activity, LC/MS
Abstract	<p>The plants from genus <i>Salvia</i> are well known for their application in traditional medicine as well as a condiment for tea and food. <i>Salvia lanigera</i> Poir. is a small herbaceous perennial with purple flowers growing in low-altitude deserts, in sandy loam and chalky sandstone soils. During the collection of <i>S. lanigera</i> from the northern coast of Egypt, an unusual population with white flowers and similar morphological characteristics was found. This prompted us to perform a comparative phytochemical study of these two populations.</p> <p>LC/MS of the extracts, obtained by extraction with 70% aq. MeOH, led to identification of 22 compounds: phenolic compounds and flavonoids. In addition, the structure of rosmarinic acid, caffeoyl malate, feruloyl malate, coumaroyl malate, luteolin-7-O-glucoside, apigenin-7-O-glucoside and luteolin was confirmed ¹H NMR after their isolation by CC and PTLC. All these compounds are discovered for the first time in <i>S. lanigera</i>. Both extracts exhibited weak DPPH radical scavenging and anti-acetylcholinesterase activities but differed in the content of the main compound – rosmarinic acid. ISSR and SCoT analyses revealed that <i>Salvia lanigera</i> with the white flower is a new variety of the species.</p> <p>Acknowledgements: The authors are thankful to the Project IC-EG/04/2022-2024/#10119 for the financial support.</p>
Short Biography	<p>2008-2012: Bachelor's degree, Biotechnology, University of Chemical Technology and Metallurgy, Sofia, Bulgaria.</p> <p>2012-2013: Master's degree, Fine Organic Synthesis, University of Chemical Technology and Metallurgy, Sofia.</p> <p>2020-2022: PhD, Bioorganic Chemistry, Chemistry of Natural and Physiologically Active Substances, Institute of Organic Chemistry with Centre of Phytochemistry (IOCCP), BAS, Sofia.</p> <p>Chemist (2013-2023) and Assist. Prof. (2023 – up to now) in the Lab. "Chemistry of Natural Compounds", IOCCP, BAS.</p> <p>Main activities: planning and conducting scientific research in the field of chemistry of natural compounds: extraction, isolation and structural characterization of secondary metabolites; 20 scientific publications with 62 citations, participation in 20 scientific projects.</p>



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Research Field Biocatalysis, Chemical biology, Synthetic Biology

Report Title **Enzymatic Synthesis and Biological Activity Study of Non-natural Amino Acids**

Keywords *Non-natural Amino Acids, Biocatalysis*

Abstract Amino acids are one of the most important small molecule building blocks with broad applications in fine chemical, pharmaceutical industry and synthetic biology. Highly selective synthesis of chiral amino acids is challenging because amino acids have multiple functionalities, such as amine, carboxylic acid or hydroxyl groups on the side chain. Inspired by the structural diversity of non-natural amino acids in natural products, we have developed enzymatic routes for stereoselective synthesis of β -hydroxy- α -amino acids and γ -hydroxy- α -amino acids. Biological activity study indicated that these amino acids are active compounds for regulation of phagocytosis and kynurenine metabolic pathway.

Short Biography Dr. Cangsong Liao got his Ph.D. in Medicinal Chemistry with focus on sesquiterpenoid natural products under supervision of Prof. Yang Ye in Shanghai Institute of Materia Medica (SIMM), Chinese Academy of Science. Motivated by the biosynthesis and enzymology of complex natural products, Liao moved to University of Basel, Switzerland and worked in Prof. Florian Seebeck's Lab as a postdoctoral researcher, where Liao developed a concise S-Adenosylmethionine regeneration reaction for biocatalytic methyl transfer reaction. In 2020, Liao started his independent group in SIMM with studies focusing on biocatalysis, enzymology and asymmetric synthesis high-value chiral building blocks.



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- Research Field** Bioactive natural products from marine organisms
- Report Title** **Secondary Metabolites from Hainan Marine Invertebrates: Chemical diversity, Biological function and Drugability**
- Keywords** *Molluscs, soft corals, structural and bioactivity*
- Abstract** Systematic chemical and biological studies on the South China Sea marine invertebrates (sponges, soft corals, molluscs etc.) have been carried out. Numerous intriguing natural products, of which some possess novel unprecedented skeletons, were isolated and characterized from above mentioned animals. Most of isolated compounds have been studied for their anticancer, immunomodulatory, antiviral, antimicrobial, and anti-inflammatory activities and some ones exhibited promising bioactivities and pharmaceutical application potentials. By describing representative studies, this communication presents a comprehensive summary regarding the achievements and progress made by our group in the past decade. Several interesting examples are discussed in detail.
- Short Biography** GUO is currently a Professor at Bohai Rim (Yantai) Adv. Res. Ins. for Drug Discovery. His research interests mainly focus on the chemistry, chemoecology and bioactivity of the secondary metabolites from marine benthic invertebrates (molluscs, sponges and coelenterates etc.) and flora. He has authored over 450 original research papers and reviews in peer-reviewed and SCI-indexed journals and 14 invited book chapters for international/national publishers such as Wiley and American Scientific Publishers etc. He has received several international or domestic awards in recognition of his scientific work, such as "Paul-Scheuer-Award" (2010).



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Research Field

Natural and bio-based ingredients

Report Title

Bio-based ingredients as alternatives for the food and pharmaceutical industries

Natural compounds, chemical characterization, bioactivity, bio-based ingredients

Keywords

Abstract

Inserted in the Mountain Research Centre, our group has been focused on studying mountain natural resources, designing sustainable protocols to extract bioactive compounds, and developing bio-based ingredients that provide bioactive properties to the products in which they are incorporated. The purpose is to offer alternatives, mainly for the food sector, to create differentiating products. Several matrices from general plants, fruits, mushrooms, and their residues have been studied, and different methodologies have been applied, including eco-friendly techniques.

The chemical analysis of the extracts and final products is based on their nutritional characterization (AOAC methods) and profile in soluble sugars (HPLC-RI), fatty acids (GC-FID), and organic acids, mainly phenolic compounds (HPLC-ESI-Orbitrap-MS). Accordingly, extracts with bioactive, preservatives, and colouring capacities have been obtained, and some prototypes have been developed.

The following steps include work in areas beyond food-based, namely the study of new bio-based alternatives to treat tumours with a high mortality rate. The fruits of *Cupressus sempervirens* L., underrated producers of large amounts of bio-residues, will be studied for their content in saponins. After optimization of the extraction and in-depth chemical characterization, these molecules' mechanisms of action will be disclosed to find alternatives as antitumour agents or therapy co-adjuvants.

Short Biography

PhD in Pharmacy, with European mention and the highest honours, from the Complutense University of Madrid (UCM).

FSR has been developing work in the area of natural products, particularly in the: i) valorization of natural mountain resources as functional foods and a source of nutraceutical ingredients; ii) development of protocols for the identification and extraction of bioactive compounds from natural matrices and bio-based residues; iii) development of protocols to evaluate the bioactive properties of natural compounds, namely their antitumor potential, and iv) development of natural and bio-based ingredients to replace the synthetic counterparts widely used as additives in food formulations.



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Research Field

Pharmacognosy

Report Title**A Preclinical Overview of Plant Sources in Drug Discovery***Medicinal plants, Preclinical studies, Ethnopharmacology, in vitro, in vivo***Keywords****Abstract**

Plants are vital to human well-being and serve as essential candidates for use as development and discovery agents for pharmaceuticals. The demand for plant-based goods is growing worldwide, and both consumers and health professionals seek evidence of the products' benefits and safe application. As a result, preclinical and clinical research on the biological activities of medicinal plants has garnered a lot of attention lately, revealing their biological actions and substantiating their traditional usage. The bioactivity investigations are necessary to identify the phytoconstituents wholly or partially responsible for the related effects. Various methods can be applied to assess the effects of medicinal plants and their secondary metabolites. Natural sources, or their active ingredients, have an ethnomedical use associated with their current application. Plant secondary metabolites show incredibly specialized actions through unique mechanisms. These are why plant metabolites could be important for developing new drugs. Secondary metabolites derived from plants are either small or macromolecules that are biosynthesized in plants, such as steroids, alkaloids, flavonoids, phenolic acids, lignans, carbohydrates, etc., have a variety of biological activities that are advantageous to humans. This presentation aimed to discuss our recent preclinical research on medicinal plants in the light of biological activity-guided fractionation assay techniques.

Short Biography

Ipek Süntar is Professor at Faculty of Pharmacy, Gazi University, Ankara, Türkiye. She got her bachelors, M.Sc. and PhD. degrees from the same University. She conducted a part of her PhD. studies in University of Wolverhampton, UK. Her research field focuses on the investigation of the in vivo biological activities of the plant sources used in traditional medicine. She has published 100 SCI-articles, 23 book chapters and edited two international books. She received awards including Scientific Encouragement Award-2014 given by Pharmacy Academy, Association of Turkish Pharmacists and Outstanding Young Scientist Award-2021 given by Turkish Academy of Science.



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Research Field

Food and Science Technology

Report Title

Employing apple pomace as a natural and functional ingredient for application in the food and nutraceutical industries

Keywords

Bio-residues, functional ingredients, bioactivity, circular economy

Abstract

The apple processing industry generates a solid residue known as apple pomace (AP), rich in bioactive compounds yet underutilized. Consequently, the primary objective of this study was to investigate AP, namely its health-promoting compounds, to exploit its full potential. First, the nutritional composition was determined using AOAC methodologies. The chemical characterization included the analysis of soluble sugars (HPLC-RI), fatty acids (GC-FID), tocopherols (HPLC-fluorescence), phenolic compounds (HPLC-ESI-Orbitrap-MS), and other organic acids (UFLC-PDA). The antioxidant capacity of the extracts obtained from AP was assessed through in vitro cell-based assays.

The nutritional assessment revealed that AP has a high dietary fibre and protein content. The sugar composition consisted of fructose, sucrose, and glucose. Linoleic acid, α -linolenic acid, and palmitic acid were the dominant fatty acids. Malic acid was the primary organic acid identified. The most abundant phenolic compounds included phlorizin-3-glucoside, quercetin-3-O-rutinoside, hydroxyphloretin isomer, quercetin-3-O-galactoside, and 3-hydroxyphloretin 2'-O-xylosyl-glucoside. AP exhibited a good antioxidant activity.

These findings indicate that the pressing method to juice extraction does not entirely remove all the healthy compounds, leading to their retention in the pomace. Therefore, AP has potential as an innovative/competitive source of functional compounds with applications in the food and nutraceutical industries.

Short Biography

Degree in Chemical Engineering (2020) from the Federal Technological University of Paraná (UTFPR-Londrina, Brazil). Chemical Engineering Master's (2020), under the scope of the Dual Diploma project between the UTFPR and the Polytechnic Institute of Bragança (IPB, Portugal). Developed research in the characterization of the lipid fractions of nuts produced with different biostimulators with potential hypocholesterolemic activity intended for application in the food industry.

Currently, she is a PhD student in Pharmaceutical Sciences at the Faculty of Pharmacy of the University of Porto (FFUP-UP) and IPB, both in Portugal, primarily focusing on recovering bio-residues from the cider production industry.



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Research Field

Mycology

Report Title**ErinacinA project – development of GOBA® *Hericium erinaceus* K food supplement and its effect on cognitive functions and gut microbiota****Keywords***Hericium erinaceus, eriancine A, cognitive functions, gut microbiota***Abstract**

Hericium erinaceus is a fungus with immunomodulating properties, effects against autoimmune disorders of digestive tract and neurodegenerative diseases. In ErinacinA project conducted in collaboration with PharmaHemp Ltd. we focused on erinacines contained in this fungus i.e., one of the main compounds with proven activity against neurodegenerative diseases.

First, we focused on different *Hericium* strains and specie and their ability to produce eriancines. We cultivated these strains on a standard substrate and chosen the most productive one. In the next step we optimized cultivation parameters such as substrate type, incubation temperature and duration, substrate weight and moisture, presence of light during incubation, time of harvesting and others. After the optimal parameters of the cultivation process were determined, a processing of the fungus such as extraction, drying milling, storage, etc. optimization took place. Stability tests were conducted, proving that final product is very stable and not prone to degradation of the main component even when exposed to high temperatures for a longer period of time.

A double-blind clinical trial on older healthy subjects was conducted using a final product named GOBA® *Hericium erinaceus* K. A beneficial effect of the new product on cognitive functions and gut microbiota of older healthy subjects was confirmed.

Short Biography

Andrej Gregori is a director of MycoMedica Ltd, a company producing food supplements from medicinal fungi and mushrooms and conducting research in the field of applicative mycology. Andrej Gregori is an assistant professor at the Biotechnical faculty, University of Ljubljana, where he lectures about mushroom cultivation and medicinal components of fungal origin.



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Research Field

Chemical engineering

Report Title

Optimization of cordycepin isolation procedure from *Cordyceps militaris*

Keywords

Cordycepin, *Cordyceps militaris*, HPLC, extraction, isolation

Abstract

Cordyceps militaris is a medicinal fungus highly valued in traditional Asian medicine, with cordycepin as its main bioactive compound. The research aimed to optimize cordycepin standard production from *C. militaris*. Production of the cordycepin standard consists of two main steps: (1.) optimization of cordycepin extraction from *C. militaris* and (2.) cordycepin isolation from the extract.

(1.) Firstly, the extraction procedure was optimized. The extraction efficiency was evaluated based on the optimal cordycepin extraction ratio and the percentage of impurities found in the dry extract. The research was comprised of five major groups of experiments, evaluating the influence of: i) ethanol concentration in the solvent on the extraction efficiency, ii) various ratios of solvent volume to dry sample mass on the extraction efficiency, iii) leaching of cordycepin from a sample from which the extract was sequentially removed and fresh solvent added, iv) pH of the sample-solvent mixture on the extraction efficiency, and v) percolation performed at different temperatures.

After completing the optimization of extraction, the cordycepin isolation was conducted.

(2.) The purification of the extract was carried out in two steps; firstly, precipitating a part of the impurities with the addition of a 100 % ethanol solution and then using the resulting supernatant for the isolation of cordycepin on various resins types. To optimize the adsorption conditions, macroporous adsorption resin NKA II and three cation exchange resins were evaluated.

An HPLC analytical method with UV-Vis detection for cordycepin determination was partially validated to monitor the extraction and isolation efficiency.



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Research Field

Plant biochemistry

Report Title**Medicinal plants and their antioxidant capacity****Keywords***Antioxidative capacity, phenolic compounds, trace metals***Abstract**

The use of medicinal plants for the treatment and prevention of diseases is common in the territory of the Republic of Srpska (B&H). Due to the widespread use of plants in addition to their medicinal properties, it is important to know that medicinal plants contain permitted amounts of trace metals. Our research included several medicinal plants collected in the territory of the Republic of Srpska. The content of total phenolic compounds and antioxidant capacity were determined in dry plant leaves by spectrophotometric methods and electron paramagnetic resonance (EPR). In addition, the content of Fe and Cu was determined by atomic absorption spectrometry. The results showed differences in the antioxidant capacity and metal content between the plants examined. The obtained differences can arise from the habitat of medicinal plants, anthropogenic influence as well as plant species, which were the subjects of discussion.

Short Biography

Kristina is bachelor student, fourth year, at Faculty Of Natural Sciences and Mathematics, University Of Banja Luka, Bosnia and Herzegovina, Department of Biology. Her research is based on plant biochemistry, focused on antioxidative and chelation properties of polyphenolic compounds. Precisely, focus is on medicinal plants and their antioxidant capacity that are distributed in the area of the Republic of Srpska, B&H.



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Research Field

Natural Products Chemistry, Metabolomics

Report Title

NMR and LC-HRMS based profiling for the quality control of food commodities – Exploitation of statistical tools for markers' identification

Keywords

NMR, HRMS, honey, table olives, profiling, STOCSY, SHY

Abstract

Foodomics employs advanced analytical instrumentation as means for food profiling, authenticity control, biomarker identification and answers regarding food quality and safety. NMR and MS-based approaches hold the lion's share to this day in the field. Nevertheless, a critical bottleneck in metabolic profiling approaches remains the identification of relevant biomarkers. This is mainly due to the absence of spectral databases or reference standards and the complexity, high variability, and unexpected nature of food matrices. Following the development of metabolite profiling approaches employing NMR and LC-HRMS, the aim of the present study was to exploit statistical tools like Statistical Total Correlation Spectroscopy (STOCSY) or Statistical Heterospectroscopy (SHY) to increase the identification confidence of tentative markers in table olive and honey matrices. STOCSY generates a pseudospectrum by correlating peaks with the same fluctuation across NMR spectra of the respective samples, while SHY can withdraw latent relationships between spectroscopic and spectrometric datasets, in this case NMR and HRMS. In the current work, table olive and honey samples from Greece were analysed both with NMR and LC-HRMS platforms. Obtained datasets were subjected to multivariate analysis (MVA) and compared throughout, raising the advantages and pitfalls of each platform.

Short Biography

Stavros Beteinakis is a post-doctoral researcher at the Division of Pharmacognosy and Natural Products Chemistry, Pharmacy, NKUA, where he completed his undergraduate and PhD studies. For his PhD studies, he received a 3-year scholarship from the State Scholarship Foundation. Over the last 5 years he has completed several secondments abroad (Spain, Switzerland, Germany) to enrich his scientific expertise. His main research interests include NMR & LC-HRMS-based profiling approaches on food commodities, structure elucidation of complex natural compounds using NMR, HRMS & HRMS/MS and computational tools, as well as the bioactivity dereplication in medicinal plants using different metabolomics approaches.



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Research Field	Life sciences, Areas: Microbiology, Natural product extraction, Biological activities
Report Title	The freshwater spongy <i>Ephydatia fluviatilis</i> as potential natural antimicrobial agent
Keywords	<i>Ephydatia fluviatilis</i> , extracts, microorganisms, biological activities
Abstract	<p>The search for new antimicrobial agents has become a necessity because various bacterial and fungal infections cause nearly 16 million deaths each year. At the same time numerous strains of pathogenic microorganisms have become resistant to the once effective first-choice antibiotics. This situation has forced the scientific community to search for new, alternative ways to cope with the emerging problem. Our study therefore aims to utilize the biological properties of the underexplored freshwater sponge <i>Ephydatia fluviatilis</i> Linnaeus, 1759. The sponge <i>E. fluviatilis</i> is the most common and abundant species in Serbian waters, but its biological potential has been insufficiently studied. A number of bioactivities of <i>E. fluviatilis</i> sponge extracts (antimicrobial activity with biofilm activity, anti-hyphal forming, ergosterol binding and sorbitol Protection assay, and cytotoxic activity) were investigated in vitro to evaluate their potential as a new source of biologically active substances of importance for medicine and pharmacy. The results showed that the extracts obtained have good biological activities. They can be considered as natural antibacterial and antifungal agents, especially against bacteria <i>Yersinia enterocolitica</i> and fungi <i>Candida auris</i>.</p>
Short Biography	<p>Dr. Ana Ćirić is a Principal research fellow at the Institute for Biological Research "Siniša Stanković"-National Institute of Republic of Serbia. The main research topics are antimicrobial activity of biologically active compounds isolated from plants, fungi, invertebrates and synthetic compounds, investigation of the influence of products on the finding of quorum sensing antagonists and biofilm, and the development of new metabolic pathways of certain compounds in the biotransformation process. She participated in 6 projects national and 11 international projects. She has published 204 papers in international peer reviewed journals of high importance: with over 5000 citations; with h-index of 39.</p>



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Research Field

Natural products chemistry, metabolomics

Report Title

Metabolomic approaches employing LC-MS for the investigation of the role of natural products in different biological platforms

Keywords

Chios mastic gum, Cichorium spinosum, mass spectrometry, metabolism, metabolomics

Abstract

In recent years, the introduction of omics approaches, and especially of the metabolomics technology, in the field of natural products (NPs) has radically progressed the discovery of new bioactive constituents, as well as the pharmacological assessment of isolated compounds or complex mixtures such as foods or plant extracts. In this framework, the current work focuses on the development of mass spectrometry-based metabolomics workflows for the investigation of the effect of NPs in different complex biological systems. As proof of concept, research on two hallmark plant-based products of Greece will be presented, and in particular one edible leafy green (*Cichorium spinosum* – stamnagkàthi) and one traditional phytotherapeutic product with multiple applications in the food, cosmetics and supplements industries (Chios mastic gum). Special emphasis is given to the examination of metabolism (or biotransformation) aspects as a means of uncovering the true active forms of NPs. From traditional phytochemistry methods to state-of-the-art analytical techniques, our ultimate goal is to adopt a holistic approach which attempts to respond to pending questions about NPs metabolism and bioactivity by utilizing a multi-platform toolset.

Short Biography

Dr. Eleni V. Mikropoulou is a pharmacist. She obtained her master's degree in Natural Products Chemistry. For her PhD studies in NKUA she received a 3-year Stavros Niarchos Foundation grant. In 2023 she was a member of the winning team for the Bionorica Phytoneering Award. Her research mainly focuses on the development of mass spectrometry-based metabolomics approaches for the investigation of the role of NPs on metabolic disorders. She has completed four secondments in three EU countries through EU research projects, she has several participations in international scientific congresses, and she has co-authored 14 publications in peer-reviewed journals.



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Research Field Natural products chemistry; discovery of lead compounds for treatment of obesity, diabetes and aging

Report Title **Myricanol prevents aging-related Sarcopenia by rescuing mitochondrial dysfunction via targeting peroxiredoxin 5**

Keywords *Sarcopenia, aging, myricanol, mitochondria, peroxiredoxin 5, redox homeostasis*

Abstract Sarcopenia is an aging-associated progressive loss of muscle mass and strength, and is accelerated by sedative lifestyle and unhealthy diet. Oxidative damage-induced dysfunctional mitochondria are considered as a culprit of muscle wasting during aging. Herein, we aimed to demonstrate whether myricanol (MY), a cyclic diarylheptanoid derived from Chinese bayberry, protects aged mice against muscle wasting through alleviating oxidative damage, and identify the direct protein target. We discovered that MY protects 18-month-old mice against the loss of muscle mass and strength through scavenging ROS accumulation to rebuild the redox homeostasis and alleviating oxidative damage in mitochondrial DNA to rescue the mitochondrial function. Taking advantage of activity-based protein profiling and biophysical assays including cellular thermal shift assay and isothermal titration calorimetry, peroxiredoxin 5, a critical hydrogen peroxide scavenging enzyme in mitochondria, was discovered and validated as the direct target of MY in protecting C2C12 myotubes against oxidative damage. Through activating peroxiredoxin 5, MY reduced ROS accumulation and damaged mitochondrial DNA. Furthermore, MY selectively binds to the residue Cys100 in peroxiredoxin 5 through hydrophobic interactions and enhances its anti-oxidative activity via the formation of intramolecular disulfide bond. Our findings provide an attractive future direction for therapy against Sarcopenia via peroxiredoxin 5.

Short Biography Dr Ligen Lin received his PhD in medicinal chemistry at Shanghai Institute of Materia Medica, Chinese Academy of Sciences in 2007. Upon graduation, he pursued his postdoc training at Baylor College of Medicine from 2008 to 2013. He started his independent research career as an assistant professor at the Institute of Chinese Medical Sciences, University of Macau, since April 2013, and got promotion to associate professor on August 2019. His researches focus on the identification of new mechanisms for regulating metabolic diseases and aging, and the discovery of novel therapeutic agents from herbal medicines for treatment of metabolic disorders. He has published more than 160 papers on high rank SCI journals, including Nature Communication, Journal of Cachexia Sarcopenia and Muscle, Cell Death and Differentiation, Aging Cell, Diabetes, British Journal of Pharmacology, et al. As the PI or co-PI, he has awarded 14 research grants with the total funding > 14 million MOP.



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Research Field microbiology, antimicrobials, biofilm-associated infections, pathogenic bacteria and fungi, virulence factors, human cell culture

Report Title **Hesperetin's ability to reduce mono- and polymicrobial biofilms**

Keywords *flavonoid, hesperetin, antimicrobial, polymicrobial biofilm, Candida albicans, Staphylococcus aureus*

Abstract Hesperetin belongs to the group of citrus flavonoids, compounds known for their rich spectrum of biological activities. Nowadays, the need to find new antimicrobial agents is increasing, so in this study we examined some biological activities of this compound. We investigated hesperetin's antimicrobial activity (microdilution method), antibiofilm activity (mono- and polymicrobial biofilm; crystal violet assay, and congo red binding assay). Minimal inhibitory concentrations of hesperetin (MIC) towards *Candida* strains were 0.165 mg/mL, while its inhibitory potential towards *Staphylococcus aureus* was lower (MIC 4 mg/mL). Hesperetin (0.165 mg/mL) reduced *Candida* biofilm formation to a certain extent, and reduced exopolysaccharide production in the biofilm matrix. At a concentration of 1.320 mg/mL, hesperetin showed a significant potential to destroy previously formed biofilm. On the other hand, higher concentrations of this compound were required to inhibit *S. aureus* biofilm formation (<50% inhibition with MIC 4 mg/mL). Significantly, in crystal violet and CFU tests, the lowest investigated hesperetin concentration (1 mg/mL) effectively reduced the formation of polymicrobial *C. albicans*-*S. aureus* biofilm.

Hesperetin is still an understudied compound that deserves much more attention. Importantly, its inhibitory effect on polymicrobial biofilms is of great interest for further studies and the development of new antimicrobial strategies.

Short Biography Tamara Carević enrolled PhD studies at the Microbiology module at the Faculty of Biology, University of Belgrade in 2021/2022. Currently, she is a junior research assistant within the Mycology Laboratory at the Institute for Biological Research "Siniša Stanković". She was a long-time recipient of scholarships from the Ministry of Education, Science and Technological Development, as well as a Dositej scholarship for the best students in the country. She is a member of the Serbian Biological Society, Federation of European Microbiological Societies, and Federation of European Biochemical Societies. Scientific fields of interest are mycology, microbiology, with emphasis on pathology and host-pathogen interaction.



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Research Field Phytochemicals; bioanalytical and organic chemistry; drug research and applications; pharmaceutical, agricultural and food Industry; plant cultivation

Report Title **Phytochemical profiling of *Cucumis metuliferus* E. Mey in vitro plant cultures**

Keywords *C. metuliferus*, *in vitro* plant culture, phytochemicals

Abstract *In vitro* plant culture represents one of the most efficient methods of cultivating plants in a sterile and strictly controlled environment. Additionally, valuable compounds like phytochemicals can be produced on a large scale through plant tissue culture, which can subsequently be utilized by the food and pharmaceutical industries. Our primary objective was to investigate how the volatile and non-volatile metabolite profiles changes during developmental period of the plant *Cucumis metuliferus* in *in vitro* cultures, by using GC-MS and UHPLC-Orbitrap analysis. Two weeks after sprouting, the first sample was collected and afterwards every two weeks, for three months. Collected samples were firstly freezed in liquid nitrogen and then kept in freezer on -20°C until analysis. Presence of catechol, ornithine, adenine, neophytadiene, phytol, n-hexadecanoic acid, dibutyl phthalate and alpha-tocopherol is revealed by GC-MS analysis, while UHPLC-Orbitrap analysis determined the presence of gallic acid pentoside, dihydroxybenzoic acid pentosyl pentoside, vanillic acid, chlorogenic acid, methoxycinnamic acid, apigenin 7-O-(6"-pentosyl)-hexoside, ferulic acid, kaempferol 3-O-hexoside, luteolin, naringenin, patuletin, chrysoeriol, phenyllactic acid hexoside, cucurbitacin B and lariciresinol. Our future research will be focused on obtaining extracts from this plant material and investigating biological properties of obtained extracts as well as the quantification of the present phytochemicals.

Short Biography Mladen Rajaković was born on July 10, 1996 in Šabac. As a student of the generation, he graduated from the Secondary Agricultural School in Šabac in 2015 as a Veterinary technician. He earned his titles BSc in Biochemistry in 2020 and MSc in Biochemistry in 2021 at Faculty of Science in Novi Sad. At the Faculty of Chemistry in University of Belgrade he began his PhD studies in Chemistry, in the academic year 2022/23. He is currently employed as a Junior research assistant at Institute for Biological Research “Siniša Stanković”, National Institute of the Republic of Serbia.



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Research Field

Analytical Chemistry of Pharmaceutical and Natural products

Report Title

Greening Pharmaceutical and Natural Product Quality Control with Green Analytical Chemistry

Keywords

Green analytical chemistry, pharmaceutical quality control, natural product quality control, environmentally friendly methods

Abstract

The safety, efficacy, and purity of products in the pharmaceutical and natural products are ensured through analytical chemistry. However, the conventional methods used in analytical chemistry involve the use of hazardous chemicals and generate a large amount of waste, which poses serious environmental and health concerns. To address these challenges, Green analytical chemistry (GAC) presents a sustainable solution by reducing the use of hazardous solvents, minimizing waste generation, and promoting energy efficiency. In quality control, GAC principles emphasize the development of eco-friendly sample preparation techniques and simple instrumental analysis procedures for pharmaceuticals and natural products. When compared to standard methods, the integration of GAC principles into quality control practices does not show any significant difference in results, which has been confirmed statistically. Moreover, GAC methods have the potential to significantly reduce the environmental footprint of the pharmaceutical and natural products while maintaining product quality and safety.

Short Biography

Sysay Palamy, Head of Department of Pharmaceutical Sciences at the Faculty of Pharmacy, University of Health Sciences, Laos, is also the Chair of the ASEAN Subcommittee on Biotechnology and SCB-Laos. He received his master's and doctoral degrees in research and development in pharmaceuticals from Khon Kaen University, Thailand, in 2012 and 2017, respectively. He is a highly respected researcher and educator in the field of pharmaceutical sciences, with a focus on quality control of modern medicines, herbal medicine products, food products, cosmetics, and food supplement products. He is particularly interested in the extraction of chemical constituents in herbal medicine using green technologies. He has been a team member of several international research projects, including the COCLICAN project (2019-2022), the ROCKET project (2021-2023), and the Mekong Pharma Network research project (Laos, Vietnam, and Cambodia) in 2022-2024, which is funded by the Foundation Pierre Fabre, France.



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Research Field

Natural Products Chemistry

Report Title**New secondary metabolites from Mongolian plants****Keywords***Phytochemistry, alkaloids, flavonoids, terpenoids***Abstract**

The flora of Mongolia encompasses 3,041 native vascular plant taxa, consisting of 2,835 species and 206 infraspecific species. Among these, 102 taxa (comprising 95 species, five subspecies, and two nothospecies) are endemic to the region. The plant species in Mongolia exhibit a richness of unique secondary metabolites, a result of their adaptation to the challenging Mongolian climate. Researchers at the Laboratory of Natural Products Chemistry, Institute of Chemistry and Chemical Technology, Mongolian Academy of Sciences, with a distinguished 50-year history, have conducted extensive phytochemical studies on over 120 plant species. Through their efforts, they have identified 240 new natural compounds, some of which demonstrated significant biological effects. Notably, daurinol, isolated from *Haplophyllum dauricum*, exhibited a robust anti-cancer effect, while talimonin from *Thalictrum simplex* demonstrated potent anti-viral activity. In addition to these discoveries, the laboratory has identified the chemical composition of essential oils from more than 250 plant species. Building on the biological effects of these oils, the researchers have developed various products. The laboratory actively engages in international collaboration, fostering partnerships with countries such as Germany, Russia, South Korea, and Vietnam.

Short Biography

Dr. Sarangerel Oidovsambuu is the head of the Laboratory of Natural Products Chemistry at the Institute of Chemistry and Chemical Technology, Mongolian Academy of Sciences. She has been leading this laboratory for the past two years. Dr. Oidovsambuu obtained both her BS and MS degrees from the National University of Mongolia in 2003 and 2005 respectively. Her career began as a lecturer at the National University of Mongolia (2005-2008). She pursued a Ph.D program at the Korea Institute of Science and Technology, completing it from 2008 to 2013. Subsequently she served as a lecturer at the National University of Medicinal Sciences (2013-2014) and an assistant professor at the New Mongol Institute of Technology (2014-2021). Throughout her career, she has successfully led 6 projects and published a total of 13 papers in international scientific journals.



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Research Field Plant biotechnology

Report Title **Biotechnological potential of medicinal important species of Mongolia**

Keywords *Mongolia, Medicinal plants, Biotechnology*

Abstract Medicinal plants play an important role in human livelihood. We have about 800 medicinal plant species in Mongolia. The studies demonstrate about the value of traditional systems of medicine as economically useful plants and the possible effects of climate change on medicinal plants. Climate change is causing noticeable effects on life cycles and distribution of the plant species. In addition to that, huge tonnes of medicinal plants in Mongolia are directly exported to foreign countries which is why it is an emerging concern in Mongolia. In the frame of protection for these rare or endangered plant species in Mongolia, we established the in vitro regeneration protocols through the tissue culture systems, generated transgenic plants with higher accumulation of useful compounds and executed several studies to identify candidate genes by OMIC technology. As well as several plant species proliferated by the tissue culture systems are already transferred to commercial companies like traditional pharmaceutical industries.

Short Biography Dr. Bolortuya Ulziibat graduated with her bachelor's and master's courses in the Department of Genetic and Molecular Biology, Faculty of Biology, Mongolian National University in 2005 and 2010. She also attended Tohoku University, Japan as a research student in 2011 and graduated with her doctoral course in 2016.

She worked as a research fellow at the Laboratory of Plant Cell Culture, Institute of Biology, Mongolian Academy of Sciences (MAS) from 2005-2011, research assistant at Tohoku University in 2016, a researcher in the plant biotechnology laboratory of general and experimental biology (same organization but name changed recently), MAS in 2016-2021, and post-doctoral researcher in Chonnam National University, South Korea.

She started working as a scientific secretary of sub-assemblies, Department of Research and Monitoring, MAS in 2023. She specialized in plant biotechnology including genetics, molecular biology, and tissue culture, and conducted several projects to improve useful compounds in medicinal important plant species through genetic engineering.



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Research Field

Economics

Report Title

Mangrove as the Source of Natural Dyes, Opportunities and Challenges to Kampung Laut, Cilacap Regency

Keywords

Mangrove, natural dye, contract farming

Abstrac

This paper identifies challenges and opportunities to manage mangrove in the Kampung Laut, Cilacap Regency as a source of natural dye. The challenges come from the awareness of the importance of mangrove ecosystems is still very limited: only as a habitat that has been hereditary for physical fulfillment, namely as firewood and building materials for houses. The process of encroachment and conversion of mangroves continues to occur. So, the sustainability of the mangrove is in question. Alternative mangrove use for the source of natural dye has not been found. The opportunities stem from the in general view of the people of Kampung Laut have good awareness of caring for and preserving the environment. One alternatives solution would be to introduce the use of mangrove as a source of natural dye. With a relatively higher purchase price, and the method of harvesting mangrove stems (mangrove wood bark), the sustainability of mangroves is more guaranteed. Cooperation between farmer/fishermen groups and INDI UGM is a pattern of business relations could be a solution. Here, mangrove is not only a source of income for the community but also farmers preserve the mangroves.

Short Biography

Catur Sugiyanto is a lecturer at the Department of Economics, Faculty of Economics and Business UGM. His research interests are mainly in local economic development, rural development and those related to agricultural development. The latest researches on local economic development includes: developing local economy based on natural dye in mangrove and peat-based villages (2020-2022) received funding from Kedaireka, Urban Farming in the City of Yogyakarta 2020 received funding from The Science and Technology Facilities Council (STFC), University of York UK, and Accelerating Cooperation inter-villages government for Sustainable Development in the Menoreh Area, Yogyakarta 2019-2023 funded by the LPDP and BRIN. Catur graduated from the Faculty of Economics in 1987, then continued his postgraduate studies obtaining an MA degree from the University of Alberta Canada in 1992 and a Ph.D in Agricultural Economics in 2002 from the University of Illinois, Urbana Champaign USA. His Professorship was awarded in 2010.



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Research Field Lipid, bioactive compounds from natural resources, computer aided drug design, biochemistry, chemical technology

Report Title **Introduction of INPC -VAST and some brief results in researching of natural products chemistry**

Keywords *INPC, VAST, Natural products*

Abstract Institute of Natural Products Chemistry (INPC) established in 1970, belonging to Vietnam Academy of Science and Technology (VAST). INPC has more than 50 years of experience in research and development on the field of natural products chemistry. From 1997, INPC become the representative contact of Regional network for Natural Products Chemistry in Southeast Asia in Vietnam and we have successfully held a conference in 1998 at Hanoi.

This report presents some results achieved by INPC on the field of folk medicine, medicinal plants and essential oils from natural resources in Vietnam according to the biological activity - oriented chemical research model.

The modern research model (*in silico*) using computer tools in screening and developing new active compounds has been applying now and initially give some positive results in searching for potential active compounds in the treatment of COVID-19 and other critical diseases. Multilateral cooperation in research, development of natural products and training of young scientists are also mentioned.

Short Biography Professor PHAM Quoc Long has been the Director of INPC for 12 years (2008-2020) and currently is Chairmain of the Scientific Council of Institute of Natural Products Chemistry – Vietnam Academy of Science and Technology (INPC-VAST). He graduated Doctorate of Chemistry in Russian Academy of Science in 1996 and becomes full professor in 2012. After then, he went for postdocral in Germany (DAAD project) and had other scientific exchanges with international collaborators including: Russia, India, France, USA... He had been the leader of many national and international projects with Russia, Italy, India, Germany, Belarus... He has more than 200 publications (100 papers ISI journals, 8 academic books, 10 patents, trained more than 20 PhD students). Based on these achievements, he has received many certificates of merit and awards from Vietnam, Russia, Belarus governments. Main research activities focus on: lipid, bioactive compounds from natural resources, computer aided drug design, biochemistry, chemical technology.



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Research Field	Chemical Biology and Nanomedicine
Report Title	Impact of Nature Product Chemistry in Healthcare: Challenges and Future Perspective
Keywords	<i>Cancer Therapy, Antimicrobial Therapy, Antimicrobial Resistance</i>
Abstract	Cancer, antimicrobial resistance and many other chronic diseases are going to make a major impact on healthcare system in coming years. Asia is going to share the maximum number of these patients considering the existence of two most populated countries and many socioeconomic challenges. Therefore, there is an urgent need to make coordinative efforts among regional countries to tackle these problems. Natural products have always been the source of drug discovery for anticancer and antimicrobial drugs. In recent years, revolution in medicinal chemistry has taken over the drug discovery, and discovery of the effective drugs from natural sources has taken a back seat. In my talk, I will talk about the advantages and challenges in the area of natural product chemistry that need to be addressed through proper coordination among regional countries for impactful biomedical applications.
Short Biography	Avinash Bajaj is Professor at Regional Centre for Biotechnology, NCR-Biotech Cluster, Faridabad. He obtained his PhD in Bioorganic Chemistry in 2008 from Indian Institute of Science, Bangalore, India, and did his post-doctoral training from University of Massachusetts Amherst, USA. His group is engineering advanced healthcare materials for biomedical applications including antimicrobial therapy, gene therapy, and cancer immunochemotherapy. His group has been engineering lipid based nanomicelles and hydrogel implants that can maintain sustained release of combination of chemotherapeutics, and have potential antimicrobial, anti-inflammatory, and anticancer therapy applications. Prof. Bajaj's group is also deciphering the impact of chemotherapy on lipid metabolism, and how these alterations in bioactive lipids alter the microenvironment and can be explored for therapeutic applications.



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Research Field

Natural Product Chemistry

Report Title

Research and Innovation of Indonesian Medicinal Plants

Keywords

Medicinal plant, New Chemical Entity, Traditional Medicine

Abstract

Medicinal plants have multifunctions and multi player effects such as green-environment, green-economy, health-tourism, agro-tourism and also has been proven to increase the household income as well as to strengthen the people-economy. More over, we do hope that the research not only stop on the scientific publication but also continue to the downstream of end product that has the economical value or New Chemical Entity (NCE), particularly to encourage national self-reliance of medicine raw materials. The sequences of medicinal plant and traditional medicine research and development activities involving research, development, design, prototype, trial, stimulating the growth of herbal industry, and service support should be able to create competitive products, acceptable by market both domestically and internationally, and accessible for health service. The future, the challenges in the field of health (Traditional Medicine) will be greater. For this reason, we must prepare and do better and faster strengthening of research and innovation through synergy and collaboration. We are very pleased that BRIN is ready to collaborate on research and innovation with universities, industries, and other parties.

Short Biography

Sofa Fajriah, Head of Research Center for Pharmaceutical Ingredients and Traditional Medicine, under Research Organization for Health, National Research and Innovation Agency, has led the institution since April 2023. She expert in the field of natural product chemistry which has published her research in many reputations journal. She also doing some research activities such as drug discovery for Hepatocarcinoma disease from *Aglaia* sp., Encapsulation of *Myristica fragrans* as Free Radical Scavenging Agent, Drugs development of Standardized Herbal Medicine and Phytopharmaca candidate from *Centella asiatica* as Hepatoprotector, Development of Standardized Herbal Medicine candidate from Green Seaweed (*Caulerpa lentillifera*) as immunomodulator, Development of Functional Food from Green Seaweed of *Caulerpa racemose* as Immunomodulator, Functional Food Preparation from Green Seaweed (*Caulerpa lentillifera*) as Immunomodulator in Toddlers, Isolation and Characterization of Phenolic Compounds from *Myristica fatua*, Isolation of Anticancer Active Compounds from *Macaranga* sp. And Study of Potential Anticancer Compounds from Mekongga Forest.



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Research Field	Natural Products Chemistry
Report Title	Searching for lead compounds against SARS-Cov-2 from traditional Chinese medicines
Keywords	<i>Natural product, Lead compound, SARS-Cov-2, traditional Chinese medicines</i>
Abstract	<p>Traditional Chinese medicine is a critical characteristic of China with a history spanning thousands of years. During the COVID-19 pandemic, traditional Chinese medicine played an essential role in fighting the deadly virus in China. Our research teams discovered a range of natural small-molecule compounds in various antiviral Chinese herbs and formulas that showed potent inhibition of 3CLpro protein activity against the novel coronavirus, using multiple technology fusion platforms for natural compound analysis and separation.</p> <p>Shuanghuanglian, a traditional Chinese patent medicine commonly used to treat acute respiratory tract infections, was studied. A total of 27 compounds were identified, and their inhibitory activities against 3CLpro were assessed. The results showed that nine compounds were potent inhibitors of 3CLpro, and baicalin and baicalein displayed comprehensive binding characteristics with 3CLpro. The crystal structure of the first nonpeptidomimetic small-molecule inhibitor of 3CLpro, baicalein, in complex with SARS-CoV-2 3CLpro was obtained in this study. In addition, the flavonoid myricetin found in many food sources proved to be a covalent inhibitor of SARS-CoV-2 3CLpro, modifying the catalytic cysteine. The results provide detailed mechanistic insights into the covalent mode of action by pyrogallol-containing natural products and serve as the basis for designing nonpeptidomimetic covalent inhibitors against 3CLpro.</p>
Short Biography	<p>Born in July 1965, a professor, group leader, and PhD supervisor at the Shanghai Institute of Materia Medica, CAS. He is also the Deputy Director and Secretary of the Party Committee of SIMM. His research revolves around natural products, specifically, extraction, isolation, and structural elucidation, as well as the structural modification of these products.</p> <p>His research group focuses on two primary areas: discovering bioactive chemical constituents in commonly used TCMs and interpreting their traditional uses. In an effort to achieve these goals, he created a spectroscopic feature-oriented method for discovering bioactive constituents. Additionally, he developed and enhanced an MS technology platform that integrates analytic and preparative HPLC and MS. This platform has aided in quickly and efficiently isolating complex ingredients from TCMs, further interpreting the chemical constituents, and revealing their bioactivities for scientific evidence.</p>



ABSTRACT



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Research Field

Mycology

Report Title

ErinacinA project – development of GOBA® *Hericium erinaceus* K food supplement and its effect on cognitive functions and gut microbiota

Keywords

Hericium erinaceus, eriancine A, cognitive functions, gut microbiota

Abstract

First, we focused on different *Hericium* strains and specie and their ability to produce eriancines. We cultivated these strains on a standard substrate and chosen the most productive one. In the next step we optimized cultivation parameters such as substrate type, incubation temperature and duration, substrate weight and moisture, presence of light during incubation, time of harvesting and others. After the optimal parameters of the cultivation process were determined, a processing of the fungus such as extraction, drying milling, storage, etc. optimization took place. Stability tests were conducted, proving that final product is very stable and not prone to degradation of the main component even when exposed to high temperatures for a longer period of time.

A double-blind clinical trial on older healthy subjects was conducted using a final product named GOBA® *Hericium erinaceus* K. A beneficial effect of the new product on cognitive functions and gut microbiota of older healthy subjects was confirmed.

Short Biography

Erik Bird is a researcher and production manager at MycoMedica Ltd. He is heavily involved in research and development of food supplements from fungi and mushrooms, optimizing details of fungal strain selection, cultivation and processing.

