4TH EUROPEAN SYMPOSIUM ON PHYTOCHEMICALS IN MEDICINE AND FOOD

June 30 – July 3, 2026
Aveiro, Portugal

BOOK OF ABSTRACTS

The 4th European Symposium on Phytochemicals in Medicine and Food (June 30 – July 3, 2026), Aveiro (Portugal), is organized with the kind support of the following organizations and entities:

PARTNERS

ORGANIZING PARTNERS

SPONSORS

4TH EUROPEAN SYMPOSIUM ON PHYTOCHEMICALS IN MEDICINE AND FOOD

June 30 – July 3, 2026 - Aveiro, Portugal

Dear 4th EuSPMF,

We are pleased to welcome you to the 4th European Symposium on Phytochemicals in Medicine and Food (4th EuSPMF). The exploitation of phytochemicals for the promotion of human health and well-being has been growing exponentially in recent years, driven by high-quality scientific research, strong networks between research institutions and industry, and effective knowledge transfer. The 4th EuSPMF aims to serve as a venue for fostering research collaborations, exchanging innovative ideas, and addressing current challenges in the field, bringing together researchers and professionals from around the world, contributing to new solutions for society.

We look forward to a fruitful and inspiring scientific event in Aveiro.

The organization has the local support of the University of Aveiro, the Department of Chemistry and CICECO -Aveiro Institute of Materials.

With our best regards,

Prof Sónia A.O. Santos

On behalf of the Organizing Committee

Table of Contents

Organizing Committee II

Programme IV

Plenary Lectures 1

Keynote Lectures 8

Oral presentations 23

Young Scientist Presentations 53

Poster presentations 90

Organizing Committee

Chair

Prof. Sónia A. O. Santos

CICECO – Aveiro Institute of Materials and Department of Chemistry,
University of Aveiro (PT)

Co- Chairs

Dr. Adriana C. S. Pais
University of Aveiro (PT)

Prof. Luigi Milella
University of Basilicata (IT)

Prof. Ana Sanches-Silva
University of Coimbra (PT)

Prof. Milen Georgiev
Bulgarian Academy of Sciences (BG)

Prof. Armando J. D. Silvestre
University of Aveiro (PT)

Dr. Hui Cao
University of Vigo (ES)

Scientific Committee

Prof. Sónia A. O. Santos
University of Aveiro (PT)

Prof. Jianbo Xiao
University of Vigo (ES)

Prof. Armando J. D. Silvestre
University of Aveiro (PT)

Prof. Lucindo José Quintans Júnior
Federal University of Sergipe (BR)

Dr. Hui Cao
University of Vigo (ES)

Prof. Jackson R. Guedes da Silva Almeida
Federal University of São Francisco Valley (BR)

Prof. Beraat Özçelik
Istanbul Technical University (TR)

Prof. Pierre-Eric Campos
University of Orléans (FR)

Prof. Elwira Sieniawska
Medical University of Lubin (PL)

Prof. Célia Vargas-de-la-Cruz
Universidad Nacional Mayor de San Marcos (PE)

Prof. Marina Kritsanida
University of Paris (FR)

Prof. Simone Moser
University of Innsbruck (AT)

Prof. Luigi Milella
University of Basilicata (IT)

Prof. Simon Vlad Luca
University of Orléans (FR)

Prof. Milen Georgiev
Bulgarian Academy of Sciences (BG)

Dr. Adriana C. S. Pais
University of Aveiro (PT)

Local Organizing Committee

Ana Clara Jacinto

Ana Rita Ferreira

Daniela Resende

Lou Zsusatz

Mariana Kergoustin

Samuel Patinha

UbaidUllah

Beatriz Loureiro

Irene Pasero

Carolina Lopes

Mafalda Santiago

Carolina Sousa

Pedro Ferreira

Sofia Morais

Programme

Monday, June 29th

12am – 2pm: Registration

Workshops

2pm – 3pm: “Multidimensional chromatography and mass spectrometry: tools for future challenges”
4pm – 5:30pm: “Smart Science: Using Artificial Intelligence in Research”

From 6:30pm: *Sunset by the sea*

Tuesday, June 30th

From 8:00am: Registration

8:45am – 9:45am: Opening Session of 4th EuSPMF

SESSION 1 - Chairs: Prof. Luigi Milella and Prof. Jelena Popovic

9:45am - PL1: Prof. Milen I. Georgiev
10:30am – **KL1:** Prof. Hye-Kyung Na

11:00am – 11:30am: Coffee break and Poster session I (PP1 – PP21)

SESSION 2 - Chairs: Prof. Giuseppe Grosso and Prof. Beraat Özçelik

11:30am – **KL2:** Prof. Raimundo Gonçalves de Oliveira Junior
12:00pm – OP1: Dr. Izabela Nawrot-Hadzik
12:15pm – OP2: Prof. Dr. Ming-Quan Guo
12:30pm – OP3: Dr. Deghima Amirouche

12:00pm – 12:45pm: Young Scientist parallel session

YSP1: Rosana Tajra

YSP2: Mariana Kergoustin

YSP3: Xincheng Wu

YSP4: Daniela Resende

12:45pm – 2:30pm: Lunch

SESSION 3 - Chairs: Prof. Esra Capanoglu and Prof. Jianbo Xiao

2:30pm – PL2: Prof Maurizio Battino

3:15pm – **KL3:** Prof. Elwira Sieniawska

3:45pm – OP4: Dr. Giorgio Cappellucci

4:00pm – OP5: Prof. Jihang Chen

3:45pm – 4:15pm: Young Scientist parallel session

YSP5: Lu Wang

YSP6: Jingyimei Liang

4:15pm – 4:45pm: Coffee break and Poster session I (PP1 – PP21)

SESSION 4 - Chairs: Prof. Raimundo Gonçalves de Oliveira Júnior and Prof. Francesca Giampieri

4:45pm – **KL4:** Prof. Ipek Süntar

5:15pm – OP6: Dr. Giuseppe T Patanè

5:30pm – OP7: Dr. Ludovica Lela

5:15pm – 5:45pm: Young Scientist parallel session

YSP7: Wenqi Huang

YSP8: Ouyang Boya

YSP9: Quanyong Wu

5:45pm – **KL5:** Prof. Lucindo Quintans

From 6:15pm: Welcome Cocktail Reception and 4th EUSPMF Group Photo

Wednesday, July 1st

From 8:00am: Registration

SESSION 5 - Chairs: Prof. Ana Sanches Silva and Prof. Milen I Georgiev

9:00am – PL3: Prof. Jianbo Xiao

9:45am – **OP8:** Dr. Carmina Sirignano

10:00am – **OP9:** Prof. Giuseppe Antonio Malfa

10:15am – **OP10:** Dr. Alessandro Maugeri

10:30am – **OP11:** Prof. Alberto Dias

9:45am – 10:45am: Young Scientist parallel session

YSP10: Helena Todorovic

YSP11: Sims K. Lawson

YSP12: Wanning Ma

YSP13: Fei Liu

YSP14: Inês S. L. Farias

YSP15: Shiye Lin

10:45am – 11:15am: Coffee break and Poster session II (PP22 – PP48)

SESSION 6 - Chairs: Prof. Ipek Süntar and Prof. Lucindo Quintans

11:15am – KL6: Prof Nazim Sekeroglu

11:45am – **OP12:** Dr. Tânia Moniz

12:00pm – **OP13:** Dr. Jolanta Sereikaité

11:45am – 12:15pm: Young Scientist parallel session

YSP16: Mafalda Santiago

YSP17: Irene Pasero

YSP18: Yuxuan Zhao

12:15pm – KL7: Prof. Giuseppe Grosso

12:45pm – 2:30pm: Lunch

SESSION 7 - Chairs: Prof. Susana Cardoso and Prof. Maurizio Battino

2:30pm – KL8: Prof. Beraat Özçelik
3:00pm – **OP14:** Dr. Joanna Oracz
3:15pm – OP15: Dr. Vittorio Carlucci
3:30pm – OP16: Prof. Balasubramaniyan Vairappan

3:00pm – 3:45pm: Young Scientist parallel session

YSP19: Elizabeth Figueroa Valencia
YSP20: Eliana Fernandes
YSP21: Pengren Zou

3:45pm – KL9: Prof. Dr. Hui Cao

4:15pm – 4:45pm: Coffee break and Poster session II (PP22 – PP48)

SESSION 8 - Chairs: Prof. Nazim Sekeroglu and Dr. Adriana C. S. Pais

4:45pm – KL10: Prof. Jelena Popovic
5:15pm – **OP17:** Prof. Andrea Gomez-Zavaglia
5:30pm – OP18: Dr. Paula Garcia Oliveira
5:45pm – KL11: Prof. Jackson Almeida

Parallel Session

4:45pm – 6:15pm: Workshop "From Structure to Binding: Molecular Docking Workshop"

Thursday, July 2nd

From 8:00am: Registration

SESSION 9 - Chairs: Prof. Laurent Picot and Prof. Luisa Custódio

8:45am – PL4: Prof Jean-Luc Wolfender

9:30am – **KL12:** Prof. Francesca Giampieri

10:00am – **OP19:** Dr. Gabriela Kowalska

10:15am – **OP20:** Dr. Giulia Baini

10:00am – 10:30am: Young Scientist parallel session

YSP22: Emanuele Rosa

YSP23: Ana R. Circuncisão

YSP24: Ana Clara Jacinto

10:30am – 11:00am: Coffee break and Poster session III (PP49 – PP71)

SESSION 10 - Chairs: Prof. Armando Silvestre and Prof. Elwira Sieniawska

11:00am – KL13: Dr. Ana C. Q. Silva

11:30am – **OP21:** Prof. Susana Cardoso

11:45pm – **OP22:** Dr. Anna Stasiłowicz-Krzemień

11:30am – 12:00pm: Young Scientist parallel session – Chair:

YSP25: Lou Zusatz

YSP26: Ana Rita Ferreira

YSP27: Inês Amaro

12:00pm – PL5: Prof. Esra Capanoglu

12:45pm – 2:15pm: Lunch

2:15pm – 2:30pm: Poster session III (PP49 – PP71)

SESSION 11 - Chairs: Prof. Nikolay T. Tzvetkov and Prof. Hye-Kyung Na

2:30pm – KL14: Prof. Luísa Custódio

3:00pm – OP23: Dr. Adriana C. S. Pais

3:15pm – **OP24:** Prof. Mi Kyeong Lee

3:30pm – OP25: Dr. Maria João Rodrigues

3:45pm – PL6: Prof. Laurent Picot

4:30pm – 5:15pm: *Awards and Closing Ceremony*

From 6:30pm – Conference Dinner

Friday, July 3rd

9:00am – 15:30pm: Aveiro Tour

From 15:30pm – Porto Wine Cellars and dinner on the Douro River

PLENARY LECTURES

PL1

Promotion of healthspan and longevity by natural compounds: myth or reality?

Milen I. Georgiev[1,2] and Monika N. Todorova[1]

[1] *Laboratory of Metabolomics, Institute of Microbiology, Bulgarian Academy of Sciences, 139 Ruski Blvd., 4000 Plovdiv, Bulgaria*
[2] *Department of Plant Cell Biotechnology, Center of Plant Systems Biology and Biotechnology, 4000 Plovdiv, Bulgaria*
georgiev@gbg.bg; ORCID: 0000-0001-5248-6135

Population aging is one of the greatest challenges facing modern societies. By 2050, the number of individuals aged 65 years and older is expected to exceed two billion worldwide, accompanied by a dramatic increase in the prevalence of age-related diseases and a growing burden on healthcare systems [1]. Although life expectancy has increased considerably over recent decades, the extension of lifespan has not always been associated with a proportional increase in healthspan, resulting in prolonged periods of morbidity and functional decline [1]. Therefore, identifying interventions that promote healthy aging and delay the onset of age-associated decline has become a major objective of contemporary biomedical research.

Aging is a complex biological process characterized by the progressive accumulation of molecular and cellular damage, leading to impaired physiological function and increased vulnerability to disease. Remarkably, many of the mechanisms underlying aging are evolutionarily conserved across species and are regulated by interconnected pathways controlling nutrient sensing, stress resistance, energy metabolism, proteostasis, and cellular maintenance [1, 2]. Modulation of these pathways has been shown to influence lifespan and healthspan in diverse model organisms, highlighting their potential as targets for geroprotective interventions.

Natural products represent a rich source of bioactive molecules capable of modulating conserved longevity pathways. Numerous plant-derived compounds have demonstrated the ability to enhance stress resilience, improve metabolic homeostasis, maintain proteostasis, and delay age-associated functional decline, making them attractive candidates for promoting healthy aging [2-4].

Utilizing the model organism *Caenorhabditis elegans*, together with omics technologies and molecular pharmacology approaches, our research aims to identify and characterize natural products with geroprotective potential [2-4]. By elucidating the molecular mechanisms underlying their effects on conserved pathways regulating stress resistance, metabolic homeostasis, and longevity, we seek to provide mechanistic insights into the regulation of aging and longevity while identifying novel geroprotective natural leads.

References:

[1] Todorova M, Savova M, Mihaylova L, Georgiev M (2024) Food Frontiers, 5: 267-310.
[2] Todorova M, Savova M, Mihaylova L, Georgiev M (2024) Phytomedicine, 134: 155971.
[3] Krustanova S, Todorova MN, Gerasimova V, Savova MS, Stoyanov S, Popova MP, Georgiev MI, Alipieva K (2026) Phytomedicine, 153: 157944.
[4] Todorova M, Savova M, Binev B, Georgiev M (2026) Phytomedicine, 155: 158117.

Acknowledgements: MIG acknowledges financial support from № КП-06-КОСТ/12.

PL2

Targeting cancer stem cells and adipocyte–tumor crosstalk: Bioactive compounds to overcome chemoresistance

Maurizio, Battino[1,2,3]

[1] *Department of Clinical Sciences, Università Politecnica delle Marche, Ancona, Italy.*
[2] *Universidad Europea del Atlantico Facultad de Ciencias de la Salud, Santander, Spain*
[3] *Jiangsu University School of Food and Biological Engineering, Zhenjiang, China.*
m.a.battino@staff.univpm.it; ORCID: 0000-0002-7250-1782

Chemoresistance is a multifactorial phenomenon driven by mechanisms including epigenetic and genomic alterations, oncogenic signaling, drug efflux, the presence of a rare subpopulation of cancer stem cells (CSCs), and tumor microenvironment–related processes. CSCs and tumor microenvironment dynamics play a key role in tumor persistence and therapeutic failure.
To address these mechanisms, the potential of bioactive compounds derived from two distinct sources to target CSCs and modulate microenvironment-driven resistance was evaluated using complementary models.
In colorectal cancer, Manuka honey, alone or combined with 5-fluorouracil, was evaluated in colonspheres enriched in CSC-like cells. Treatment modulated spheroid morphology, increased ROS, enhanced apoptosis, and improved chemosensitivity. These effects involved pathways related to stemness, survival, drug resistance, angiogenesis, and self-renewal, including reduced expression of drug efflux transporters and CSC-related signaling.
In breast cancer, particularly in obesity, adipocyte–tumor crosstalk plays a key role in shaping the tumor microenvironment. This was investigated in breast cancer cells, using conditioned media from preadipocytes, mature adipocytes, and adipocytes treated with licorice root extract. Licorice induced remodeling of the adipocyte secretome, reducing pro-tumorigenic adipokines and altering redox-related factors. While mature adipocyte signals promoted tumor-supportive effects, including reduced oxidative stress and enhanced survival, licorice-treated conditioned media increased ROS and modulated pathways involved in tumor progression, including estrogen signaling (aromatase) and the renin–angiotensin system (RAS). This may sensitize cells to ROS-dependent chemotherapeutics.
Preliminary data in CSC-enriched breast cancer mammospheres show that adipocyte-conditioned media enhance spheroid growth, compactness, and tumorigenic features, reduce doxorubicin accumulation (fluorescence-based), and attenuate ROS production, indicating a protective microenvironment. In contrast, conditioned media from licorice-treated adipocytes increased drug accumulation, oxidative stress, and apoptosis, partially reversing chemoresistance.
Overall, these findings highlight the potential of bioactive compounds to target CSCs and modulate tumor microenvironment–driven resistance, providing insights into strategies to overcome chemoresistance.

PL3

Flavonoid Ammoniation: A Novel Chemical Mechanism Linking Food Processing, Amino Acid Metabolism, and Healthy Aging

Yuxuan Zhao[1], Hui Cao[1], Jianbo Xiao[1]

[1] *University of Vigo, Nutrition and Bromatology Group, Department of Analytical Chemistry and Food Science, Faculty of Science, Ourense E32004, Spain*

jianboxiao@yahoo.com; ORCID: 0000-0003-3311-770X

Flavonoids undergo extensive chemical transformations during food processing and digestion. However, the formation and biological significance of nitrogen-containing flavonoid derivatives remain poorly understood. In this study, epigallocatechin gallate (EGCG) was used as a representative flavonoid to investigate a novel ammoniation pathway leading to the formation of *N*-EGCG.

Liquid chromatography-mass spectrometry and gas chromatography-mass spectrometry analyses identified *N*-EGCG as a naturally occurring metabolite in fermented tea. Its abundance increased with fermentation degree, while EGCG levels declined. Correlation analysis suggested that free amino acids, particularly serine and threonine, contribute to *N*-EGCG formation as nitrogen donors [1].

The biological relevance of this transformation was further investigated in Drosophila melanogaster and Caenorhabditis elegans models of methionine overload. *N*-EGCG was detected in vivo following EGCG supplementation. Its formation was associated with reduced methionine accumulation, restoration of one-carbon metabolism, and improved metabolic homeostasis. In *Drosophila*, EGCG alleviated hyperhomocysteinemia and normalized methionine-cycle metabolites [2]. In *C. elegans*, EGCG reduced oxidative stress, improved reproductive capacity, restored lifespan, and reversed metabolic disturbances induced by excessive methionine intake. These protective effects were accompanied by activation of the DAF-16/FOXO pathway.

Together, these findings identify flavonoid ammoniation as a previously unrecognized chemical transformation that occurs during both food processing and in vivo metabolism. The formation of *N*-EGCG links polyphenol chemistry with amino acid metabolism and provides a new framework for understanding how dietary flavonoids regulate metabolic health and aging. Nitrogen-containing flavonoid derivatives may represent a promising new class of functional metabolites for future food and nutrition research.

References

[1] Y. Zhao,et al., *Food Chem.*, vol. 493, p. 146024, Nov. 2025

[2] Y. Zhao, et al., *Phytomedicine*, vol. 156, p. 158230, Jul. 2026

Acknowledgments: This work was supported by National Natural Science Foundation of China (32472327), the Ramón y Cajal grant (RYC2020-030365-I), the Xunta de Galicia “Excelencia” program (ED431F2022/01).

PL4

Chemodiversity in the Digital Age: How Metabolomics and AI Are Transforming Pharmacognosy

Jean-Luc Wolfender[1,2], A. Kirchhoffer[1,2], Arnaud Gaudry[1,2], Luis Quiros-Guerrero[1,2], Olivier Marco Pagni[3], Florence Mehl[3], Frederic Burdet[3], Laurence Marcourt[1,2], Bruno David[4], Antonio Grondin[4], Adriano Rutz[1,2], Emerson Ferreira Queiroz[1,2], Louis-Félix Nothias[1,2,5] Pierre-Marie Allard[1,2,6]

[1] *Institute of Pharmaceutical Sciences of Western Switzerland, University of Geneva, CMU, 1211 Geneva, Switzerland*

[2] *School of Pharmaceutical Sciences, University of Geneva, CMU, 1211 Geneva, Switzerland*

[3] *Vital-IT, SIB Swiss Institute of Bioinformatics,1015 Lausanne, Switzerland*

[4] *Green Mission Pierre Fabre, Branche Phytochimie et Biodiversité, Institut de Recherche Pierre Fabre, 3 Avenue Hubert Curien, BP 13562, 31562 Toulouse, France*

[5] *Université Côte d'Azur, CNRS, ICN, Nice, France*

[6] *Department of Biology, University of Fribourg, 1700 Fribourg, Switzerland.*

jean-luc.wolfender@unige.ch; ORCID: 0000-0002-0125-952X

The convergence of omics technologies, digital data, and artificial intelligence is reshaping pharmacognosy, offering unprecedented insights into the chemical diversity of plants and microorganisms through advanced metabolomic profiling. Contemporary LC-MS platforms generate rich qualitative datasets from natural extracts; however, significant challenges persist in the accurate annotation of metabolites, the correlation of spectral data with bioactive compound quantities, and the elucidation of three-dimensional molecular structures critical for bioactivity prediction.

Our research addresses these challenges by leveraging large-scale metabolomic datasets derived from thousands of diverse plant and fungal extracts. A central focus is the use of taxonomic relationships to enhance confidence in mass spectrometry annotations and to minimize redundancy [1]. The scale and complexity of these data demand innovative computational solutions; accordingly, we develop semantic web-based knowledge graphs to structure intricate relationships among compounds, organisms, and bioactivities, thereby enabling advanced querying and pattern discovery [2].

By integrating artificial intelligence with these knowledge graphs, we aim to automate the assessment of chemical compositions and bridge traditional pharmacognosy with modern digital methodologies. This integrated approach streamlines natural product research, accelerates the identification of novel bioactive compounds, and opens new pathways for drug discovery. Recent applications demonstrating the effectiveness of these strategies in natural product research will be presented.

References

[1] Rutz, A. et al. *J Agric Food Chem 2023*, 71: 18010-18023.

[2] Gaudry, A. et al. *Acs Central Science*, 2024; 10: 494-510.

Acknowledge: We gratefully acknowledge funding from the Swiss National Science Foundation (SNF No. CRSII5_189921/1 and (ANR-SNF "MetaboLinkAI" N° IC00I0L-231646)

PL5

From Fig to Fork: Processing, By-Product Valorization, and Applications of Ficus carica

Seda Yaylali Simsek[1], Beyza Saricaoglu[1], Hafizenur Sengul-Binat[2], Ebru Fıratlıgil[1], Esra Capanoglu[1]

[1] *Department of Food Engineering, Faculty of Chemical and Metallurgical Engineering, Istanbul Technical University, Istanbul, Türkiye*

capanogl@itu.edu.tr; ORCID 0000-0003-0335-9433

Ficus carica L. (fig), one of the oldest cultivated fruit trees (Moraceae family), has attracted growing scientific attention due to its phytochemical diversity and wide-ranging food and pharmaceutical applications. Global production exceeds one million tonnes annually, with Türkiye leading as the foremost producer of dried figs [1]. The fruit has a nutritionally balanced composition of carbohydrates, dietary fibre, amino acids, minerals, and vitamins, together with a wide range of secondary metabolites including phenolic acids, flavonoids, anthocyanins, carotenoids, and tocopherols. Phytochemical content varies significantly depending on cultivar, harvest stage, and processing method. Drying concentrates bioactives but may also compromise their stability. Microwave and hot-air drying generally outperform sun-drying in phenolic retention, while thermal treatments may reduce volatile benzaldehyde, an important sensory compound [2]. Accordingly, many studies have focused on drying fig fruit and reducing the technical challenges associated with this process. Recent research has aimed to improve drying efficiency and preserve nutrients by applying novel technologies before or during drying. Studies have also examined innovative edible film applications to extend shelf life [3]. In addition, increasing attention has been given to the valorisation of fig by-products and the development of innovative food products from them, helping to protect the environment and reduce industrial waste [2]. Green extraction strategies such as ultrasound-assisted, microwave-assisted, and water-based extraction have improved the recovery of rutin, chlorogenic acid, and quercetin from fig leaves under mild conditions and short processing times, making them industrially attractive [4]. These extracts can be used as natural antioxidants, cyanidin-based colorants, and functional additives in bakery, dairy, and beverage products. Overall, recent findings highlight fig and its by-products as promising sources of functional ingredients with antioxidant, antidiabetic, anti-inflammatory, and antimicrobial potential. In this work, recent findings from our laboratory on the phytochemical characterisation and bioactivity of fig-derived materials will be shared and discussed in the context of the literature.

References

[1] Tan, C.-H. et al. J. Food Meas. Charact., 2026, 20, 3750–3773.

[2] Teruel-Andreu, C. et al. Food Chemistry, 2025, 465, 141977.

[3] Gizaw, Y. et al. Foods, 2025, 14, 1562.

[4] Xyderou-Malefaki, A. et al. Food Bioprod. Process., 2025, 154, 259–269.

Acknowledgments: This work was supported by the Istanbul Technical University Scientific Research Projects Coordination Unit under the project entitled *"From Field to Table: Efficient and Sustainable Solutions for Fig Processing, Packaging, and Functional Food Production"* (Project No. 46276).

PL6

Marine Microalgae and Seaweeds as Sources of Bioactive Compounds for Photodynamic, Anticancer, Antibacterial and Antiviral Applications

Laurent PICOT[1]

[1] *UMR CNRS 7266 LIENSs, La Rochelle Université, 17042 La Rochelle, France*

laurent.picot@univ-lr.fr ; ORCID: 0000-0003-4656-3557

Marine microalgae, cyanobacteria and seaweeds constitute sustainable reservoirs of structurally diverse bioactive compounds with major potential for health-oriented innovation. This contribution presents an integrated research strategy developed at La Rochelle University for the discovery, extraction, characterization and pharmacological evaluation of marine natural products, with emphasis on photosynthetic pigments and seaweed-derived antiviral molecules. Within the ANR Photomer framework, screening of 142 green extracts from 30 microalgal and cyanobacterial species revealed highly phototoxic diatom pigment derivatives, particularly pheophorbide *a* and related chlorophyll metabolites from *Skeletonema marinoi*, displaying strong light-dependent antitumour activity, absence of dark toxicity and a phototoxicity higher than the reference photosensitizer mTHPC. These findings supported the development of antibacterial photodynamic approaches against acne-associated bacteria, including *Cutibacterium acnes*, *Staphylococcus aureus* and *S. epidermidis*, with additional antibiofilm, anti-lipogenic and keratinocyte-compatible properties. The presentation also highlights standardized microbead extraction, HPLC pigment mapping and UPLC-MS^E metabolomics for exploring pigment chemodiversity, chemotaxonomic markers and minor metabolites across 37 microalgal strains [1]. In *Porphyridium purpureum*, this workflow enabled the detection of chlorophyll derivatives, carotenoids, lipids and gracilamide B, suggesting new chemical markers and possible anti-melanoma leads. Eco-efficient extraction and purification methods, including microwave-assisted extraction and centrifugal partition chromatography, are discussed as scalable tools for sustainable biorefinery. Finally, the antiviral potential of brown seaweeds is illustrated by *Fucus ceranoides* extracts inhibiting coronavirus 3CL protease. A ligand-fishing strategy using immobilized 3CLpro magnetic microspheres enabled the targeted capture of algal peptides, subsequently characterized by HRMS, enzymatic assays and molecular docking [2]. Overall, these results support marine biotechnology as a source of low-impact, nature-inspired solutions for cancer, infection, skin care, phototherapy and nutraceutical applications.

References

[1] Van Heukelem, L.; Thomas, C.S. Journal of Chromatography A, 2001, 910, 31-49.

[2] Duarte Filho, L.A.M.S.; Yanaguibashi Leal, C.E.; Bodet, P.-E.; Beserra de Alencar Filho, E.; Almeida, J.R.G.S.; Porta Zapata, M.; Achour, O.; Groult, H.; Gouveia Veloso, C.A.; Viegas Júnior, C.; et al. *Marine Drugs*, 2024, *22*(6), 244.

Acknowledgments: This work was supported by the Interreg Atlantic Area Programme through the European Regional Development Fund (ERDF), under the SMACC+ project, “Sustainable Microalgae and Cyanobacteria-Based Bioactive Compounds for Cosmeceuticals and Nutraceuticals” project code: EAPA_0145/2024, and the EnhanceMicroAlgae project, “High Added-Value Industrial

Opportunities for Microalgae in the Atlantic Area" project code: EAPA_338/2016. We also acknowledge the French National Research Agency (ANR) for funding the Emergence Bio Photomer project, Ifremer for funding the PHASMA project, the French Cancer League (Ligue contre le Cancer, Comité 17) for funding our research projects and a PhD grant on microalgal pigments, and the French Ministry of Higher Education, Research and Space.

KEYNOTE LECTURES

KL1

Reprogramming STAT Signaling with Food-Derived Bioactive Compounds: Implications for Cancer Prevention and Therapy

Hye-Kyung Na[1]

[1]*Department of Food Science and Biotechnology, College of Engineering, Sungshin Women's University, Seoul 01133, Republic of Korea*

nhk1228@sungshin.ac.kr; ORCID: 0009-0005-3520-9829

Signal transducers and activators of transcription (STATs) are key regulators of cell proliferation, survival, inflammation, metastasis, and therapeutic resistance. Aberrant activation of STAT signaling, particularly STAT3, has been implicated in the initiation and progression of various human cancers, making it an attractive target for both cancer prevention and therapy. Increasing evidence indicates that naturally occurring food-derived bioactive compounds can modulate STAT signaling through distinct molecular mechanisms. Curcumin, a dietary polyphenol derived from turmeric, suppresses canonical STAT3 signaling through direct interaction with critical cysteine residues involved in STAT3 activation. This interaction inhibits Tyr705 phosphorylation, dimerization, nuclear translocation, and transcriptional activity of STAT3, leading to suppression of oncogenic transformation and induction of apoptosis. Likewise, 15-keto-prostaglandin E2 (15-keto PGE2), an electrophilic lipid mediator present in edible red algae, directly targets STAT3 and attenuates its oncogenic signaling, thereby suppressing tumor growth and progression. Recent studies have revealed an additional layer of STAT3 regulation involving its non-canonical mitochondrial function. Salsolinol, a naturally occurring tetrahydroisoquinoline found in several foods, suppresses mitochondrial STAT3 Ser727 phosphorylation, resulting in disruption of mitochondrial electron transport chain function, excessive reactive oxygen species generation, mitochondrial dysfunction, and subsequent cancer cell death. Emerging evidence also suggests that modulation of the balance between STAT3 and STAT1 signaling contributes to the anticancer activity of dietary bioactive compounds. Collectively, these findings reveal that food-derived bioactive compounds can regulate both nuclear and mitochondrial STAT signaling through distinct molecular mechanisms, thereby suppressing tumor development and progression. As STAT3 continues to emerge as a major therapeutic target in oncology, food-derived bioactive compounds capable of modulating STAT signaling may provide a unique bridge between functional food development and drug discovery.

KL2

Unlocking Holobiont Interactions for the Design of New Bioactive Guttiferones

Raimundo Gonçalves de Oliveira Junior[1], David Hozain[1], Gilles Pakora[1], Thalisson Amorim de Souza[1], Didier Buisson[2], Marie-Christine Lallemand[1]

[1] *CiTCoM UMR 8038 CNRS, Faculté de Pharmacie de Paris, Université Paris Cité, France.*
[2] *MCAM UMR 7245 CNRS, Muséum National d'Histoire Naturelle, France*
raimundo.goncalves-de-oliveira-junior@u-paris.fr; ORCID 0000-0002-9458-1744

Guttiferones are structurally diverse polycyclic polyprenylated acylphloroglucinols (PPAPs) widely recognized for their remarkable biological activities, particularly antiparasitic and cytotoxic properties [1]. Their complex architectures and broad pharmacological potential have motivated extensive medicinal chemistry efforts aimed at generating new analogues with improved bioactivity and selectivity. However, the synthesis of oxygenated guttiferones, key intermediates for the preparation of second- and third-generation derivatives, remains a major bottleneck due to the low efficiency, limited selectivity and environmental burden associated with conventional organic synthesis. Biotransformation offers an attractive alternative by combining high catalytic performance, regio- and stereoselectivity and reduced environmental impact, in accordance with green chemistry principles. In this context, plant-endophyte interactions represent an underexplored source of specialized biocatalysts capable of producing structurally novel natural product derivatives. Endophytic microorganisms associated with guttiferone-producing plants may have evolved enzymatic machinery able to selectively transform these metabolites into new bioactive compounds. Building on the expertise of the PNAS team at the CiTCoM laboratory in the development of several generations of guttiferone analogues [2], this project explores endophyte-mediated biotransformation as a sustainable strategy to access valuable oxygenated derivatives. Endophytic fungi isolated from *Symphonia globulifera* efficiently converted several guttiferones (A, B, C/D and E) into new cyclized metabolites, with *Pseudopestalotiopsis simitheae* achieving conversion yields above 70%. The resulting oxyguttiferones exhibited enhanced antiproliferative activity against chemoresistant metastatic melanoma cells, high selectivity toward normal fibroblasts, and evidence of tubulin-targeting activity, highlighting the potential of holobiont-derived biocatalysts to generate novel bioactive guttiferones.

References

[1] Conceição M. et al. *Chemico-Biolical Interactions*, 2023, 370, 110313.
[2] Hozain D. et al. *Bioorganic & Medicinal Chemistry Letters*, 2025, 122, 130186.

Acknowledgments: This work has received support under the program "*Investissement d'Avenir*" launched by the French Government and implemented by ANR, with the reference « ANR-18-IdEx-0001 » as part of its program « Emergence ». The authors also thank ANR for founding (ANR-25-CE43-4843-01, BiotPPAPs project).

KL3

Lipid profile perturbations in relation to antibiotic tolerance, and natural products adjuvant activity in resistant *Mycobacterium tuberculosis* clinical isolates.

Anna Zabost[1], Rafał Sawicki[2], Grzegorz Jankowski[2], Marcin Ziomek[3], Wiesław Truszkiewicz[2], Arkadiusz Syta[4], Benita Hryć[3], Ewa Augustynowicz-Kopeć[1], Piotr Podlasz[5], Małgorzata Chmielewska[5], Elwira Sieniawska[3]

[1] *Department of Microbiology, National Tuberculosis and Lung Diseases Research Institute, Warsaw, Poland*
[2] *Chair and Department of Biochemistry and Biotechnology, Medical University of Lublin, Lublin, Poland*
[3] *Department of Natural Products Chemistry, Medical University of Lublin, Lublin, Poland*
[4] *Department of Technical Computer Science, Lublin University of Technology, Lublin, Poland*
[5] *Department of Pathophysiology, Forensic Veterinary Medicine and Administration, Faculty of Veterinary Medicine, University of Warmia and Mazury in Olsztyn, Poland*
esieniawska@pharmacognosy.org; ORCID 0000-0003-4773-0329

Because shifts in membrane composition influence permeability, drug flux, and the performance of resistance-associated machineries independently of stable genetic mutations, the dynamic restructuring of the cell envelope lipid landscape has emerged as a critical factor in antibiotic tolerance in *Mycobacterium tuberculosis*, Membrane and surface-exposed lipids are particularly important during stress and nutrient limitation, where they support phenotypic tolerance by maintaining envelope integrity and function. Furthermore, variations in membrane lipid makeup can regulate multidrug efflux systems, including the Rv1258c (Tap) transporter, thereby modulating susceptibility to several first-line anti-tubercular drugs [1-2].
We performed comprehensive lipidomic profiling of drug-susceptible and drug-resistant clinical isolates of *Mycobacterium tuberculosis* to determine how variations in membrane lipid composition relate to antibiotics susceptibility and to the potentiating effects of natural compounds combined with first-line agents.
Our data show that natural compounds potentiate the efficacy of rifampicin and isoniazid, likely through a combination of efflux suppression, interference with transcriptional processes, and perturbation of central metabolism. Resistant isolates display pronounced lipidome restructuring, including shifts in lipid class distribution, reduced acyl chain length, and altered saturation levels, all of which are expected to influence membrane biophysics and drug permeability. These findings position lipid metabolic plasticity and membrane remodelling as core determinants of resistance phenotypes and underscore the promise of natural compounds as adjunctive agents targeting these pathways.

References

[1] Larrouy-Maumus, G.; et al. ACS Infectious Diseases 2016, 2, 352-360.
[2] Charalambous, K.; et al. BMC Biochemistry 2008, 9, 31.

Acknowledgments: The authors received funding for this work from The National Science Centre: UMO-2022/45/B/NZ7/00412.

KL4

SWOT Analysis of Preclinical Studies in Natural Product Research: Challenges and Future Perspectives

Ipek Süntar[1]

[1]*Department of Pharmacognosy, Faculty of Pharmacy, Gazi University, Ankara, Türkiye*

ipesin@gazi.edu.tr ; ORCID: 0000-0003-4201-1325

Nature-based products are one of the most important sources for drug discovery owing to their remarkable chemical diversity and broad spectrum of biological effects. Traditional medicinal knowledge continue to guide the identification of promising plant-derived therapeutic agents. However, despite the high number of preclinical studies conducted on natural products era, the translational success of these findings into clinically approved therapies remains limited. Thus, a comprehensive evaluation of the current strengths, weaknesses, opportunities, and threats (SWOT) associated with preclinical natural product research is necessary.

Preclinical studies provide several advantages in elucidating pharmacological effects, evaluating molecular mechanisms, investigating safety profiles, and identifying potential therapeutic agents via *in vitro* and *in vivo* experimental models. Furthermore, advances in phytochemical analysis, omics technologies, molecular docking, and network pharmacology have enhanced the scientific quaility of natural product research. Nevertheless, several critical limitations still exist, including poor standardization of plant materials, variability in phytochemical composition, inadequate experimental design, insufficient reproducibility, limited translational relevance of animal models, and publication bias toward positive findings. In addition to these weaknesses, emerging technologies present important opportunities for improving the value and translational impact of preclinical studies. Artificial intelligence-assisted screening, precision medicine approaches, and multi-target therapeutic strategies may contribute substantially to future drug development processes. On the other hand, threats such as low-quality publications, lack of regulatory harmonization, ethical concerns, and sustainability problems related to biodiversity conservation remain major challenges in the field.

In conclusion, improving standardization strategies, enhancing methodological quality, and providing translational relevance are essential for the future achivement of natural product-based drug discovery. A SWOT-based perspective may provide a realistic framework for the identification of current gaps and guiding future research strategies in preclinical natural product studies.

KL5

From Brazilian biodiversity to the clinic approach: the therapeutic potential of pequi oil

Lucindo José Quintans-Júnior[1,*], Victor Augusto Barrêto Monteiro[1], Walderi Monteiro da Silva Júnior[1], Jullyana Souza Siqueira Quintans[1]

[1] *Federal University of Sergipe. Graduate Program in Health Sciences. São Crisytóvão – Sergipe, Brazil*

lucindo@academico.ufs.br; ORCID: 0000-0001-5155-938X

Brazilian biodiversity represents one of the richest reservoirs of bioactive natural products for drug discovery and pharmaceutical innovation [1]. This lecture will present a translational research journey illustrating how traditional knowledge and natural product research can evolve into evidence-based clinical applications, using *Caryocar coriaceum* (pequi) oil as a representative case study. The presentation will discuss the pharmacological rationale supporting the anti-inflammatory and analgesic properties of pequi oil, followed by the development of an advanced nanostructured topical formulation designed to improve physicochemical stability, skin permeation, and therapeutic performance [2]. Particular emphasis will be placed on the translational pathway from biodiversity to clinical evaluation through a randomized controlled clinical trial in women with knee osteoarthritis. The formulation, combined with therapeutic exercise, promoted significant improvements in pain, pressure pain threshold, physical function, knee-related quality of life, and inflammatory status, including sustained reductions in TNF-α, while demonstrating an excellent safety profile. The lecture will also address the challenges of transforming biodiversity-derived compounds into clinically relevant innovations, highlighting the integration of ethnopharmacology, pharmaceutical technology, nanomedicine, and clinical research. This experience exemplifies how multidisciplinary collaboration can bridge Brazilian biodiversity and modern translational medicine, providing new opportunities for developing safe, effective, and scientifically validated phytopharmaceutical interventions for chronic musculoskeletal diseases.

References

[1] Valli, M. et al. *Journal of Natural Products*, 2013, 76, 439–444.
[2] de Faro Silva, R. et al. *Biomed. Pharmacother.*, 2022, 150, 112938.

Acknowledgments: LJQJr (Process No. 303940/2022-0) is a CNPq Research Productivity Fellow. This study is another outcome of the French-Brazilian Network on Natural Products (FB2NP)

KL6

From farm to fork: Sustainable valorization of agri-food industry by-products

Nazım Şekeroğlu[1]

[1]*Gaziantep University, Faculty of Science and Literature, Department of Biology, 27310, Gaziantep- Türkiye*

nazimsekeroglu@gantep.edu.tr; nsekeroglu@gmail.com; ORCID: 0000-0002-0630-010

Processed foods constitute an important component of human nutrition worldwide. However, agricultural production, food processing, distribution, and consumption generate millions of tons of by-products and organic waste materials annually. These residues, including fruit and vegetable peels, seeds, kernels, pomace, stalks, husks, bran, whey, and other plant-derived materials, are often underutilized or discarded, contributing to environmental pollution, greenhouse gas emissions, and economic losses. Nevertheless, such organic residues represent valuable and sustainable resources that can be effectively utilized through appropriate management and valorization strategies. Their sustainable use can enhance resource efficiency, reduce environmental impacts, minimize waste generation, and support the development of sustainable food systems. Historically, many materials currently regarded as by-products were not considered as a waste. Before the emergence of the modern agri-food industry, they served as valuable foodstuffs and ingredients in traditional and nutritious diets, reflecting efficient resource utilization and contributing to healthy dietary practices across generations. Building on this traditional knowledge, increasing attention is being directed toward upcycling food waste into value-added natural foods and ingredients [1]. Through innovative processing technologies, agri-food by-products can be transformed into functional ingredients, nutraceuticals, natural additives, and novel food products with enhanced nutritional and economic value [2]. This approach not only reduces food waste but also promotes circular economy principles and sustainable resource management. In the context of growing global food demand, resource scarcity, and sustainability challenges, the valorization of agri-food by-products has emerged as a promising strategy for creating resilient food systems. Drawing inspiration from traditional knowledge and combining it with modern technologies, this study explores the concept of “Farm to Fork” sustainable valorization, emphasizing the conversion of agricultural and food-processing residues into value-added products. Ultimately, this holistic approach can maximize resource utilization, generate economic opportunities, and contribute to a more sustainable, resource-efficient, and environmentally responsible food system.

References

[1] Du, X. et al. *ACS Food Science & Technology,* 2026, 6 (4), 853-856.
[2] Won, HJ et al. *Front. Sustain. Food Syst*., 2026, 10, 1841645.

KL7

Feeding the aging brain: role of nutrition on cognitive resilience

Giuseppe Grosso[1]

[1] *Department of biomedical and Biotechnological Science, University of Catania*
giuseppe.grosso@unict.it; ORCID: 0000-0003-3930-5285

Cognitive decline and dementia represent major global public health challenges, particularly in aging populations. Emerging evidence suggests that nutrition plays a central role in brain health through its influence on inflammation, oxidative stress, metabolic dysfunction, gut microbiota composition, and neurodegenerative processes. Epidemiological studies consistently indicate that adherence to healthy dietary patterns, especially the Mediterranean diet, is associated with reduced risk of cognitive decline, dementia, and Alzheimer's disease. Experimental and intervention studies further support the potential cognitive benefits of compounds such as anthocyanins, curcumin, flavan-3-ols, and resveratrol. Plant-derived foods rich in vitamins, fiber, and phytochemicals such as (poly)phenols appear to exert neuroprotective effects through antioxidant and anti-inflammatory mechanisms. Specific (poly)phenols have been demonstrated to modulate neuronal signaling, synaptic plasticity, neuroinflammation, and oxidative damage. The presentation also highlights the emerging role of the gut–brain axis, emphasizing how fiber-rich and (poly)phenol-rich foods may influence cognitive health through microbiota-derived metabolites and immune modulation. Although current findings are promising, further long-term studies are needed to clarify causal mechanisms and optimize nutritional strategies for cognitive preservation. Given the increasing burden of cognitive impairment and the absence of effective curative therapies, nutrition-based preventive approaches may represent a sustainable strategy to promote healthy brain aging.

KL8

Sustainable Food Packaging From Agro-Waste: Biodegradable Film Development Using Hazelnut and Artichoke By-Products

Ilayda Hizir Kadi (İlayda Hızır Kadı)[1,2], Evren Demircan[1], Beraat Ozcelik (Özçelik)[1,3]

[1] *Department of Food Engineering, Faculty of Chemical and Metallurgical Engineering, Istanbul Technical University, Maslak, TR-34469, Istanbul, Türkiye*
[2] *Department of Food Engineering, Faculty of Engineering, Izmir Institute of Technology, TR-35430, Izmir, Türkiye*
[3] *Bioactive Research& Innovative Food Manufac. Indust. Trade Ltd., Katar Street, Teknokent ARI-3, B110, Sarıyer, 34467, Istanbul, Türkiye*
ozcelik@itu.edu.tr; ORCID: 0000-0002-1810-8154

Growing recognition of the ecological burden imposed by plastic waste has fostered the development of environmentally benign and biodegradable packaging materials. This study aims to develop a sustainable approach to valorizing hazelnut processing by-products, specifically skins and shells, by converting them into bioactive, polyphenol-rich extracts using pressurized hot water extraction (PHWE), an environmentally friendly green technology. The recovered extracts were incorporated into biodegradable polyvinyl alcohol/carboxymethyl cellulose (PVA/CMC) films at varying concentrations (1–3%), and the resulting composites were comprehensively characterized in terms of structural, mechanical, thermal, and barrier properties. FTIR, DSC, and XRD analyses demonstrated strong hydrogen bonding, increased thermal stability, and reduced crystallinity due to polyphenol–polymer interactions. Phenolic incorporation enhanced UV-blocking capability, increased antioxidant activity by up to fivefold, and reduced oxygen- permeability by 69% relative to neat PVA while maintaining desirable transparency (>70%). Optimal formulations (HSkE-II) exhibited a 39% increase in elongation at break and improved flexibility without compromising film integrity. Application tests using fresh-cut apples, watermelon, and chicken revealed significant reductions in microbial growth, lipid oxidation, and weight loss during storage, confirming the films' potential for smart and active food packaging. This work highlights an efficient valorization strategy for hazelnut industry by-products and demonstrates their functional integration into sustainable biodegradable packaging systems.

KL9

Oxygen-Driven Thermal Degradation of Isorhamnetin in Boiling Water: Product Profiling, Energetics, and Anti-Obesity Mechanisms in C. elegans

Hui Cao[1]

[1]*Universidade de Vigo, Nutrition and Bromatology Group, Department of Analytical and Food Chemistry, Faculty of Sciences, 32004 Ourense, Spain*

hui_cao0830@yahoo.com; ORCID: 0000-0002-0584-4734

Dietary flavonoids are prone to structural transformations upon heating, yet it remains unclear whether their post-heating biological activity is driven by the parent compound or its degradation products. This study constructed a time-resolved three-dimensional product-structure-activity network for isorhamnetin (ISO) in boiling water. A total of 12 products were identified and classified into phenolic acids, hydroxylated adducts, and dimers. Density functional theory (DFT) calculations supported a degradation mechanism involving quinone formation, nucleophilic attack at the C2 position, and cleavage of the C-ring. Further biological evaluation revealed that ISO and its major degradation products, phloroglucinol (PG) and 2,4,6-trihydroxybenzoic acid (THBA), alleviate glucose-induced metabolic reprogramming and lipid accumulation in *Caenorhabditis elegans* through a DAF-16/FOXO-dependent mechanism associated with H3K4me3/H3K27me3. Overall, this work provides a structural map of ISO under cooking-like conditions and offers new insights into the preservation of polyphenol bioactivity during thermal transformation.

Acknowledgments: This research was funded by the Juan de la Cierva Incorporación Program (IJC2020-046055-I) and the Diputación de Ourense INOU Program–Campus Auga (INOU2025).

KL10

From traditional to functional jelly formulations: utilization of black raspberry pomace extract

Jelena Popović-Djordjević[1], Katarina Šavikin[2], Nikola Tomić[1], Olgica Nedić[3]

[1] *University of Belgrade, Faculty of Agriculture, Belgrade, Serbia*
[2]*Institute for Medicinal Plants Research "Dr. Josif Pančić", Tadeuša Košćuška 1, Belgrade, Serbia*
[3] *Institute for the Application of Nuclear Energy (INEP), University of Belgrade, Belgrade, Serbia*
jelenadj@agrif.bg.ac.rs; ORCID: 0000-0003-4057-3826

Black raspberry (*Rubus occidentalis*) is a rich source of anthocyanins, particularly cyanidin derivatives, along with ellagitannins [1]. A renewed interest in black raspberry, not only for its unique flavor but also for characteristics associated with health and sensory quality in preparation of functional food is notable [2]. Creation of low-sugar black raspberry products, such as jellies with refined sugar substitutes, is one direction of functional food production.
For this purpose, four jelly formulations enriched with 3% of black raspberry pomace (BRP) extract were developed; PS-pectin/sucrose; GS-gelatin/sucrose; PI-pectin/inulin; GI-gelatin/inulin, as well as four control samples. All samples were examined for their phytochemical composition (total phenolic content-TPC and total anthocyanin content - TAC), functional characteristics (*in vitro* antioxidant and antidiabetic activities) and sensory attributes. HPLC was used for quantitative analysis of the main anthocyanins (cyanidin-3-*O*-glucoside, cyanidin-3-*O*-rutinoside and cyanidin-3-*O*-sambubioside).
The results indicated that TPC and TAC were higher in samples with inulin (GI and PI) compared to those with sucrose. The antioxidant activity measured by $DPPH^{\cdot}$ and $ABTS^{\cdot+}$ assays was significantly different between samples enriched with BRP ($p<0.05$), while samples with inulin (GI and PI) did not show significant differences compared to jellies with sucrose in FRAP assay ($p>0.05$). The samples showed no significant differences toward α-amylase inhibition (IC_{50}-3.41-3.61 mg/mL), with exception of control pectin/inulin (CPI) sample which expressed significantly lower activity compared to other samples ($p<0.05$). On the other hand, only pectin-based jelly formulation PI showed inhibitory potential toward α-glucosidase enzyme (IC_{50}-0.82±0.02 mg/mL).
For sensory evaluation, 16 sensory attributes were assessed, showing significant discrimination among the samples. The gelling agents influenced perceptual differences between the formulations in terms of texture and appearance, while the flavor attributes were mainly affected by the sweetening ingredients used. The results of the study showed that enriching jelly with anthocyanins as well as the choice of gelling agent and sweetener can help to obtain a healthier option for consumers.

References

[1] Krgović N, et al., *Ind Crop Prod* 2025, 223:120237
[2] Toshima S, et al., *Sci Hortic-Amsterdam*, 2021, 285:110204

Acknowledgement: Authors acknowledge the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia for financial support (Grant Nos. 451-03-33/2026-03/200003, 451-03-34/2026-03/200116 and 451-03-34/2026-03/200135).

KL11

Medicinal plants from caatinga biome: Chemical constituents and chemotaxonomic significance

Jackson Roberto Guedes da Silva Almeida[1]

[1] *Center for Studies and Research of Medicinal Plants (NEPLAME), Federal University of Vale do São Francisco (UNIVASF), 56.304-205, Petrolina, Pernambuco, Brazil*

jackson.guedes@univasf.edu.br; ORCID: 0000-0002-0867-1357

The Caatinga biome (semi-arid vegetation) is a highly threatened biome covering a vast area in Northeastern Brazil and is the source of few studied natural resources. Many medicinal plant species from Caatinga are widely known and used in folk medicine and for commercial manufacturing of phytotherapeutic products. Few chemical, ethnobotanical and pharmacological studies have been undertaken in this region, in spite of the great cultural and biological diversity to be found there. The purpose of this lecture is to present results of research carried out at the Federal University of Vale do São Francisco with the species *Annona leptotela*, *Annona coriacea*, *Annona vepretorum*, *Lonchocarpus araripensis*, *Hymenaea martiana, Passiflora cincinnata* and *Passiflora foetida*, typical species from the Caatinga biome. The main chemical constituents identified in extracts of these species will be presented. Regarding the pharmacological activity, results will be presented on the antinociceptive and anti-inflammatory activity. The exact mechanism involved in the antinociceptive and anti-inflammatory activities is not completely understood but, at least in part there is the participation of opioid receptors and inhibition of cyclooxygenase enzyme. Docking studies confirm this hypothesis. Pharmacological and chemical studies are continuing in order to characterize the mechanism responsible for these effects.

KL12

Plant-based functional foods for healthy skin aging

Francesca Giampieri[1]

[1]Department of Clinical Sciences, Polytechnic University of Marche, Ancona
f.giampieri@staff.univpm.it; ORCID: 0000-0002-8151-9132

Skin aging is a complex biological process driven by both intrinsic factors, such as immunosenescence and inflammation, and extrinsic factors, including ultraviolet radiation, pollution, tobacco exposure, and poor nutrition. These stimuli contribute to increased reactive oxygen species production and oxidative stress, promoting cellular damage, senescence, extracellular matrix remodeling, and impaired tissue repair. In this context, plant-based bioactive compounds from functional foods represent promising natural strategies to support healthy skin aging. This presentation summarizes the research experience of the Bioenergetics Lab at the Polytechnic University of Marche on strawberry- and blueberry-derived bioactive compounds and their application in skin health. Strawberries and blueberries are highlighted as valuable models due to their richness in vitamin C, folate, anthocyanins, and their high total antioxidant capacity. In vitro studies using human dermal fibroblasts, keratinocytes, and macrophages exposed to different oxidative, inflammatory, microbial, or UV-related stressors showed that berry-based formulations may improve cell viability, reduce apoptosis, decrease intracellular ROS levels, modulate inflammatory biomarkers, and support mitochondrial function. These findings supported the development of two pre-industrial skincare prototypes: a daily moisturizer and a sunscreen enriched with berry extracts and selected antioxidant compounds. Stability testing, antioxidant capacity assessment, patch testing, and photopatch testing conducted in human volunteers confirmed the safety and potential applicability of these formulations. Overall, this research supports the use of plant-based functional ingredients as innovative, natural, and eco-sustainable tools for healthy skin aging and cosmeceutical development.

KL13

Natural Bioactive Compounds: Functional Additives for Engineering Advanced Biomaterials

Ana C. Q. Silva, Maria C. Teixeira, João P. F. Carvalho, Carla Vilela, Armando J. D. Silvestre, Carmen S. R. Freire

CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, Aveiro 3810-193, Portugal

ana.cristina.silva@ua.pt ; ORCID: 0000-0002-8015-5904

Natural bioactive compounds encompass a wide array of molecules derived from plants and other biological sources, exhibiting, among others, antioxidant, anti-inflammatory, antimicrobial, and antitumoral activities. Despite their promising therapeutic potential, the direct application of these compounds is often limited by their poor physicochemical stability, low aqueous solubility, and reduced bioavailability [1]. Incorporating these compounds into biopolymeric-based systems can address these limitations by improving stability and enabling controlled delivery [1,2]. In addition, their intrinsic bioactivity can be leveraged to confer specific biological functions to the material, supporting the design of advanced functional biomaterials with tailored features and enhanced performance.

In this communication, we highlight recent advances from our research group (BioPol4Fun, CICECO – Aveiro Institute of Materials, University of Aveiro) in the development of functional biomaterials incorporating natural bioactive compounds, including phytochemicals such as caffeine, curcumin, rutin, and plant-derived extracts (e.g., *Eucalyptus globulus*), as well as bioactive polysaccharides and proteins [2]. Herein, the bioactive molecules were integrated into biopolymeric platforms, including two-dimensional (2D) systems, such as nanostructured bacterial nanocellulose membranes and thin polymeric films, and three-dimensional (3D) systems, including hydrogel-based bioinks for 3D bioprinting and biopolymeric microneedle arrays. These systems target both cosmetic (e.g., anti-aging and cellulite treatment) and therapeutic applications, including topical and transdermal drug delivery, antimicrobial therapies, and biofabrication.

Overall, this body of work demonstrates the synergies arising from integrating natural bioactive compounds in sustainable, high-performance biomaterials for biomedical applications, resulting in more effective, safe, and economic cosmetic and therapeutic solutions.

References

[1] Han, H.S. et al. *Bioactive Materials*, 2022, 14, 182–205.
[2] Silva, A.C.Q. et al. *Molecules*, 2022, 27(1), 94.

Acknowledgments: The works presented herein were developed within the scope of the project CICECO-Aveiro Institute of Materials, UID/50011/2025 (DOI 10.54499/UID/50011/2025) & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), financed by national funds through the FCT/MCTES (PIDDAC).

KL14

From Coastal Invasion to Phytochemical Innovation: Invasive Seaweeds as Sources of Bioactive Compounds for Food, Health and Biotechnology

Luísa Custódio

Centre of Marine Sciences (CCMAR/CIMAR LA), University of Algarve, Faculty of Sciences and Technology, Building 7, Campus of Gambelas, 8005-139 Faro, Portugal
lcustodio@ualg.pt; ORCID 0000-0003-4338-7703

Biological invasions are among the major drivers of biodiversity loss, ecosystem disruption and economic damage worldwide. In marine environments, invasive seaweeds such as *Sargassum muticum*, *Asparagopsis armata*, *Undaria pinnatifida* and, more recently, *Rugulopterix okamurae*, are spreading across coastal ecosystems, affecting native communities, fisheries, aquaculture, tourism and coastal management. However, while invasive seaweeds represent a serious environmental threat, their large and recurrent biomass may also offer an opportunity for sustainable valorisation. Rich in polysaccharides, phenolic compounds, pigments, fatty acids, sterols and other specialised metabolites, these species can be explored as potential sources of bioactive ingredients for food, cosmetics, agriculture, pharmaceuticals and biotechnology. This presentation will focus on the biotechnological potential of invasive marine algae, with particular emphasis on *Rugulopterix okamurae*, an invasive brown seaweed now affecting southern European coasts, including Portugal. Preliminary results on its chemical composition and biological properties indicate the presence of valuable compounds with antioxidant, enzyme-inhibitory and functional potential, supporting further research into its possible applications. Importantly, biomass valorisation should not be seen as a substitute for prevention, control or eradication measures. Instead, it should be framed as a complementary circular-economy strategy, using biomass removed from invaded areas while avoiding any incentive for cultivation or further spread. The presentation will therefore also address regulatory, environmental and policy considerations needed to ensure that invasive biomass exploitation is safe, responsible and aligned with ecosystem restoration goals.

Acknowledgments: This study received portuguese national funds from FCT - Foundation for Science and Technology through contracts UID/04326/2025, UID/PRR/04326/2025, and LA/P/0101/2020 (DOI:10.54499/LA/P/0101/2020). This work also benefited from funding from the project REVALGAE (EAPA_0130/2024, Interreg Atlantic Area), co-funded by the European Union. In Portugal, national co-funding provided by APA—Agência Portuguesa do Ambiente. MJR was supported by FCT (DOI: 10.54499/UIDP/04326/2025).

ORAL PRESENTATIONS

OP1

From Stilbenes to Regenerative Polysaccharides: Translational Potential of *Reynoutria japonica* Rhizome in Oral and Soft Tissue Regeneration

Izabela Nawrot-Hadzik[1], Magdalena Fast[2], Tomasz Gębarowski[3], Adam Matkowski[1], Jakub Hadzik[4]

[1]*Division of Pharmaceutical Biology and Botany, Department of Pharmaceutical Biology and Biotechnology, Faculty of Pharmacy, Wroclaw Medical University, Poland*
[2]*Department of Dosage Form Technology, Faculty of Pharmacy, Wroclaw Medical University, Poland*
[3]*Department of Biostructure and Animal Physiology, Faculty of Veterinary Medicine, Wrocław University of Environmental and Life Sciences, Poland*
[4]*Department of Dental Surgery, Faculty of Dentistry, Wroclaw Medical University, Poland*
izabela.nawrot-hadzik@umw.edu.pl; ORCID: 0000-0002-5797-7336

Reynoutria japonica (syn. *Polygonum cuspidatum*; Ph. Eur.: *Polygoni Cuspidati Rhizoma et Radix*) is widely recognized as a rich source of stilbenes, particularly resveratrol and piceid. While the biological activity of its low-molecular-weight polyphenols has been extensively investigated, the contribution of high-molecular-weight constituents to tissue regeneration remains insufficiently explored.

Within a research program, we investigated rhizome extracts prepared using organic solvents as well as traditional decoction methods and demonstrated their ability to stimulate human gingival fibroblast proliferation and collagen synthesis. These findings supported the development of mucoadhesive polymeric delivery systems enabling sustained release of bioactive compounds and improved local application in the oral cavity.

Interestingly, strong proliferative effects were also observed for traditional decoctions, suggesting the involvement of water-soluble macromolecules. Subsequent fractionation via ethanol precipitation yielded polysaccharide-rich fractions, which were characterized using HPLC-RI, HPLC-MS and FTIR spectroscopy. These fractions demonstrated significant stimulation of fibroblast proliferation, confirmed by MTT assay, Ki-67 expression and cell cycle analysis. Similar proliferative effects were confirmed in an additional human fibroblast model, indicating a broader soft tissue–supporting profile of the isolated macromolecular constituents.

Our findings suggest that, beyond well-characterized stilbenes, polysaccharides represent an underrecognized yet biologically active fraction of *R. japonica* rhizome. Together, these results highlight the translational potential of *R. japonica* rhizome as a source of bioactive constituents supporting soft tissue regeneration and localized therapeutic strategies.

OP2

Potential hypoglycemic, hypolipidemic, and anti-hyperuricemic components from two medicinal plants explored by affinity ultrafiltration LC-MS with four drug targets

Ming-Quan Guo [1,2], and Meng-Jia Xu[1,2]

[1]*Ningbo Cixi Institute of Biomedical Engineering, Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, Ningbo 315201, China*
[2]*University of Chinese Academy of Sciences, Beijing, 100049, China*
guomingquan@nimte.ac.cn ; ORCID: 0000000266275627

Natural products are promising for managing interconnected metabolic disorders like diabetes, hyperlipidemia, and hyperuricemia [1,2]. *Rheum tanguticum* (rhubarb) and *Ampelopsis grossedentata* are traditionally used, but their specific bioactive components and mechanisms of action for these multi-target activities remain unclear.
This study employed an integrated strategy. First, in vitro inhibitory assays against α-glucosidase, pancreatic lipase, and xanthine oxidase were conducted. Then, a bio-affinity ultrafiltration LC-MS/MS method targeting these three enzymes plus α-amylase was used for rapid screening of the corresponding bioactive ligands. Further verification involved molecular docking and *in vitro* enzyme inhibition assays. Finally, compound-target interaction networks were constructed to decipher their mechanisms of action.
The extracts of both plants showed significant inhibitory activity against the key enzymes listed above. For R. tanguticum, affinity ultrafiltration rapidly identified 14, 23, 15, and 10 potential ligands for α-glucosidase, α-amylase, lipase, and xanthine oxidase, respectively. For A. grossedentata, four major flavonoids (quercetin, myricetrin, dihydromyricetin, taxifolin) were effectively screened and characterized. Molecular docking supported their binding affinities. The constructed interaction networks provide insights into their multi-comonent and multi-target mechanisms of actions. This work highlights the potential of both plants as sources of multi-functional natural therapeutics for metabolic syndrome, and showcase its wide application potentials for other traditional medicinal herbs.

References

[1] Zhang, H. et al. Food Chemistry,2022,375, 131856.
[2] Hua, X. et al., *Food Frontiers,2025, 6(1). 1-20*.

Acknowledgments: This work was partly supported by the Ningbo Yongjiang Talent Introduction project (No.2022A-078-G)

OP3

Phytochemical Profiling and *In Vivo* Anti-Inflammatory Activity of Fennel Pignut (*Bunium ferulaceum*) Tubers: An Underexplored Mediterranean Natural Resource

Deghima Amirouche [1,2], Nadjat Righi[3], Elisabete Coelho[4], Maria Inês Arranca[4], Sónia S. Ferreira[4], Susana M. Cardoso[4], Faiza Baali[5], Diana Ansorena[1], Iciar Astiasarán[1], Manuel A. Coimbra[4]

[1] *Departamento de Ciencias de la Alimentación y Fisiología, Facultad de Farmacia y Nutrición, CIN Centro de Investigación en Nutrición, INS Instituto de Nutrición y Salud, Universidad de Navarra, Irunlarrea s/n, Pamplona 31008, Spain*
[2] *Laboratory of Genetics, Biotechnology and Valorization of Bioresources, University of Biskra, BP 145RP, Biskra 07000, Algeria*
[3] *Laboratory of Applied Biochemistry, Faculty of Natural and Life Sciences, University Ferhat Abbas Setif 1, Setif, 19000, Algeria*
[4] *LAQV-REQUIMTE, Department of Chemistry, University of Aveiro, Campus Universitario de Santiago, 3810-193 Aveiro, Portugal*
[5] *Faculté des Sciences de la Nature et de la Vie et Sciences de la Terre, Département de Biologie, Université de Ghardaia, 47000, Algeria*
damirouche@unav.es; ORCID: 0000-0001-8046-1066

The discovery of underexplored plant species as sources of safe and effective health-promoting phytochemicals remains a priority in natural product research [1]. Fennel pignut (*Bunium ferulaceum*), a wild edible tuber traditionally foraged in Mediterranean regions [2], has received limited scientific attention despite its ethnobotanical significance. This study provides the first integrated investigation of its, phenolic profile, and functional properties—combining phytochemical characterization with *in vivo* toxicity and anti-inflammatory evaluation to establish its potential as a valuable natural resource for food and health applications. The tuber's extract contained compounds like catechins and 5-O-caffeoylquinic and feruloylquinic acids. The hydromethanolic extract contained notable amounts of polyphenols (95 mg GAE/100 g d.w). It exhibited good DPPH· radical scavenging ability (IC_{50} = 383 µg/mL), a total antioxidant capacity of 144 µg AAE/mg extract, and a β-carotene bleaching inhibition of 57 %. Mice fed with the tuber's powder and their extract showed a significant reduction in acute inflammation in xylene-induced ear edema reaching 45 % at 2.5 g/kg b.w for the tuber's powder and 52 % at 600 mg/kg b.w for the extract. Moreover, mice treated with a single oral dose (2.0 g/kg b.w) of the extract showed no signs of toxicity. This study highlights the functional activities and safety of *B. ferulaceum* tubers and their polar extracts, supporting their potential in food and medicinal applications.

References

[1] Clemente-Villalba, J. et al. *Foods*, 2024, 13, 853.
[2] Mohammad Hosseini M. et al. *Chem. Biodiversity*, 2021, 13, e2100317 (2-29).

Acknowledgments: The author acknowledges the support of the European Union's Horizon Europe research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 101206095. Elisabete Coelho thanks the research contract (DL 57/2016/CP1482/CT0038) funded by national funds (OE), through FCT, in the scope of the framework contract foreseen in numbers 4, 5 and 6 of the article 23, of the Decree-Law 57/2016, of August 29, changed by Law 57/2017, of July 19.

OP4

Bridging phytochemistry and immunomodulation: an integrated *in silico/in vitro* study on *Baccharis dracunculifolia* DC. leaf extract

Giorgio, Cappellucci[1,4], Mariana, Romão-Veiga[2], Vanessa Rocha, Ribeiro-Vasques[2], Elisabetta, Miraldi[1,4], Giulia, Baini[1,4], José Maurício, Sforcin[2], Marco, Biagi[3,4]

[1] *Department of Physical Sciences, Earth and Environment, University of Siena, Siena, 53100, Italy*
[2] *São Paulo State University (UNESP), Department of Genetics, Microbiology and Immunology, Institute of Biosciences, Campus Botucatu, Dr. Plinio Pinto e Silva street, s/n, Rubião Júnior, Botucatu, SP 18618-691, Brazil*
[3] *Department of Food and Drug, University of Parma, Parma, 43124, Italy*
[4] *SIFITLab, Italian Society of Phytotherapy, Via Laterina, 8, Siena, 53100, Italy*
giorgi.cappellucci@unisi.it ; ORCID: 0009-0001-2037-3133

Medicinal plants represent a valuable reservoir of bioactive phytochemicals with potential applications in both pharmaceutical and functional food fields. *Baccharis dracunculifolia* DC., a South American species traditionally employed for inflammatory disorders and gastrointestinal ailments, is particularly recognized as one of the main botanical sources of Brazilian green propolis. In this study, an integrated *in silico/in vitro* approach was applied to investigate the immunomodulatory activity of a dry leaf extract of *B. dracunculifolia* (BDE) and to elucidate the molecular pathways involved in its biological effects.

Phytochemical characterization by colorimetric assays and HPLC-DAD analysis revealed a complex profile rich in polyphenols, terpenoids, and cinnamic acid derivatives, including artepillin C, pinocembrin, and pinobanksin. Additional metabolites, such as baccharin, drupanin, naringenin, and isosakuranetin, were retrieved through phytochemical databases and incorporated into a Network Pharmacology (NP) workflow. Computational analyses highlighted the interaction of BDE phytochemicals with signaling networks involved in inflammation and immune regulation, suggesting a multitarget mechanism of action. To improve the translational relevance of the study, *in silico* ADME prediction and a simulated gastrointestinal digestion model were combined to evaluate the bioaccessibility and potential intestinal absorption of the main constituents.

The immunological activity of BDE was assessed in THP-1 monocytes and peripheral blood mononuclear cells (PBMCs). Flow cytometry analyses demonstrated modulation of TLR-2 and TLR-4 expression together with activation of p38, ERK1/2, and NF-κB signaling pathways. Moreover, ELISA assays showed increased release of IL-1β, IL-6, IL-2, and IL-10 under basal conditions, while a marked reduction of TNF-α production was observed in LPS-stimulated cells, indicating a dual immunoregulatory effect.

Overall, the integration of phytochemical profiling, computational prediction, digestion studies, and cellular assays provided a comprehensive understanding of the biological potential of *B. dracunculifolia*. These findings support the valorization of this species as a promising source of immunomodulatory phytochemicals for future applications in nutraceuticals, functional foods, and phytopharmaceutical development.

References

[1] Cappellucci, G. et al. *Journal of Pharmacy and Pharmacology, 2026,* 78.3: rgaf110.

OP5

Ellagic acid and procyanidin C1 from *Cynomorium songaricum* activate SERCA2 to inhibit ER stress in metabolic syndrome

Zhihao Liu[1,2], Jihang Chen[1,2]

[1] *Shenzhen Key Laboratory of Steroid Drug Discovery and Development, Department of Pharmaceutical Science, Division of Biomedical Health Sciences, School of Medicine, The Chinese University of Hong Kong, Shenzhen, Guangdong, PR China.*
[2] *The Chinese University of Hong Kong, Shenzhen Futian Biomedical Innovation R&D Center, Shenzhen, Guangdong, PR China.*
chenjihang@cuhk.edu.cn; ORCID: 0009-0000-5692-8949.

Cynomorium songaricum Rupr., a traditional edible and medicinal plant in China, has hypoglycemic potential, yet the molecular mechanisms and direct targets underlying its protective effects against endoplasmic reticulum (ER) stress-associated metabolic dysfunction remain incompletely understood. ER stress is recognized as a driver of metabolic disease, and the unfolded protein response (UPR) integrates IRE1α, PERK, and ATF6 signaling to reshape insulin resistance (IR), oxidative stress, and lipogenesis [1]. We investigated the pharmacological activities and therapeutic potential of a flavonoid-enriched fraction from *Cynomorium songaricum* (CSF) and its major active constituents. Using LC/MS, network pharmacology, and functional screening in complementary high insulin and glucose (HIHG)/high palmitic acid and oleic acid (HPHO) cell models, we identified ER stress as a principal pathway underlying CSF action. This mechanism was further validated in a 5-month HFD-induced diabetic mouse model through integrated transcriptomic, plasma metabolomic, and lipidomic analyses, which showed that CSF markedly alleviated ER stress, improved IR, and suppressed oxidative stress and lipogenesis. Further activity-guided screening identified ellagic acid (EA) and procyanidin C1 (PCC1) as two major active constituents mediating these protective effects. To define the core target underlying these effects, we integrated transcriptomic analysis with CMAP analysis and PPI network construction, which convergently prioritized SERCA2 as the central node. SERCA2-dependent ER stress relief was associated with restoration of insulin signaling through the IRE1α-JNK-IRS1 axis and attenuation of PERK-eIF2α-ATF4 stress signaling linked to redox homeostasis and oxidative injury [2]. Here, molecular docking, molecular dynamics simulations, SPR, CETSA, thapsigargin-based inhibition, and siRNA-mediated knockdown *in vitro* and *in vivo* consistently demonstrated that EA and PCC1 directly target SERCA2, restore ER Ca^{2+} homeostasis, and relieve ER stress-driven metabolic dysfunction. Collectively, these findings establish SERCA2 as both a central mediator of CSF activity and a therapeutically actionable target, providing a mechanistic basis for developing *Cynomorium songaricum*-derived actives as lead compounds metabolic disorders.

Reference

[1] C. Hetz, K. et al. *Nature reviews Molecular cell biology,* 2020, *21* (8), 421.
[2] U. Ozcan et al. *Science,* 2004, *306* (5695), 457.

Acknowledgments: This work was supported by the research grants from National Natural Science Foundation of China (82274160), Shenzhen Fundamental Research Program (Grant No. JCYJ20230807114103007), Shenzhen Science and Technology Program (GJHZ20240218114200001), Guangdong Natural Science Foundation (2023A1515011492), Shenzhen-Hong Kong Cooperation Zone for Technology and Innovation (HZQB-KCZYB-2020056), Shenzhen Science and Technology Program (ZDSYS201606081515458) and CAS Interdisciplinary Team of "Light of West China" Program (xbzg-zdsys- 202405).

OP6

From Phytochemical to Pure Anthocyanins: Targeting Leydig Cell Steroidogenesis with Cyanidin-3-O-Glucoside

Giuseppe T. Patanè [1,2,3], Rúben J. Moreira [3,4], Ana D. Martins [4], Pedro F. Oliveira [4], Stefano Putaggio [1], Antonella Calderaro [1], Ester Tellone [1], Davide Barreca [1], Marco G. Alves[3]

[1] *Department of Chemical, Biological, Pharmaceutical and Environmental Sciences, University of Messina, 98166 Messina, Italy*
[2] *Prof. Antonio Imbesi" Foundation, University of Messina, Messina, 98100, Italy*
[3] *Institute of Biomedicine (iBiMED), Department of Medical Sciences, University of Aveiro, 3810-193 Aveiro, Portugal*
[4] *LAQV-REQUIMTE, Department of Chemistry, University of Aveiro, 3810-193 Aveiro, Portugal*
giuseppe.patane@studenti.unime.it ORCID: 58001037500

Anthocyanins are among the most widely consumed dietary polyphenols and are traditionally classified as "beneficial" antioxidants for male reproductive health. Yet accumulating evidence in andrology points to an antioxidant paradox: when antioxidant exposure is mismatched to the underlying redox state, it can disrupt physiological redox signalling and impair fertility [1]. In this context, the specific impact of anthocyanins on testicular endocrine function under non-stressed, near-physiological conditions remains poorly defined.

Here, we investigated how anthocyanin-rich phytocomplexes and the representative anthocyanin cyanidin-3-O-glucoside (C3G) shape steroidogenesis and cellular metabolism in non-stressed murine Leydig TM3 cells. An anthocyanin-enriched fraction from *Callistemon citrinus* (0–1.00 µg/mL) induced biphasic, redox-dependent responses: low concentrations induce a mild mitohormetic adaptation, whereas higher concentrations increased intracellular ROS, upregulated *Nr0b2* (SHP), downregulated *Cyp17a1*, and reduced androstenedione output despite preserved *Star* expression, consistent with a transcriptional brake on androgen biosynthesis. In parallel, exposure to C3G (0–24.2 µg/mL) produced a non-linear modulation of redox homeostasis, mitochondrial integrity, and PKA-dependent signalling. Intermediate doses (0.24–2.42 µg/mL) of C3G maintained mitochondrial function and supported a more proliferative metabolic phenotype, while selectively lowering androstenedione production in association with reduced global PKA substrates phosphorylation, suggesting interference with cAMP/PKA-driven activation of key steroidogenic proteins.

Exometabolomic profiling revealed a coordinated rewiring of Leydig cell metabolism, with shifts in amino acid, energy, and lipid-related pathways that were tightly coupled to anthocyanin dose and to the degree of steroidogenic repression. Together, these data show that anthocyanin-based interventions, from complex extracts to pure C3G, can negatively modulate Leydig cell steroidogenesis under basal conditions through complementary, redox-sensitive mechanisms involving Nr0b2/Cyp17a1 regulation, altered PKA-dependent signalling, and metabolic remodelling. These findings highlight a dose- and context-dependent antioxidant paradox in male reproductive endocrinology

and raise important safety considerations for the use of anthocyanin-rich nutraceuticals in the management of male fertility.

References:

[1] Patanè, GT. et al. *J Physiol*, 2026,604: 1028-1044.

OP7

Not Just a Wild Salad: Phytochemicals from *Crepis vesicaria* L. and Their Vascular Effects

Ludovica, Lela[1], Margherita, Accardo[2], Nadia, Benedetto[1], Alessandro, Garramone[2], Giovanna, Scavone[2], Mariangela, Spadafino[1], Vincenzo, Brancaleone[1], Luigi, Milella[1]

[1]*Department of Health Sciences, University of Basilicata, Potenza, Italy*
[2]*Department of Basic and Applied Sciences, University of Basilicata, Italy*
luigi.milella@unibas.it; ORCID: 0000-0002-5874-1237

Crepis vesicaria L. is a wild edible species from the Mediterranean area belonging to the Asteraceae family. The aerial parts and roots of plants from *Crepis* genus are widely consumed as salads, infusions, decoctions, or incorporated into traditional dishes [1]. In addition, these species are used in folk medicine for the treatment of hepatic and cardiovascular disorders, diabetes [2], although their phytochemical and biological properties remain poorly explored. Considering that postprandial hyperglycemia is a key risk factor in the onset of metabolic disorders and a major contributor to endothelial dysfunction through oxidative stress mechanisms, this study aimed to investigate the phytochemical composition of *C. vesicaria* leaves and their potential effects on glucose metabolism and endothelial function. Plant material was extracted by exhaustive maceration using a hydroalcoholic mixture (EtOH 70%). The phytochemical profile was characterized by UPLC-MS, revealing the presence of major classes of specialized metabolites, including flavonoids, terpenes, tannins, and phenolic acids. Among these bioactives, chicoric acid, identified as the main constituent of leaf tissue, attenuates hyperglycemia-induced endothelial dysfunction. In line with this, and to mimic hyperglycemia-induced vascular damage, the biological activity of the leaf extract was further evaluated in bovine aortic endothelial cells (BAECs) exposed to high glucose conditions. Treatment with the extract significantly reduced intracellular reactive oxygen species levels and improved mitochondrial membrane potential, indicating a protective effect on cellular redox status and mitochondrial function. Moreover, the extract modulated glucose uptake in BAECs and increased the expression of endothelial nitric oxide synthase (eNOS), suggesting an overall improvement in endothelial function. In conclusion, *C. vesicaria* leaf extract exhibits antioxidant and endothelial-protective properties, supporting its potential as a source of bioactive compounds for the management of metabolic and vascular disorders.

References

[1] Barda, C. et al. *Molecules*, 2022, 27(19), 6173.
[2] Pedreiro, S. et al. *International Journal of Environmental Research and Public Health*, 2021, 18(1), 151.

OP8

Prenylated benzoic acid derivatives from *Glycyrrhiza foetida* targeting multidrug-resistant *Staphylococcus aureus*

Carmina, Sirignano[1], Massimiliano, Lucidi[2], Francesco, Imperi[2,3], Daniela, Visaggio[2], Eleonora, D'Intino[4], Carlotta, Marianecci[4], Vincenzo, Summa[1], Paolo, Visca[2] and Orazio, Taglialatela Scafati[1]

[1] *Department of Pharmacy, University of Naples Federico II, Naples, Italy*
[2] *Department of Science, Roma Tre University, Rome, Italy*
[3] *Santa Lucia Foundation IRCCS, Rome, Italy*
[4] *Department of Drug Chemistry and Technologies, Sapienza University of Rome, Rome, Italy*
carmina.sirignano@unina.it; ORCID: 0000-0003-4420-4809

The rapid emergence and global spread of multidrug-resistant (MDR) pathogens have become a critical public health concern, severely compromising the efficacy of current antimicrobial therapies. The limited effectiveness of conventional antibiotics against resistant strains underscores the urgent need to identify new chemical scaffolds capable of overcoming bacterial defense mechanisms [1]. In this context, natural products represent an invaluable reservoir of structurally diverse and biologically active molecules [2]. In this study, a library of over one hundred plant-derived compounds, including terpenes, flavonoids, alkaloids, and phenolics, was screened for antibacterial activity against *Escherichia coli* MG1655 and *Staphylococcus aureus* ATCC 25923. Compounds displaying low minimum inhibitory concentrations against *S. aureus* were selected for further investigation.

The most promising hits emerging from the screening belonged to a class of prenylated benzoic acid derivatives from *Glycyrrhiza foetida* (Fabaceae), already included in the compound library. These candidates were subsequently subjected to an extensive panel of microbiological and pharmacological studies to further characterize their antibacterial profile.

Selected compounds were investigated to elucidate their cellular target and mode of action, as well as their ability to affect biofilms and persister cells. Their mechanism was further explored through molecular dynamics simulations and in vitro assays using model membranes. Additionally, combination studies with standard-of-care anti-staphylococcal antibiotics, including daptomycin, piperacillin, and azithromycin, were performed to evaluate potential interactions and their suitability for combination therapies. The propensity for resistance development was also assessed.

Finally, toxicity and antibacterial efficacy were evaluated in an in vivo insect infection model (*Galleria mellonella*), providing preliminary insights into safety and biological activity in a complex system.

References

[1] Balasegaram, M. et al., *Lancet*, 2024, 404, 1385-1387.
[2] Angelini, P. *Antibiotics*, 2024, 13, 746.

OP9

Integrated Phytochemical and Biological Evaluation of Wild Artichoke (*Cynara cardunculus* subsp. *cardunculus*, Asteraceae) Leaf Extracts: Multifunctional Bioactivities in Hepatic and Colorectal Cancer Models

Giuseppe Antonio Malfa[1,2], Simone Bianchi[1,2], Alessandra Pino[3], Donata Condorelli[1], Claudia Di Giacomo[1,2], Rosaria Acquaviva[1,2]

[1] *Department of Drug and Health Sciences, University of Catania, Viale A. Doria 6, 95125 Catania, Italy.*
[2] *Research Centre on Nutraceuticals and Health Products (CERNUT), University of Catania, Viale A. Doria 6, 95125 Catania, Italy.*
[3] *Department of Agriculture, Food and Environment, University of Catania, Via Santa Sofia 100, 95123 Catania, Italy*
giuseppe.malfa@unict.it; ORCID 0000-0002-6733-0587

Cynara cardunculus subsp. *cardunculus* L. [*Cynara cardunculus* L. var. *sylvestris* (Lam.) Fiori], commonly referred to as wild artichoke, is a spiny taxon closely related to cultivated artichokes [*C. scolymus* L., *C. cardunculus* var. *scolymus* (L.) Fiori, *C. cardunculus* subsp. *scolymus* (L.) Hegi]. This species is widely distributed across the Mediterranean area and has been traditionally used for nutritional and medicinal purposes. In this study, aqueous and hydroalcoholic leaf green extracts were prepared from wild populations collected along the southern coast of Sicily (Syracuse, Italy). The HPLC-DAD analysis showed that both extracts exhibit a rich phenolic profile, mainly composed of caffeoylquinic acids and flavonoids, including luteolin and apigenin derivatives. The aqueous extract of wild artichoke showed considerable biological activity in an *in vitro* model of early hepatic steatosis; it restored HepG2 cell viability, reduced ROS production and lipid peroxidation, increased thiol levels, and modulated gene expression, including upregulation of Nrf2, Gpx, and SOD1 and downregulation of IL-6, TNF-α, and IL-1β. The phytocomplex from the hydroalcoholic extract, differently, demonstrated selective cytotoxicity in CaCo-2 colorectal cancer cells (IC_{50} 13.07 µg/mL at 24 hours), promoting ROS-dependent apoptosis via Nrf2 activation and increasing the expression levels of p53, Bax, cytochrome c, and caspase-3. No necrotic effects were detected (LDH release), and no cytotoxicity was observed in HFF-1 fibroblasts at concentrations up to 50 µg/mL. Furthermore, the extract exhibited antimicrobial activity against enteric pathogens, including *E. faecalis* and *S. aureus*, and demonstrated synergistic effects with 5-FU (IC_{50} < 0.8), a standard first-line chemotherapeutic agent in colorectal cancer therapy. In conclusion, these results indicate that the phytocomplexes derived from *C. cardunculus* leaf extracts highlights their potential as modulators of hepatic oxidative stress and as selective antitumor agents in colorectal cancer. The additional antimicrobial and chemosensitizing properties further support their development as nutraceuticals for use in Integrated Oncology Medicine.

References

[1] Acquaviva, R. et al. *Molecules,* 2023, 28, 2475.
[2] Bianchi, S. et al. *Biology*, 2026, 15, 475.

OP10

Oxidative stress is triggered by a flavonoid-rich extract of bergamot juice to hinder colorectal cancer

Alessandro, Maugeri [1], Martina, Farina[2], Michele, Navarra [2]

[1] *Department of Veterinary Sciences, University of Messina, Messina, Italy*
[2] *Department of Chemical, Biological, Pharmaceutical and Environmental Sciences, University of Messina, Messina, Italy*

amaugeri@unime.it; ORCID 0000-0002-8670-3123

The second most prevalent cause of cancer-related deaths globally is colorectal cancer (CRC). Diet plays a pivotal role in the prevention of CRC. Indeed, research indicates that eating a diet high in polyphenols may reduce the risk of colorectal cancer. The purpose of this work was to evaluate the underlying processes and show the possible anticancer effects of a flavonoid-rich extract of bergamot juice (BJe) in both *in vitro* and *in vivo* CRC models. To this aim, CRC cells (i.e., Caco-2, HT-29 and HCT-116) have been employed to investigate the mechanism of action of BJe, whereas a mouse model of azoxymethane (AOM)-induced CRC was exploited to observe the anticancer effects of BJe.

Several CRC cells, particularly HCT-116, had their proliferation suppressed by BJe. It caused apoptosis in this cell line, stopped the cell cycle in the G1 phase, and altered the expression of genes linked to both apoptosis and the cell cycle. Additionally, BJe reduced the mitochondrial membrane potential and induced the formation of reactive oxygen species. The increased levels of 8-oxo-2′-deoxyguanosine and the phosphorylation of histone H2A.X indicate that BJe caused DNA damage in the nucleus of these malignant cells. In *in vivo* setting, BJe was able to reduce the quantity of abnormal crypt foci in mice with AOM-induced CRC. Additionally, BJe decreased both the quantity and proportion of mice with tumours and polyps.

Our research elucidates the underlying mechanism of action and supports the function of BJe against CRC.

OP11

From Waste to Value: Bioactive Potential of Grapevine By-Products

Bárbara Ferreira[1,2], Ana Teixeira[1,2,3], Amélia Silva[3], Alberto C.P. Dias[1,2]

[1]*Centre of Molecular and Environmental Biology (CBMA), Department of Biology, Campus de Gualtar, University of Minho, 4710-057 Braga, Portugal*
[2]*IBS, Institute of Science and Innovation for Bio-Sustainability, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal*
[3]*Centre for the Research and Technology of Agro-Environmental and Biological Sciences (CITAB), University of Trás-os-Montes and Alto Douro (UTAD), Quinta de Prados, 5000-801 Vila Real, Portugal*
albertocpdias66@gmail.com; ORCID: 0000-0003-3641-3248

The growing interest in sustainable strategies within the agri-food sector has spotlighted vitivinicultural by-products as promising sources of bioactive compounds. Residues from grape vinification processes and grapevine leaves from green pruning are recognized as valuable matrices due to their rich phytochemical composition and associated bioactivities. Although their composition and biological potential vary depending on grapevine variety and processing conditions, both remain relevant sources of compounds with promising bioactive properties [1, 2]. The present study evaluates the antioxidant potential and biological effects of extracts obtained from *Vitis vinifera* cv. *Alvarinho* green pruning leaves (AL) and vinification-derived grape skins (AS). Both extracts were characterized through *in vitro* antioxidant assays, including ABTS radical scavenging activity and superoxide anion scavenging capacity. AL demonstrated higher antioxidant efficiency, achieving EC_{50} values at lower concentrations, indicating stronger radical scavenging potential. To assess biological relevance, *Saccharomyces cerevisiae* was used as a model system, including wild-type (WT) and oxidative stress-sensitive mutant strains (*sod2* and *yap1*). In the WT strain, both extracts reduced cell viability after 2 hours of incubation, with no significant effects at 1 hour, indicating a time-dependent response. Conversely, mutant strains exhibited enhanced growth in the presence of the extracts, with AL promoting the most cell viability. These findings suggest a differential cellular response depending on the oxidative status, with AL showing higher potential to modulate redox-related pathways. Thus, AL was selected for further evaluation under induced oxidative stress conditions, where a protective effect was observed, particularly in *sod2* strain. Overall, this study supports the valorisation of grapevine by-products, particularly green pruning leaves, as sustainable sources of bioactive compounds with potential functional applications for the food and pharmaceutical industries.

References

[1] Lopes, et al. *Molecules*, 2025, 30(2), 362.
[2] Singh, Jyoti, et al. *Frontiers in chemistry*, 2023, 11, 1290619.

Acknowledgments: This work is supported by National Funds by FCT – Portuguese Foundation for Science and Technology, under the projects https://doi.org/10.54499/UIDB/04050/2020 (CBMA) and UID/04033/2025 (CITAB). B.F. received a grant from FCT through CITAB´s DP AgriChains (UI/BD/150724/2020). The STrengthS4WineChaiN Project (NORTE2030-FEDER-01786100) and was co-financed by the ERDF under the NRP 2021-2027 [NORTE2030] is also acknowledge. The authors also acknowledge Soalheiro for providing the raw material used in this study.

OP12

Nano-Enriched Plant Sprouts as Novel Functional Food products to Reach Nutrient Needs

Beatriz Meneses-Silva[1,2], Cláudia Nunes[2], Salette Reis[2], Maria Rangel[1], Tânia Moniz[1,2,3]

[1] *LAQV, REQUIMTE, Instituto de Ciências Biomédicas de Abel Salazar, Universidade do Porto, Rua de Jorge Viterbo Ferreira, 228, 4050-313 Porto, Portugal*
[2] *LAQV, REQUIMTE, Departamento de Ciências Químicas, Faculdade de Farmácia, Universidade do Porto, Rua de Jorge Viterbo Ferreira, 228, 4050-313 Porto, Portugal*
[3] *LAQV, REQUIMTE, Departamento de Química e Bioquímica, Faculdade de Ciências, Universidade do Porto, Rua do Campo Alegre, s/n, 40160-007 Porto, Portugal*
tmoniz@icbas.up.pt; ORCID 0000-0002-3175-3844

Nutrient-related deficiencies affect 2 billion people worldwide and are usually related with inadequate food consumption practices, particularly concerning vitamin B12. Its deficiency affects mainly vegetarian, pregnant women, children and elderly people, causing neurological and haematological disorders.
Vitamin B12 deficiency is improved by pharmacological supplements, but oral formulations present only 2% absorption. Few studies reported B12 crops fortification but the uptake mechanism remains poorly understood and more efficient approaches are required.
To correct nutrients deficiencies, edible sprouts have been suggested as alternative functional food products [1]. Considering the benefits of nanotechnology in the field of supplementation, namely the ability to increase nutrients bioavailability [2], this knowledge has also been considered for this purpose.
Since B12, iron and folate metabolism are closely related, the work comprises the production of functional food products, particularly enriched sprouts using nanoparticles as delivery systems for the selected nutrients (B12, iron and folate).
The design and characterization of B12-loaded and iron nanoparticles were already performed and the first results on alfalfa sprouts biofortification were obtained. Both nanoformulations were fully regarding their physicochemical properties and results showed that the nanoparticles presented the desired characteristics such as size and charge. The impact on morphological parameters of the plants was accessed, and no undesired effects were found on the fresh and dry weight of the plants and well as in the length of the sprouts, thus highlighting the applicability of the supplementation strategies. Subsequent studies will focus on the evaluation of the phytotoxicity and the safety of the formulations in *in vitro* cellular studies.

References

[1] Aloo, S. O. et al., *Nutrients*, 2021, 13, 2882.
[2] Kapoor, P. et al., *NanoImpact*, 2022, 26, 100407.

Acknowledgments: The authors would like to thank the scientific collaboration under the FCT project UIDB/50016/2020. Funding: T. Moniz thanks FCT for funding through project COMPETE2030-FEDER-00696700 15854.

OP13

β-Carotene-Macromolecules Complexes for Functional Foods

Alma Bočkuvienė[1,2], Antanas Strakšys[1], Inga Gabriūnaitė[1,2], Tatjana Kavleiskaja[2], Rūta Gruškienė[1], Jolanta Sereikaitė[1]

[1] *Department of Chemistry and Bioengineering, Vilnius Gediminas Technical University, Vilnius, Lithuania*
[2] *Institute of Chemistry, Vilnius University, Vilnius, Lithuania*
jolanta.sereikaite@vilniustech.lt; ORCID: 0000-0003-0888-2178

β-Carotene (CAR) is a natural lipophilic compound that belongs to the carotenoid family. It is composed of a polyene system with eleven conjugated double bonds and a β-ring at each end of the chain. CAR attracts attention due to its health benefits. It is a precursor of vitamin A. CAR consumption is also associated with a reduced risk of cardiovascular disease, cancer, and type 2 diabetes, as well as preventing age-related macular degeneration. However, CAR is insoluble in water and degrades when exposed to heat, light, or oxygen [1].

To incorporate CAR into functional foods, particularly water-based foods, CAR formulations with macromolecules were developed. CAR was complexed with chitooligosaccharides, xylan, or inulin. The interaction of the components was confirmed using spectroscopic methods and differential scanning calorimetry measurements. The physical and chemical properties of the obtained complexes, including solubility, size, zeta-potential, and antioxidant activity, were investigated. CAR complexation with macromolecules did not cause the loss of the antioxidant activity of CAR and ensured water solubility. Furthermore, the complexation improved the long-term stability of CAR in the dark at 4 °C and at room temperature, as well as its stability at higher temperatures. The stability of CAR is also enhanced by the additional coating of the CAR-macromolecule complex and preparation of the ternary system. This is exemplified by the CAR-2-hydroxypropyl-β-cyclodextrin complex coated with pectin and the CAR-inulin complex coated with lactoferrin. Therefore, these newly developed complexes could be used as a new technology to deliver CAR and fortify food.

References

[1] Melendez-Martinez, A. J. et al., *Annual Review of Food Science and Technology*, 2021, 12, 433-460.

Acknowledgments: The research has received funding from the Research Council of Lithuania (LMTLT), project No S-PD-24-55 and from European Social Fund under a grant agreement with the Research Council of Lithuania, project No 09.3.3-LMT-K-712-19-0064 and 09.3.3-LMT-K-712-02-

OP14

Effect of Biological and Thermal Processing on the Phytochemical Profile and Antioxidant Activity of Cornelian Cherry (*Cornus mas* L.) Seeds

Joanna Oracz[1], Natalia Sygitowicz[1], Gabriela Kowalska[1]

[1]*Institute of Food Technology and Analysis, Faculty of Biotechnology and Food Sciences, Lodz University of Technology, 2/22 Stefanowskiego Street, 90-537 Lodz, Poland*

joanna.oracz@p.lodz.pl; ORCID: 0000-0003-2469-3369

The aim of this study was to characterize the phytochemical profile of cornelian cherry (*Cornus mas* L.) seeds and to evaluate the effect of biological and thermal processing on their bioactive potential. As an underutilized by-product of fruit processing, cornelian cherry seeds were subjected to natural fermentation of whole fruits, natural fermentation of seeds separated from the fruit flesh, and germination, followed by drying or roasting under different conditions. The identification and quantification of phenolic compounds and iridoids were performed using ultra-high-performance liquid chromatography coupled with diode-array detection and electrospray ionization tandem mass spectrometry (UHPLC-DAD-ESI-MS/MS), while antioxidant properties were assessed based on total phenolic content, free radical scavenging activity, and ferric reducing antioxidant power (FRAP). In addition, the content of 5-hydroxymethylfurfural (HMF) was determined as an indicator of thermally induced changes.

The phytochemical profile varied significantly depending on the pretreatment method and thermal processing conditions. Comprehensive analysis of cornelian cherry seeds revealed the presence of a wide range of bioactive compounds, including ellagitannins, gallotannins, ellagic acid derivatives, hydroxybenzoic acid derivatives, and iridoids. In dried, unroasted seeds, native hydrolysable tannins constituted the dominant fraction, particularly ellagitannins and gallotannins. Biological pretreatment resulted in substantial qualitative and quantitative changes in these compounds. Fermentation of the seeds proved to be the most effective treatment for increasing the content of native hydrolysable tannins and iridoids, indicating enhanced release or formation of extractable phytochemicals. Germination also improved the bioactive profile of the raw material and enhanced antioxidant activity, suggesting that this process promoted the formation or release of compounds with strong radical scavenging and reducing properties. In contrast, fermentation conducted on whole fruits produced a less pronounced effect, suggesting that the fruit matrix may limit the extent of biochemical transformations occurring in the seeds.

Roasting induced substantial changes in the phytochemical profile, resulting in a decrease in ellagitannins, gallotannins, and most iridoids, accompanied by an increase in gallic acid, ellagic acid derivatives, and other compounds associated with the thermal degradation of hydrolysable tannins. Despite this extensive restructuring of the phytochemical profile, roasted seeds retained high antioxidant activity, suggesting that degradation products formed during heating also contributed substantially to the overall bioactive potential of the final product. HMF was formed only after roasting, with higher levels observed under more intensive thermal treatment conditions.

These findings demonstrate that both biological and thermal processing can effectively modulate the functional properties of cornelian cherry seeds, supporting their potential application as a source of phytochemicals and as a valuable ingredient in functional foods.

OP15

Valorization of Olive Mill Wastewater: Insights into Its Phytochemical Composition and Antidiabetic Activity

Vittorio, Carlucci[1], Immacolata, Faraone[1,2], Muhammad, Tuseef[1], Daniela, Russo[1,3], Alisia, Taddei[1], Claudia, Mangieri[1], Federica, Santopietro[1], Luigi, Milella[1]

[1]*Department of Health Sciences, University of Basilicata, Potenza, Italy*
[2]*Innovative Startup Farmis s.r.l., Potenza, Italy*
[3]*Spinoff BioActiPlant s.r.l., Potenza, Italy*
luigi.milella@unibas.it; ORCID: 0000-0002-5874-1237

Olea europaea L. is one of the most significant fruit crops in the Mediterranean basin, with olive groves covering approximately 11.1 million hectares worldwide [1]. However, the vast annual production of olives leads to environmental concerns, mainly through the accumulation of by-products. Among these, olive mill wastewater (OMWW) represents a major industrial and ecological challenge. Despite its traditional classification as waste, OMWW is an under-explored reservoir of bioactive compounds with diverse biological activities [2], offering significant potential for high-value recovery. Nevertheless, its biological properties remain insufficiently characterized, particularly in relation to metabolic health. In this context, the present study aims to bridge this gap by investigating the biological potential of OMWW, with a specific focus on its glucose-modulating activity.

After appropriate liquid-liquid extraction with hexane and ethyl acetate (EA), the EA fraction was dried and analyzed using liquid chromatography-mass spectrometry (LC-MS) and gas chromatography-mass spectrometry (GC-MS) techniques. This enabled the identification of several classes of metabolites including organic acids, phenolic acids, phenylethanoid glycosides, secoiridoids, flavonoids, and triterpenoids. Quantitative analysis revealed that 3-hydroxytyrosol (158.67±12.82 mg/g DW), oleuropein (122.19 ± 2.64 mg/g DW), and *p*-coumaric acid (117.94 ± 3.85 mg/g DW) were the most abundant constituents in the extract. OMWW demonstrated robust radical scavenging activity and a significant inhibitory action on key enzymes involved in diabetes management. Furthermore, functional assays in STC-1 cells revealed that OMWW modulates glucose metabolism through a dual mechanism, involving the reduction of intestinal glucose transport and the stimulation of GLP-1 secretion via interaction with intestinal bitter taste receptors.

Overall, these findings establish a mechanistic link between the OMWW phytochemical profile and its metabolic effects, supporting its valorization from waste to a high-value nutraceutical resource.

References

[1] Cherni, M. et al. *Resources, Environment and Sustainability*, 2026, 100288.
[2] Enaime, G. et al. *Environmental Science and Pollution Research*, 2024, *31*(14), 20853-20880.

OP16

Nimbolide as a Novel Therapeutic Agent in Liver Cancer and Its Metastasis

Balasubramaniyan Vairappan[1]

[1]*Department of Biochemistry, Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Dhanvantari Nagar Pondicherry-605006, India.*

balamaniyan@gmail.com; ORCID: 0000-0003-1708-4864

Hepatocellular carcinoma (HCC) accounts for nearly 90% of primary liver cancers and remains a leading cause of cancer-related mortality worldwide. Despite advances in diagnosis and therapy, outcomes remain poor, and the global burden of HCC continues to increase, highlighting the urgent need for novel, mechanism-based therapeutic strategies. Nimbolide, a bioactive terpenoid isolated from *Azadirachta indica* (neem), has emerged as a promising multi-target anticancer agent. Preclinical evidence from in vitro and in vivo studies demonstrates that Nimbolide exerts potent anti-proliferative and pro-apoptotic effects while suppressing inflammation, angiogenesis, invasion, and metastasis. Beyond oncology, Nimbolide has shown protective effects in several inflammatory and metabolic disorders, underscoring its broad biological relevance. My talk will integrate emerging experimental evidence on the role of Nimbolide in regulating hepatocarcinogenesis and metastatic progression, with particular emphasis on its ability to modulate the gut-liver axis. Key mechanisms include restoration of gut microbiota homeostasis, attenuation of bacterial translocation through regulation of intestinal tight junction proteins, and suppression of inflammatory signaling pathways in experimental HCC models. In addition, the impact of Nimbolide on hepatic microRNA regulation and its implications for tumor progression and metastasis will be discussed. Collectively, these findings position Nimbolide as a promising candidate for multi-level therapeutic intervention in HCC, with potential translational relevance.

OP17

Structure–Function Relationships Driving the Multimodal Antioxidant Action of Quinoa-Derived Peptides

Nelson Romano[1], Andrea Gomez-Zavaglia[1]

[1] *Center for Research and Development in Food Science and Technology, (CCT-CONICET La Plata) RA1900, La Plata, Argentina*

angoza@qui.uc.pt; ORCID: 0000-0002-8705-0160

Quinoa protein hydrolysates are emerging as sustainable sources of bioactive peptides with antioxidant potential but their functionality depends on structural organization and environmental conditions. In this work, a quinoa protein hydrolysate (QpH) was produced using the broad-specificity protease Protamex, yielding a highly hydrolyzed peptide pool (degree of hydrolysis 44%) dominated by low-molecular-weight species (<5 kDa). Size exclusion chromatography confirmed that nearly 95% of peptides were below 5,000 Da, with a major fraction around 700 Da.

The pH-dependent conformational landscape of QpH was investigated by ATR-FTIR spectroscopy coupled with Principal Component Analysis (PCA) and Multivariate Curve Resolution (MCR). This approach enabled the resolution of four distinct structural states corresponding to protonated (acidic), deprotonated (alkaline), aggregated (isoelectric), and background matrix components. Acidic conditions favored protonated, disordered conformations with limited antioxidant reactivity, whereas neutral and alkaline pH promoted deprotonation of carboxyl groups, electrostatic repulsion, peptide unfolding, and enhanced solvent exposure of reactive residues. Zeta potential measurements corroborated this transition, revealing strongly negative surface charge at pH 7–9.

Antioxidant performance increased markedly with pH, as determined by ABTS radical scavenging. Biological validation was performed using an *in vivo* membrane oxidation model based on *Lactiplantibacillus plantarum* WCFS1 and *cis*-parinaric acid as a lipid peroxidation probe. QpH exerted a dose-dependent protective effect, significantly increasing the kinetic time constant of oxidation and preserving up to ~55% of membrane lipids at the highest concentration tested without compromising bacterial viability or membrane integrity.

The results demonstrate that antioxidant activity arises from a multimodal mechanism combining radical scavenging, Fe^{2+} chelation by deprotonated carboxylates, and physical shielding at the membrane interface by amphipathic peptides. This integrated structure–function approach establishes a mechanistic basis for the rational design of quinoa-derived peptide ingredients aimed at mitigating oxidative stress in food and biological systems.

Acknowledgments: This work has received funding from the Argentinean Agency for the Scientific and Technological Promotion (ANPCyT) (Project PICT/2020/0482) and the Argentinean Research Council (CONICET) (projects PIP11220210100021CO and PIBAA 0754).

OP18

Evaluation of biotechnological potential of *Arnica montana* extracts through metabolomics and machine learning integration

Paula, Garcia-Oliveira[1,2], Lucía, Cassani[1,2,3], Aurora, Silva[4], Clara, Grosso[4], M. Fátima, Barroso[4], Jesus, Simal-Gandara[1,3], Luigi, Lucini[5], Pascual, García-Pérez[6]

[1] *Universidade de Vigo, Department of Analytical and Food Chemistry, Faculty of Science, 32004 Ourense, Spain*
[2] *Instituto de Agroecoloxía e Alimentación (IAA), Universidade de Vigo, Campus Auga, 32004 Ourense, España.*
[3] *Agricultural and Food Research Group (AA1), Galicia Sur Health Research Institute (IIS Galicia Sur). SERGAS-UVIGO, 36312 Vigo, Spain*
[4] *REQUIMTE/LAQV, Instituto Superior de Engenharia do Porto, Instituto Politécnico do Porto, Rua Dr António Bernardino de Almeida 431, 4200-072 Porto, Portugal*
[5] *Department for Sustainable Food Process, Università Cattolica del Sacro Cuore, Via Emilia Parmense 84, 29122 Piacenza, Italy*
[6] *Department of Food Technology, Nutrition and Food Science, Veterinary Faculty, University of Murcia, Regional Campus of International Excellence "Campus Mare Nostrum", 30100 Murcia, Spain*
paula.garcia.oliveira@uvigo.es; ORCID: 0000-0003-4058-3709

Some of the most commonly used methods for extracting bioactive compounds from natural matrices include heat-assisted extraction (HAE), ultrasound-assisted extraction (UAE), microwave-assisted extraction (MAE), and pressurized liquid extraction (PLE). Each method is based on different principles, which can affect the recovery, composition, and functionality of the resulting extracts. Consequently, a comparative evaluation of these methods is essential to identify the most effective approach for retrieving biologically relevant metabolites from natural sources.
In this study, the differences in the phytochemical profile of previously optimized *Arnica montana* extracts obtained using these four techniques were comprehensively evaluated. An integral approach, combining untargeted metabolomics, machine learning-based chemometrics and the evaluation of *in vitro* biological activities was applied. Data integration and interpretation were performed using the Data Integration Analysis for Biomarker discovery using Latent cOmponents (DIABLO) framework.
Multivariate analyses revealed clear differences in the metabolic and phenolic profile among the extracts, with PLE extract exhibiting the most distinctive phytochemical profile. Regarding phenolic profile, anthocyanins, lignans, and related compounds were the main phenolic compounds present in all the extracts. DIABLO analysis successfully elucidated associations between specific metabolites and biological properties, with PLE and MAE being the most discriminant extracts. Specifically, MAE extract showed strong antioxidant and neuroprotective effects that were principally associated with triterpenoid metabolites. On the other hand, the anti-inflammatory, cytotoxic, and antioxidant activities of PLE extract were linked to anthocyanins and flavonols.
These findings enhance the understanding of how extraction technologies affect the functional potential of *A. monatana* extracts and provide a basis for developing more

efficient applications, selecting the extraction method according to desired phytochemicals and specific biological properties.

References

[1] Nieto, G. et al., *Foods*, 2023, 13(1), 47.
[2] Gil-Martín, E. et al., *Food Chemistry*, 2022, 378, 131918.

Acknowledgments: P. Garcia-Perez acknowledges financial support through the Ramon y Cajal program of the Ministry of Science, Innovation and Universities, the State Research Agency (reference: RYC2023-044123-I) and the European Social Fund Plus (FSE+), and through the ATTRACT-RYC program of the University of Murcia. L. Cassani (ED481D-2024-002) and P. Garcia-Oliveira (ED481B-2025/058) acknowledge Consellería de Educación, Ciencia, Universidades e Formación Profesional (Xunta de Galicia) for the financial support. L. Cassani also thanks the financial support from Deputación Provincial de Ourense (INOU 2026). The authors gratefully acknowledge the financial support provided by the CYTED IBERO-CIRCULAR Network (323RT0142). Furthermore, appreciation is extended to the EU and FCT for their funding through programs UIDB/50006/2020; UIDP/50006/2020; LA/P/0008/2020. Fátima Barroso (2020.03107.CEECIND) and Clara Grosso (CEECIND/03436/2020) thank FCT for the FCT Investigator grant.

OP19

Antioxidant and photoprotective effects of *Rosa rugosa* pomace extracts: EPR, spectrophotometric analysis and keratinocyte–melanocyte co-culture studies

Gabriela, Kowalska [1], Krystian Mokrzyński [2], Gabriela, Rzepkowska [1], Joanna, Oracz [1]

[1]*Institute of Food Technology and Analysis Faculty of Biotechnology and Food Sciences Lodz University of Technology Poland*
[2]*Department of Biophysics Faculty of biochemistry, biophysics and biotechnology, Jagiellonian University in Cracow Poland*
gabriela.kowalska@p.lodz.pl; ORCID: 0000-0002-5476-7034

Rose pomace, a by-product of fruit processing, represents a largely underutilized biomass that poses both an environmental burden and an opportunity for sustainable valorization. The aim of this study was to characterize the chemical and biological properties of ethanolic extracts obtained from *Rosa rugosa* pomace, with particular emphasis on their phenolic composition, antioxidant activity, photoprotective potential, and suitability for eco-friendly reuse of plant-processing residues.
The content and profile of phenolic compounds were analyzed using spectrophotometric methods and UHPLC-DAD, revealing the presence of flavan-3-ols and phenolic acids, including catechins and procyanidins, known for their strong antioxidant properties. Antioxidant activity was evaluated using the DPPH radical scavenging assay, performed both by classical UV–Vis spectrophotometry and by electron paramagnetic resonance (EPR) spectroscopy. Additionally, EPR-based techniques were applied to assess the ability of the extracts to neutralize reactive oxygen species. The extracts exhibited pronounced scavenging activity against the DPPH radical, superoxide anion (via EPR spin-trapping), and singlet oxygen, confirmed by time-resolved singlet oxygen phosphorescence detection.
The biological relevance of the extracts was investigated in a keratinocyte–melanocyte co-culture model. Cell viability and metabolic activity were assessed using the MTT assay, while PI/Calcein staining and wound healing assay were used to evaluate cytotoxicity and regenerative capacity. Furthermore, the photoprotective effects of the extracts were examined after repeated exposure to solar-simulated radiation in co-cultures differing in native pigmentation levels.
The results demonstrate that *Rosa rugosa* pomace, traditionally regarded as waste, can be successfully upcycled into a source of biologically active compounds with strong antioxidant and photoprotective properties, supporting its potential application in sustainable food, cosmetic, and biomedical formulations aligned with circular economy principles.

OP20

Innovation in Phytotherapy for Cosmetics: *In Vitro* and *In Vivo* Efficacy of a Biotechnological *Perilla frutescens* Phytocomplex

Giulia, Baini[1,2], Giovanna, Rigillo[2,3], Elisabetta, Miraldi[1,2], Giovanna, Pressi[4], Marco, Biagi[2,5]

[1] *Department of Physical Sciences, Earth and Environment, University of Siena, Siena, 53100, Italy*
[2] *SIFITLab, Italian Society of Phytotherapy, Via Laterina, 8, Siena, 53100, Italy*
[3] *Department of Biomedical, Metabolic and Neural Science, University of Modena and Reggio Emilia, 41125 Modena, Italy.*
[4] *Aethera Biotech s.r.l., 36043 Camisano Vicentino, Italy*
[5] *Department of Food and Drug, University of Parma, Parma, 43124, Italy*
giulia.baini2@unisi.it; ORCID: 0009-0006-7221-3277

Current research on medicinal plants is increasingly oriented toward the integration of biotechnological innovation, advanced phytochemical characterization, and sustainable production. In this context, *in vitro* plant cell cultures represent a promising strategy for obtaining standardized and reproducible phytocomplexes, independent of the environmental variables that affect the quality of conventional botanical extracts. This presentation describes an applied research and development case study in the field of functional cosmetics, focusing on *Perilla frutescens* (L.) Britton, a medicinal plant widely used in Asia and known for its content of rosmarinic acid and other polyphenols with anti-inflammatory, antioxidant, and anti-allergic activities.

Using plant cell culture biotechnology, a standardized phytocomplex of *P. frutescens*, enriched in rosmarinic acid and total polyphenols, was produced. Its biological activity was evaluated in *in vitro* models of skin inflammation using human HaCaT keratinocytes, by analyzing markers involved in epidermal barrier maintenance, including tight junctions, filaggrin, and loricrin, as well as the release of pro-inflammatory cytokines and activation of the JNK/MAPK signaling pathway. The results showed a significant protective and anti-inflammatory activity of the phytocomplex, which was able to preserve skin barrier integrity, modulate upstream transcriptional signals, and reduce the downstream expression of inflammatory mediators. Moreover, the treatment showed positive effects on cell viability.

As a first functional application, the phytocomplex was investigated for the protection of the vaginal mucosa using a reconstructed multilayer model and a subsequent preliminary clinical observation in mature and peri-menopausal women. *In vivo* tests showed an improvement in deep hydration and elasticity after only two weeks of treatment. Overall, these findings indicate that the biotechnological phytocomplex of *P. frutescens* represents an innovative, sustainable, and promising ingredient for cosmetic, dermatological, and mucosal applications with protective and anti-inflammatory activity.

References

[1] Pressi, G. et al. *Pharmaceutics*, 2023, 15(1), 240.

OP21

Development of a liquid soap incorporating propolis from the Montesinho Natural Park

Maria F., Sousa[1,2,3], Nicolas, Justus[1,2,3], Sandra, Barbosa[1,4,5,6], Ana R., Circuncisão[6], Cristina, Almeida-Aguiar[5], Izamara, de Oliveira[8], Maria C., Ribeiro[3], Maria J., Sousa[2], Olívia, Pereira[2,7], Susana M., Cardoso[6]

[1]*Montesino – Organic Beekeeping, 5300-358, Bragança, Portugal;*
[2]*Instituto Politécnico de Bragança, 5300- 252, Bragança, Portugal;*
[3]*UTFPR, Universidade Tecnológica Federal do Paraná, 84017-220, Ponta Grossa, Brasil;*
[4]*CITAB, University of Trás-os-Montes and Alto Douro, 5000-801, Vila Real, Portugal;*
[5]*CBMA, Department of Biology, University of Minho, 4710-057, Braga, Portugal;*
[6]*LAQV-REQUIMTE, Department of Chemistry, University of Aveiro, 3810-193, Aveiro, Portugal;*
[7]*LiveWell Research Centre, Instituto Politécnico de Bragança, 5300-252, Bragança, Portugal;*
[8]*CIMO, LA SusTEC, Instituto Politécnico de Bragança,, 5300- 253, Bragança, Portugal.*
susanacardoso@ua.pt ; ORCID 0000-0002-7882-737X

Propolis is a resinous substance produced by bees, known for its antioxidant, healing, anti-inflammatory, and antimicrobial properties [1]. Owing to the high biodiversity of Montesinho Natural Park (Portugal), locally sourced propolis represents a valuable bioactive resource with largely unexplored dermo-cosmetic potential. This study aimed to valorize this propolis as a natural and antiseptic ingredient in liquid soap formulations. To achieve this, grounded propolis was extracted by maceration (30 g/100 g solvent, 5 days, room temperature) using two solvents: ethanol 70% (v/v) (ME70) and monopropylene glycol (MMPG). The raw material showed high quality, with low ash (0.8%) and wax (7.3%) contents. Spectrophotometric analysis revealed that MMPG was more efficient than ME70, yielding higher total phenolic content (57.5 vs. 49.6 mg GAE/mL), total flavonoids (23.5 vs. 18.4 mg QE/mL), and antioxidant activity (DPPH: 88.4 vs. 78.1 mg AAE/mL and ABTS: 86.1 vs. 75.4 mg AAE/mL), respectively. Antimicrobial assays revealed high inhibitory (MIC) and bactericidal (MBC) potential. ME70 was slightly stronger against Gram-positive *Staphylococcus aureus*, while MMPG stood out for its potent antifungal action and selectivity in not inhibiting the skin-protective *Staphylococcus epidermidis*. Despite these differences, the UHPLC-DAD-ESI/MS analysis showed similar chemical profiles between both solvents, composed of 44 compounds, predominantly flavonoids (chrysin, pinocembrin, galangin, pinobanksin) and phenolic acids (caffeic acid, p-coumaric acid, ferulic acid) and their derivatives. Following incorporation at 5% into a liquid soap, the extracts corroborated pH (6.0) and viscosity stability, especially at 5 ºC. Regardless of slight oxidation at 45 ºC, the final product showed promising bactericidal activity against *Escherichia coli*, *S. aureus*, and *Propionibacterium acnes*. Overall, this work demonstrates the promising potential of Montesinho propolis as a natural, functional ingredient for sustainable cosmetic innovation.

References

[1] Pant, K. et al. *Food Control*, 2024, 155, 110097.

Acknowledgments: Financial support from PRR (Recovery and Resilience Plan, Adult Impulse Program, Mountain Consortium for Knowledge) through an Innovation Scholarship awarded to M.F. Sousa and N. Justus in collaboration with Montesino; BioCosMap project (COMPETE2030 – FEDER

- 02162400), co-financed by FEDER through COMPETE2030 under the PT2030 program. PT national funds (FCT/MECI), through the projects: UID/50006/2025, DOI 10.54499/UID/50006/2025 (LAQV) and UID/6157/2023 (LiveWell). S.M. Cardoso thanks FCT/MCTES funding through the Institutional Call to Scientific Employment Stimulus.

OP22

Honokiol–Cyclodextrin Systems Processed with Supercritical CO_2: From Amorphisation to Improved Biopharmaceutical Properties

Anna Stasiłowicz-Krzemień[1], Izabela Skiera[1], Krystyna Skalicka-Woźniak[2], Filip Stojceski[3], Gabriele Maroni[3], Jihang Chen[4], Judyta Cielecka-Piontek[1]

[1] *Poznan University of Medical Sciences, Department of Pharmacognosy and Biomaterials, Rokietnicka 3, 60-806 Poznan, Poland*
[2] *Department of Natural Products Chemistry, Medical University of Lublin, ul. Chodźki 1, 20-093 Lublin, Poland*
[3] *Dalle Molle Institute for Artificial Intelligence (IDSIA-USI/SUPSI), Lugano-Viganello, Switzerland*
[4] *School of Medicine, The Chinese University of Hong Kong, Shenzhen, 2001 Longxiang Boulevard, Longgang District, Shenzhen, Guangdong 518172, P.R. China*
astasilowicz@ump.edu.pl; ORCID 0000-0001-5211-661X

Honokiol is a natural lignan derived from Magnolia species, exhibiting diverse biological activities, including antioxidant, anti-inflammatory, antimicrobial, neuroprotective, and anticancer effects. Despite its high therapeutic potential, its practical application is limited by very low aqueous solubility and poor dissolution rate. Therefore, the development of effective delivery systems is essential to improve its biopharmaceutical performance.
The aim of this study was to obtain an amorphous and stable form of honokiol through complexation with cyclodextrins and to evaluate its impact on physicochemical and biological properties. Various cyclodextrins, including α-, β-, γ-cyclodextrin, methyl-β-cyclodextrin, hydroxypropyl-α-, hydroxypropyl-β-, and hydroxypropyl-γ-cyclodextrin, were used to prepare systems at molar ratios of 2:1, 1:1, and 1:2 via the kneading method. Following selection of the most promising solubiliser, systems were further developed using supercritical CO_2 at 2000 and 6000 PSI, 50°C, and processing times of 30, 90, and 180 minutes. Molecular dynamics simulations were employed to characterize the binding interactions of honokiol–methyl-β-cyclodextrin systems. The obtained systems were characterized using Fourier-transform infrared spectroscopy and X-ray powder diffraction. Solubility, dissolution rate under simulated gastric and intestinal conditions, and permeability across biological membranes (PAMPA model) were evaluated. Additionally, biological activity was assessed, including antioxidant potential, anticholinergic activity, and inhibition of hyaluronidase, elastase, and α-glucosidase. Stability studies were also conducted under ambient conditions.
Honokiol exhibited very low solubility (0.16 µg/mL), which was markedly increased to 31.13 mg/mL upon complexation with methyl-β-cyclodextrin (1:2, kneading). Systems obtained using supercritical CO_2 exhibited extremely high solubility, precluding the achievement of supersaturation due to viscosity limitations. Enhanced dissolution rate and permeability were also observed. Improved solubility translated into increased biological activity across tested assays.
Cyclodextrin-based systems, particularly with methyl-β-cyclodextrin, effectively improve the solubility, permeability, and biological activity of honokiol. Supercritical CO_2 processing further enhances these properties, making it a green, promising approach for developing efficient honokiol delivery systems

OP23

Designing Sustainable Plant Cultivation Strategies: Biostimulation and Phytotoxicity Screening of Fucus vesiculosus Eutectic Extracts

Adriana, CS Pais[1,2], Mariana, Kergoustin[1], Samara, Rodrigues[3], Valentina, F Domingues[3], Sónia, AO Santos[1]

[1] *CICECO-Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal*
[2] *CESAM-Centre for Environmental and Marine Studies, Department of Chemistry, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal*
[3] *REQUIMTE/LAQV, Instituto Superior de Engenharia do Porto, Polytechnic Porto, Rua Dr. António Bernardino de Almeida, 431, 4200-072 Porto, Portugal*
a.c.p.s@ua.pt; ORCID: 0000-0002-0974-4853

Sustainability is increasingly pursued through the circular economy and green chemistry, aligned with the UN 2030 SDG. Because environmental pollutants from products such as personal care items, pesticides, pharmaceuticals and industrial additives are widely detected in water, soil and food, new products should be evaluated for risks to ecosystems and human health before commercialization. Green chemistry encourages safer chemical design across the full life cycle, including safer solvents and renewable feedstocks. In this context, eutectic solvents (ESs)—including DESs and NADESs—have attracted attention as greener alternatives due to their stability, biodegradability, low cost and potential natural origin. ESs are widely explored for extracting bioactive compounds, particularly from marine macroalgae, supporting blue-economy valorisation. However, “non-toxic” claims require verification, since ESs and ES-based formulations can show biological synergy and must be assessed for cytotoxicity and phytotoxicity. In this work, six ES (using one hydrogen bond donor and six hydrogen bond acceptors) were prepared to extract phlorotannins from Fucus vesiculosus. The phytotoxicity and biostimulation of these ESs and their corresponding F. vesiculosus extracts was evaluated using five species (Lepidium sativum L. (garden cress), Sinapis alba L. (white mustard), Lactuca sativa L. (lettuce), Cucumis sativus L. (cucumber), and Zea mays L. (maize or corn). The ESs showed dose-dependent responses however did not exhibit significant phytotoxicity at 50-100 mg/L, as most assays revealed no significant changes on root and stem growth or seed germination. Similarly, the ESs extracts were tested at 50-100 mg/L and in general, they did not affect plant growth. Indeed, corn exposure to choline acetate:urea extract (50 mg/L) resulted in plant stimulation, mainly in seeds germination. Overall, these results reveal that the tested eutectic formulations are compatible with plant systems at the evaluated concentrations, presenting a potential as biostimulant-like agents in cultivation.

Acknowledgments: This work was developed within the scope of the project CICECO–Aveiro Institute of Materials, UID/50011 & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), financed by national funds through the FCT/MCTES (PIDDAC). This work was also developed within the project (ALGREEN, 2022.04670.PTDC), financially supported by national funds (OE), through FCT/MCTES.

OP24

Substrate-Driven Chemical Diversity and Fungal Biotransformation in *Hericium erinaceus*

Se Hwan Ryu[1], Se Jeong Kim[1], Beom Seok Kim[1,2], Bang Yeon Hwang[1], Mi Kyeong Lee[1]

[1] *College of Pharmacy, Chungbuk National University, Cheongju 28160, Republic of Korea*
[2] *Farmther Corp., Cheongju 28535, Republic of Korea*
[3] *College of Pharmacy and Research Institute of Pharmaceutical Sciences, Gyeongsang National University, Jinju 52828, Republic of Korea*
mklee@chungbuk.ac.kr; ORCID 0000-0001-5814-2720

Mushrooms are valuable biological resources rich in essential nutrients and diverse bioactive constituents. In recent years, commercially cultivated mushrooms have attracted increasing attention, as variations in cultivation conditions can significantly influence their growth characteristics and metabolite profiles. In this study, the effect of substrate composition on metabolite profiles and biological activities was investigated. *Hericium erinaceus* (lion's mane mushroom) is a well-known medicinal species containing bioactive constituents associated with anti-diabetic, neuroprotective, and gastrointestinal activities. *H. erinaceus* was cultivated on two different substrates, sawdust and brown rice, and their chemical profiles and biological activities were comparatively evaluated. Distinct new compounds were isolated from mushrooms grown on each substrate [1]. The sawdust-cultivated fruiting bodies predominantly contained hericene A and exhibited significant anti-diabetic and neurotrophic activities. In contrast, mushrooms cultivated on brown rice were characterized by NDPIH as a major constituent and demonstrated anti-*Helicobacter pylori* activity [2]. Furthermore, supplementation of the brown rice substrate with *Angelica gigas* resulted in fungal-mediated biotransformation of *A. gigas* constituents, leading to the production of new metabolites. These findings demonstrate that substrate composition critically influences the chemical quality and functional properties of cultivated mushrooms. Strategic substrate modulation represents a promising approach to enhance bioactive compound production and generate value-added materials. Moreover, the use of edible substrates such as brown rice may contribute to the development of sustainable and functional mushroom-based resources.

References

[1] Lee, S.K. et al. *J. Ethnopharmacol*, 2020, 262, 113197.
[2] Ryu, S.H. et al., *Future Food*, 2026, 13, 100903.

Acknowledgments: This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT, 2022R1A2C1008081).

OP25

Exploring Natural UV Filters from Salt-Tolerant Plants

João Vieira[1], Fortune Siyanbola[1], Riccardo Trentin[2], Zoltán Cziáky[3], Luísa Custódio[1], Maria João Rodrigues[1]

[1] *Centro de Ciências do Mar do Algarve (CCMAR/CIMAR LA), Campus de Gambelas, Universidade do Algarve, 8005-139 Faro, Portugal*
[2] *Department of Biology, University of Padova, Via U. Bassi 58/B, 35131 Padova, Italy*
[3] *Agricultural and Molecular Research and Service Institute, University of Nyíregyháza, 4400 Nyíregyháza, Hungary*
mjrodrigues@ualg.pt

The environmental and health concerns associated with synthetic UV filters used in sunscreens have intensified the search for sustainable and safer photoprotective alternatives. Salt-tolerant coastal plants are exposed to high salinity, intense solar radiation and thermal stress, conditions that promote the accumulation of secondary metabolites with antioxidant and UV-protective functions. In this study, aqueous and ethanolic extracts from fourteen salt-tolerant plant species collected along the Algarve coast were systematically evaluated for antioxidant activity, inhibition of skin-ageing-related enzymes (tyrosinase, elastase and lipase), in vitro photoprotective properties, and phytochemical composition. Antioxidant capacity was assessed using DPPH and ABTS assays, enzyme inhibition against tyrosinase, elastase and lipase, photoprotection was evaluated by UV–Vis absorption and SPF calculation, and phenolic profiles were characterized by HPLC-ESI-MS/MS. Overall, ethanolic extracts consistently outperformed aqueous extracts across most bioassays, showing higher radical scavenging capacity, stronger enzyme inhibition and broader UV absorption. *Polygonum maritimum* emerged as the most multifunctional species, combining high total phenolic content (≈497 mg GAE/g DW), potent antioxidant activity (EC_{50} ≈ 0.1 mg/mL for DPPH and ABTS), strong inhibition of tyrosinase (IC_{50} = 0.06 mg/mL) and lipase (IC_{50} = 0.24 mg/mL), and intense UVB absorption with extension into the UVA region. *Acacia saligna* exhibited robust antioxidant and anti-tyrosinase activity associated with flavonoid- and tannin-rich profiles, while *Helichrysum italicum* subsp. *picardi* showed exceptional photoprotective performance, reaching SPF values above 20 at low concentrations (0.25–0.50 mg/mL). These results demonstrate that selected salt-tolerant plants from the Algarve coast represent promising natural sources of multifunctional photoprotective agents, supporting their potential application in the development of sustainable cosmetic formulations.

Acknowledgments: This research was supported by Biodiversa+, the European Biodiversity Partnership, through the SaltyBeats project under the 2023–2024 BiodivNBS joint call, co-funded by the European Commission (Grant Agreement No. 101052342) and by Portuguese national funds through FCT (DOI: 10.54499/BiodivNBS/0015/2023). Additional funding was provided by the Interreg Atlantic Area programme through the REVALGAE project (EAPA_0130/2024). Institutional support was further provided by Portuguese national funds from FCT – Foundation for Science and Technology through contracts UID/04326/2025 (DOI:10.54499/UID/04326/2025), UID/PRR/04326/2025 (DOI:10.54499/UID/PRR/04326/2025), and LA/P/0101/2020 (DOI:10.54499/LA/P/0101/2020) attributed to CCMAR. Individual support to M.J.R. was provided by FCT through the programme contract UIDP/04326/2020, and E.F. acknowledges FCT for the PhD fellowship UI/BD/151301/2021.

4th European Symposium on Phytochemicals in Medicine and Food

YOUNG SCIENTIST PRESENTATIONS

YSP1

Phytochemical composition (flavonoid content) and antioxidant activities of fruit juices, tea extracts and propolis: analysis of its potential use in oral health

R.S. Tajra[1], L.I.C. Lopes[2], F. Capela e Silva[3], M.C.D. Pereira[4], A.S.M. Batista[5], R. Pastorinho[6], M.R. Martins[7]

[1] *MED - Instituto Mediterrâneo para a Agricultura, Ambiente e Desenvolvimento & CHANGE - Instituto para as Alterações Globais e Sustentabilidade, Universidade de Évora, Évora, Portugal*
[2] *Departamento de Química e Bioquímica, Escola de Ciências e Tecnologia, Universidade de Évora, Évora, Portugal.*
[3] *Departamento de Ciências Médicas e da Saúde, Escola de Saúde e Desenvolvimento Humano, MED - Instituto Mediterrâneo para a Agricultura, Ambiente e Desenvolvimento & CHANGE - Instituto para as Alterações Globais e Sustentabilidade, Universidade de Évora, Évora, Portugal*
[4] *Departamento de Paisagem, Ambiente e Ordenamento, MED - Instituto Mediterrâneo para a Agricultura, Ambiente e Desenvolvimento & CHANGE - Instituto para as Alterações Globais e Sustentabilidade, Universidade de Évora, Évora, Portugal*
[5] *Departamento de Zootecnia, Universidade Estadual Vale do Acaraú, Sobral, Brasil*
[6] *Departamento de Ciências Médicas e da Saúde, Escola de Saúde e Desenvolvimento Humano, CHRC - Comprehensive Health Research Centre, Universidade de Évora, Évora, Portugal*
[7] *Departamento de Ciências Médicas e da Saúde, Escola de Saúde e Desenvolvimento Humano, Laboratório HERCULES, Universidade de Évora, Évora, Portugal*

rosana_solon@uvanet.br ; ORCID: 0000-0002-5604-5828

Phytochemicals, particularly phenolic compounds and flavonoids, are recognized for their antioxidant and anti-inflammatory properties, which may protect oral health by modulating oxidative stress associated with periodontal disease and dental caries[1]. These bioactives are intrinsically linked to fruit pigmentation: red fruits provide kaempferol and anthocyanins; purple/blue fruits are rich in anthocyanins and resveratrol; orange/yellow fruits contain quercetin; while green/white fruits contribute other phenolic classes[2]. This study quantified total phenolic and flavonoid content in commercial beverages (Portugal) and Brazilian red propolis extracts (11% and 20%), comparing fruit juices and herbal infusions against propolis as a high-density phenolic reference. Total phenolics were determined by the Folin-Ciocalteu method, and flavonoids by aluminum chloride method, both performed in duplicate with standard calibration curves. Results were expressed as mg GAE/mL (propolis) and mg GAE/100 mL (beverages). A wide variation in phenolic content was observed. Among beverages, blueberry+raspberry juice (rich in anthocyanins) showed the highest concentration—1.1× higher than grape juice (abundant in anthocyanins and resveratrol). Blueberry tea exhibited the lowest content, making blueberry+raspberry juice 8.6× more concentrated. The most striking difference emerged when comparing beverages to propolis: 100 mL of juice contained 9× the phenolic content of 1 mL of 20% propolis and 12× that of 11% propolis, highlighting propolis's extreme bioactive concentration. Red/purple fruit juices also

demonstrated high flavonoid levels when expressed as quercetin equivalents. Results demonstrated a consistent positive association between total phenolic content and antioxidant capacity across all samples, suggesting phenolic compounds as primary contributors to antioxidant activity. This systematic comparison provides a foundation for future research into their biological efficacy and potential adjuvant role in dietary approaches to oral health prevention, particularly concerning oxidative stress modulation in oral tissues.

References

[1] Oliveira Neto, et al., *Ciências e Educação*, 2024.
[2] Associação Portuguesa de Nutrição. Colher Saber. E-book n. 61. Porto; 2021.

Acknowledgments: MED - Instituto Mediterrâneo para a Agricultura, Ambiente e Desenvolvimento & CHANGE - Instituto para as Alterações Globais e Sustentabilidade, Universidade de Évora, Évora, Portugal;

YSP2

Valorization of Wine Industry By-Products: Phenolic Composition and Antioxidant Activity of Wine Pomace Polar Extracts

Mariana Kergoustin[1], Daniela P. Resende[1], Adriana C. S. Pais[1,2], Juan J. Villaverde[3], Armando J. D. Silvestre[1], Sónia A. O. Santos[1]

[1] CICECO – Aveiro Institute of Materials, Santiago University Campus, University of Aveiro, 3810-193 Aveiro, Portugal
[2] CESAM-Centre for Environmental and Marine Studies, Department of Chemistry, Santiago University Campus, University of Aveiro, 3810-193 Aveiro, Portugal
[3] Misión Biológica de Galicia (MBG-CSIC), Santiago de Compostela, España
mkergustin@ua.pt; ORCID: 0009-0005-3520-9829

The amount of waste generated by wine industry has increased significantly in recent years, highlighting the urgent need for sustainable strategies for its management and valorisation. In this context, the present study aims to characterize the phenolic fraction from wine pomace from Alentejo (Portugal), Gaillac (France) and Galicia (Spain). Ultrasound-assisted extraction (UAE) was carried out for 1h at 20°C on wine residues pre-extracted with dichloromethane to remove lipophilic components. The antioxidant activity of the extracts was assessed using the DPPH and ABTS assays, while total phenolic content (TPC) was determined using the Folin-Ciocalteu method. The chemical characterization of the extracts was conducted using ultra-high performance liquid chromatography-diode array detection coupled with tandem mass spectrometry (UHPLC-DAD-MS^n). All the pomace extracts revealed the presence of phenolic compounds belonging to different subclasses, including flavan-3-ols (catechin and epicatechin) and flavanols (quercetin and quercetin glycosides). Additionally, phenolic acids, anthocyanins (malvidin derivatives) and stilbenoids were also found in the pomace extracts from Alentejo (Portugal) (Figure 1) and Gaillac (France). These findings highlight the potential of wine pomace as a valuable source of bioactive compounds, supporting its sustainable valorization.

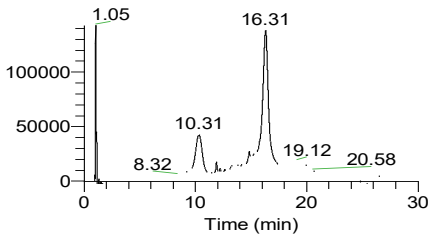

Figure 1: UHPLC chromatogram of the wine pomace extract from Portugal recorded at 520nm

Acknowledgments: This work was developed within the scope of the project CICECO–Aveiro Institute of Materials, UID/50011 & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), financed by national funds through the FCT/MCTES (PIDDAC). This work is supported by the European Union through Interreg Sudoe Program (Project Soil&WineResidues S2/1.1/E0258)

YSP3

Preconception Dietary EGCG Prevents Bubble Tea-Induced Intergenerational Obesity and Oxidative Stress via Vitellogenin-Mediated Nutrient Transport in *Caenorhabditis elegans*

Xincheng Wu[1,2], Shiye Lin[1,2], Wenqi Huang[1,2], Mohamed A. Farag[3], Shaoyun Wang[4], Thomas Efferth[5], Haoming Wu[1,2], Jesus Simal-Gandara[1,2], Hui Cao[1,2], Jianbo Xiao[1,2,6]

[1] *Universidade de Vigo, Nutrition and Bromatology Group, Department of Analytical Chemistry and Food Science, Faculty of Science, 32004 Ourense, Spain*
[2] *Instituto de Agroecoloxía e Alimentación (IAA), Universidade de Vigo, Campus Auga, 32004 Ourense, Spain*
[3] *Pharmacognosy Department, Faculty of Pharmacy, Cairo University, Cairo 11562, Egypt*
[4] *College of Chemical Engineering, College of Biological Science and Engineering, Fuzhou University, Fuzhou 350108, China*
[5] *Department of Pharmaceutical Biology, Institute of Pharmaceutical and Biomedical Sciences, Johannes Gutenberg University Mainz, 55128 Mainz, Germany*
[6] *Research Group on Food, Nutritional Biochemistry and Health, Universidad Europea del Atlántico, Isabel Torres 21, 39011 Santander, Spain*
xincheng.wu@uvigo.gal; jianboxiao@yahoo.com

Maternal nutrition is increasingly recognized as a determinant of offspring metabolic health, yet whether bubble tea (BT), a sugar- and saturated fat-rich dietary matrix, induces intergenerational obesity together with oxidative stress and whether such effects can be prevented remain unclear. Using *Caenorhabditis elegans*, we investigated maternal BT exposure and the preventive role of preconception epigallocatechin gallate (EGCG). Chemical characterization showed that BT was enriched in sucrose and saturated fatty acids, mainly C12:0 and C18:0. Maternal BT exposure increased lipid accumulation, glucose and triglyceride levels, impaired physiological performance, reduced oxidative stress resistance, decreased SOD and CAT activities, and disrupted central carbon metabolism, with these phenotypes persisting into the F1 generation. Preconception EGCG significantly attenuated these changes and also protected against lipid accumulation induced by representative single sugar (glucose, fructose) and fatty acid (lauric acid) components. Mechanistically, the intergenerational lipid-lowering and antioxidative effects of EGCG depended on DAF-16/FOXO signalling and were associated with the histone marks H3K4me3 and H3K9me2 [1]. Notably, EGCG reduced vitellogenin synthesis and yolk protein abundance (YP170, YP115), and its protective effect was abolished in *vit-2* and *vit-5* mutants, indicating a central role for vitellogenin-mediated maternal nutrient transport [2]. These findings identify a vitellogenin-centred nutrient axis as a key mechanism by which preconception EGCG prevents maternal BT-induced intergenerational obesity and oxidative stress, providing a mechanistic basis for dietary polyphenol intervention before conception.

References

[1] Wan, Q. L. et al. *Nature Communications*, 2022, 13(1), 768.

[2] Dowen, R. H. & Ahmed, S. *Current Biology*, 2019, 29(15), R748-R751.

Acknowledgments: This study was supported by Xunta de Galicia (Excelencia-ED431F2022/01), the Ramón y Cajal grant (RYC2020-030365-I to Jianbo Xiao), the Juan de la Cierva Incorporación grant (IJC2020-046055-I to Hui Cao), and the China Scholarship Council (Grant No. 202306820008).

YSP4

Deep insight into lipophilic fraction characterization of winery by-products from three different origins

Daniela P. Resende[1], Mariana Kergoustin[1], Adriana C. S. Pais[1,2], Juan J. Villaverde[3] Armando J. D. Silvestre[1], Sónia A. O. Santos[1]

[1] *CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, 3810-193 Aveiro, Portugal*
[2] *CESAM – Centre for Environmental and Marine Studies, Department of Chemistry, University of Aveiro, 3810-193 Aveiro, Portugal*
[3]*Misión Biológica de Galicia (MBG-CSIC), Santiago de Compostela, España*
danielapresende@ua.pt; ORCID: 0009-0006-4929-286X

Globally, the wine industry generates large amounts of by-products every year, driving increasing interest in their valorisation for the development of high added-value products. This study focuses on the characterization of the lipophilic fraction of wine residues, namely pomace and stems, from three different regions: Alentejo (Portugal), Galicia (Spain) and Gaillac (France).
The lipophilic composition of dichloromethane Soxhlet extracts was analysed by gas chromatography-mass spectrometry (GC-MS) both before and after alkaline hydrolysis. Qualitative and quantitative analysis revealed that pomace extracts are particularly rich in triterpenic compounds, especially oleanolic acid with 49.37±6.50, 47.49±3.52 and 64.11±9.54 mg of compound/g of extract in the extracts from Galicia, Alentejo and Gaillac, respectively. Conversely, stem extracts were found to be richer not only in triterpenic compounds, but also in phytosterols namely sitosterol with 42.87±5.73 and 24.78±0.67 mg of compound/g of extract in the extracts from Galicia and Alentejo, respectively and unsaturated fatty acids, including 9,12-octadecadienoic acid (7.20±0.90, 26.41±1.10 mg of compound/g of extract from Galicia and Alentejo, respectively) and 9-octadecenoic acid (2.57±0.18, 16.10±0.62 mg of compound/g of extract from Galicia and Alentejo, respectively).
After alkaline hydrolysis, a significant increase, up to fivefold, in the total identified compounds was observed in pomace extracts, whereas stem extracts showed a less pronounced increase. In both matrices, a notable rise in the content of fatty acids, particularly the unsaturated fatty acids was observed. These results represent a significant contribution to the valorisation of these winery by-products as promising sources of valuable phytochemicals.

Acknowledgments: This work was developed within the scope of the project CICECO–Aveiro Institute of Materials, UID/50011 & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), financed by national funds through the FCT/MCTES (PIDDAC). This work is supported by the European Union through Interreg Sudoe Program (Project Soil&WineResidues S2/1.1/E0258)

YSP5

Mechanistic Study of Dietary Polyphenol 1,2,3,4,6-Pentagalloyl Glucose (PGG) in Alleviating Depression-Like Behaviors Through Regulation of Neuronal Pyroptosis via the lncRNA DANCR/DDX3X–NLRP3 Axis

Lu, Wang[2], Junqing, Huang[4], Jianbo Xiao[1,2,3]

[1] *State Key Laboratory for Development and Utilization of Forest Food Resources, Zhejiang A&F University, Hangzhou 311300, China*
[2] *Universidade de Vigo, Nutrition and Bromatology Group, Department of Analytical Chemistry and Food Science, Instituto de Agroecoloxía eAlimentación (IAA)-CITEXVI, 36310 Vigo, Spain*
[3] *Research Group on Food, Nutritional Biochemistry and Health, Universidad Europea del Atlántico, Isabel Torres 21, 39011 Santander, Spain*
[4] *Guangzhou Key Laboratory of Formula-Pattern of Traditional Chinese Medicine, Jinan University, Guangzhou, China*

jianboxiao@uvigo.es; ORCID 0009-0003-8823-9066; jqhuang@jnu.edu.cn; ORCID 0000-0002-7924-9356

1,2,3,4,6-Pentagalloyl glucose (PGG), an active component derived from medicinal and edible plants such as Galla Chinensis and Paeonia lactiflora, has shown potential in depression intervention, although its molecular mechanism remains unclear. In this study, analysis of peripheral blood samples from 25 clinical participants revealed that the long non-coding RNA DANCR was significantly elevated in the serum of patients with depression. Using a chronic restraint stress (CRS) mouse model, we demonstrated for the first time that PGG exerts neuroprotective effects against depression-like behaviors by targeting the lncRNA DANCR-mediated DDX3X–NLRP3 signaling axis.
Our results showed that DANCR expression was significantly upregulated in the prefrontal cortex (PFC) of CRS mice. Overexpression of DANCR in the PFC aggravated neuronal pyroptosis and enhanced stress susceptibility. Dietary supplementation with PGG for 21 days significantly alleviated depression-like behaviors and reduced DANCR expression levels. This study identifies a novel antidepressant target of PGG from the perspective of the “non-coding RNA–inflammatory microenvironment” axis, providing a theoretical basis for the neuroprotective effects of bioactive compounds from medicinal and edible plants.

Acknowledgments: This work was supported by National Natural Science Foundation of China (No. 82474366).

YSP6

Early-life redox perturbation programs intergenerational redox vulnerability through DAF-16/FOXO and SKN-1/Nrf2 signaling in *Caenorhabditis elegans*

Jingyimei Liang[1,2], Tianli yue[1,], Jianbo Xiao[2]

[1] *College of Food Science and Technology, Northwest University, Xi'an, 710069, China*
[2] *Universidade de Vigo, Nutrition and Bromatology Group, Department of Analytical Chemistry and Food Science, Faculty of Science, Ourense, 32004, Spain*
jianboxiao@yahoo.com; ORCID: 0000-0003-3311-770; yuetl@nwu.edu.cn; ORCID: 0009-0003-9426-4284

Early metabolic stress is a key factor influencing long term intergenerational adaptation in organisms. While excessive dietary methionine is known to disrupt one-carbon metabolism, it remains unclear whether early gestational methionine excess induces sustained epigenetic remodeling, thereby affecting redox stability in offspring. Using C. elegans as a model, we demonstrate that early gestational methionine excess in parental induces sustained metabolic stress in offspring, impairing their functional stability. This manifests as impaired motility, shortened lifespan, and elevated oxidative stress levels. Mechanistically, this intergenerational vulnerability is associated with metabolic reprogramming towards a serine-glycine-one-carbon axis. This leads to methyl donor imbalance and chromatin remodeling, characterized by SET-2/WDR-5.1 dependent H3K4 hypermethylation. Meanwhile, the stress response programs of DAF-16/FOXO and SKN-1/Nrf2 are restricted, thus affecting the redox adaptability of the offspring. Importantly, intervention with the dietary polyphenol epigallocatechin gallate (EGCG) can restore metabolic homeostasis and alleviate these chromatin and transcriptional restrictions. In summary, our findings reveal a metabolic and epigenetic framework by which early-life nutritional imbalances influence intergenerational redox resilience. We also emphasize that EGCG represents a potential nutritional strategy to alleviate metabolic stress caused by methionine excess.

Acknowledgments: This study was support by the National Natural Science Foundation of China (No.32372348), the Key Research and Development Program of Shaanxi Provinceand of China (2024NC-ZDCYL-04-06). And This study was also supported by Ramón y Cajal grant (RYC2020-030365-I), Xunta de Galicia for supporting the program (Excelencia-ED431F2022/01), and Juan de la Cierva Incorporación for Hui Cao (IJC2020-046055-I). Meanwhile, this work was supported by the China Scholarship Council (Grant No. 202206300009). Funding for open access charge was provided by the University of Vigo or University of Vigo/CISUG. This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CNCS/CCCDI - UEFISCDI, through the project Center of Excellence in water management, materials, by-products and waste valorisation for circular bioeconomy implementation, proposal number PN-IV-P6-6.1-CoEx-2024-0056, contract 6 CoEx/08.01.2026.

YSP7

Dietary EGCG promotes transgenerational host defense through a lactate-H3K27ac axis

Wenqi Huang[1], Jianbo Xiao[1], Hui Cao[1]

[1]*Universidade de Vigo, Nutrition and Bromatology Group, Department of Analytical and Food Chemistry, Faculty of Sciences, 32004 Ourense, Spain*

huangwenqi1997@outlook.com

Parental diet is a key determinant of offspring health and immune function, in part through epigenetic regulation. However, the mechanism by which specific dietary bioactive compounds reshape metabolic-epigenetic networks to drive transgenerational adaptive responses remains poorly understood. Here, we investigate whether and how epigallocatechin-3-gallate (EGCG), a well-characterized dietary bioactive compound, modulates heritable host defense through metabolic-epigenetic crosstalk. In mice, EGCG administration led to a decrease in *Escherichia coli* burden across multiple tissues in paternal and male offspring in a sex-specific manner, accompanied by metabolic and pro-inflammatory factor changes. In Drosophila melanogaster, early-life EGCG exposure increased survival upon *Pseudomonas aeruginosa* or *Staphylococcus aureus* infection and persisted for two subsequent generations. Mechanistically, EGCG reduced intestinal amino acids, thereby moderately inducing activation of activating transcription factor 4 (ATF4), which in turn enhanced maternal glycolysis and immune adaptation. Tyrosine supplementation abolished the enhanced host defense and metabolic changes. Furthermore, ATF4-induced activation of glycolysis promoted ovarian lactate production, serving as a substrate for increased global H3K27 acetylation in the offspring. Together, these findings suggest that dietary bioactive compounds modulate metabolic and gene regulatory processes, with functional evidence supporting a role for amino acid metabolism and lactate in linking metabolic remodeling to enhanced resistance to infection in the offspring. This work provides mechanistic insight into how diet can shape heritable immune function through metabolic-epigenetic interplay.

Acknowledgments: This work was supported by National Natural Science Foundation of China (32472327), the Ramón y Cajal grant (RYC2020-030365-I to Jianbo Xiao), the Xunta de Galicia "Excelencia" program (ED431F2022/01 to Jianbo Xiao) and the Juan de la Cierva Incorporación grant (IJC2020-046055-I to Hui Cao).

YSP8

Quercetin alleviates MSG-induced oxidative toxicity and functional decline in *Caenorhabditis elegans*

Boya Ouyang[1], Quanyong Wu[1], Jingyimei Liang[1], Hui Cao[1], Jesus Simal-Gandara[1], Jianbo Xiao[1, 2]

[1] *Universidade de Vigo, Nutrition and Bromatology Group, Department of Analytical Chemistry and Food Science, Instituto de Agroecoloxía e Alimentación (IAA) - CITEXVI, 36310 Vigo, Spain*
[2] *Research Group on Food, Nutritional Biochemistry and Health, Universidad Europea del Atlántico, Isabel Torres 21, 39011 Santander, Spain*

Monosodium glutamate (MSG) is a widely used food additive [1]. However, the long-term consequences of developmental exposure to MSG on aging-associated physiological homeostasis remain poorly understood. This study investigated whether developmental MSG exposure induces persistent oxidative toxicity and lifespan deterioration in *Caenorhabditis elegans* and evaluated the protective effects of quercetin (Que).
Synchronized worms were exposed to MSG during development (L1–L4) and subsequently treated with Que during early adulthood. Lifespan, locomotor activity, reproductive performance, stress resistance, oxidative stress biomarkers, targeted metabolomics, transcriptomics, and pathway-associated functional analyses were assessed. Developmental MSG exposure significantly shortened lifespan, impaired locomotor function, and altered reproductive patterns without affecting body length. These phenotypic changes were accompanied by increased reactive oxygen species accumulation, reduced antioxidant defenses, and decreased resistance to heat and oxidative stress. Targeted metabolomic analysis revealed reductions in multiple amino acids and tricarboxylic acid cycle intermediates, suggesting disruption of metabolic homeostasis and energy metabolism. Transcriptomic profiling further indicated disturbances in glutathione metabolism, xenobiotic detoxification, and stress-response networks. Functional analyses using a *gst-4p*::GFP reporter strain suggested suppression of *gst-4*-associated detoxification responses following MSG exposure, whereas Que partially restored detoxification capacity. Furthermore, the lifespan-protective effect of Que was markedly attenuated in *daf-16(mu86)* mutants, supporting the involvement of DAF-16-dependent stress resilience.
Collectively, these findings suggest that Que partially mitigates developmental MSG-induced oxidative stress and functional decline through modulation of metabolic and stress-response pathways.

References

[1] Zanfirescu, A. et al. Compr. Rev. Food Sci. Food Saf., 2019, 18, 1111-1134.

Acknowledgments: This work was supported by the National Natural Science Foundation of China (32472327), the Ramón y Cajal grant (RYC2020-030365-I), the Xunta de Galicia "Excelencia" program (ED431F2022/01), the Juan de la Cierva Incorporación grant (IJC2020-046055-I), and the CoEx project (6 CoEx/08.02.2026).

YSP9

Tea Polyphenols Enhance Embryonic Development and Mitigate DMSO-Induced Toxicity in *Drosophila*

Quanyong Wu[1], Caohuizi Xiao[2], Boya Ouyang[1], Jesus Simal-Gandara[1, 3], Yaping Qi[4], Zi Chen[5]

[1]*Universidade de Vigo, Nutrition and Bromatology Group, Department of Analytical and Food Chemistry, Faculty of Science, 32004 Ourense, Spain*
[2]*O Castro British International School, 36419 San Pedro De Cela (Mos) Pontevedra, Spain*
[3]*Galicia Sur Health Research Institute, Vigo, Spain.*
[4]*Advanced Institute for Materials Research (WPI-AIMR), Tohoku University, Sendai 980-8577, Japan*
[5]*Division of Thoracic Surgery, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, USA*

jsimal@uvigo.gal, ORCID: 0000-0001-9215-9737; qi.yaping.a2@tohoku.ac.jp, ORCID: 0000-0002-0367-3695; zchen33@bwh.harvard.edu, ORCID: 0000-0001-5927-0249

Tea polyphenols (TPs), potent antioxidants found in tea, offer cellular protection and health benefits [1]. Dimethyl sulfoxide (DMSO), a widely used organic solvent in medicine, remains controversial due to its potential embryonic toxicity [2]. This study explored the effects of TPs from oolong and black tea, DMSO exposure, and their combined treatment on embryonic development using a fruit fly model. TPs from oolong tea (rich in catechin and EGCG) and black tea (mainly catechin) promoted embryonic development, enhanced larval vitality, and improved oxidative stress resistance in adults. Catechin intervention mirrored the effects of TPs from oolong and black tea, while the effect of EGCG was sex-dependent. DMSO showed dose-dependent toxicity, with 1% concentrations disrupting organ development and preventing emergence. Notably, EGCG and oolong tea TPs supported normal organ formation. Furthermore, catechin and tea TPs alleviated 0.5% DMSO-induced damage, boosting larval vitality, adult locomotion, and body weight in males, while reducing oxidative stress.

References

[1] Ohishi, T. et al.. *Molecules*, 2021, 26(2), 453.
[2] Gook, D. A. et al. *Journal of assisted reproduction and genetics*, 2016, 33, 1247-1252.

Acknowledgments: Y.P.Q. acknowledges support from Tohoku University TUMUG Startup Research FUND, FY2023 AIMR Fusion Research Fund, AIMR Overseas Dispatch Program for Young Researchers FY2023, and FY2024 AIMR Fusion Research Fund. The publications will carry a text of thanks of the type Funding for open access charge: University of Vigo or University of Vigo/CISUG second corresponds

YSP10

Pathogen Assessment, Morphological and Chemical Properties of Three Common Bean (*Phaseolus vulgaris* L.) Varieties

Helena Todorović[1,2], Svetlana Roljević Nikolić[1], Đorđe Vojnović[3], Aleksandar Kostić[2], Isidora Knežević[1], Jelena Popović-Đorđević[2]

[1] *Tamiš Research and Development Institute, Novoseljanski put 33, Pančevo, Serbia*
[2] *University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11080 Belgrade, Serbia*
[3] *University of Novi Sad, Faculty of Agriculture, Dositej Obradović Square 8, 21000 Novi Sad, Serbia*

todorovic@institut-tamis.rs; ORCID: 0009-0006-8353-1828

Common bean (*Phaseolus vulgaris* L.) is a nutritionally valuable legume rich in proteins and bioactive compounds, and represents an important component of healthy and sustainable human diets [1]. However, the use of infected seed remains a major constraint, as seed-borne phytopathogenic fungi can reduce germination, impair plant growth and yield, and reduce nutritional quality or lead to the production of mycotoxins, making the beans unsuitable for human consumption [2].

The aim of this study was to investigate the morphological traits, general phytochemical profile, antioxidant activity, and the presence of phytopathogenic fungi on the seeds of different common bean varieties: white (W), red-mottled (RM), and golden-yellow (GY), cultivated in 2025 in the experimental field near Pančevo, Serbia.

Significant differences ($p<0.05$) were observed among the studied varieties for most morphological traits. Variety RM showed the highest values for pod length (9.35 cm), pod weight (2.03 g), number of seeds per pod (3.77), seed weight per pod (2.03 g), and 100-seed weight (35.86 g). Using standard phytopathological isolation methods, three isolates from GY seeds were morphologically characterized as *Fusarium oxysporum*, whereas no phytopathogenic fungi were detected in the other varieties. Furthermore, variety RM differed significantly from varieties GY and W, exhibiting the highest values for total phenolic content (1.21 mg GAE/g FW), total flavonoid content (0.76 mg QE/g FW), DPPH· radical scavenging activity (4.36 mg TE/g FW), $ABTS^{\cdot+}$ (17.20 mg TE/g FW), and CUPRAC (5.25 mg AAE/g FW). All varieties differed significantly in total carotenoid content, with GY showing the highest value (22.04 µg/g FW). It is expected due to the golden-yellow seed color of GY.

The obtained results indicate that local common bean varieties represent valuable sources of bioactive compounds, with significant variability among them. Cultivar RM showed the most favorable functional properties, suggesting its potential for functional food development. The presence of *F. oxysporum* in variety GY indicates the need for further investigation of its impact on seed quality and bioactive compound content.

References

[1] Minuye, M., and Bajo, W. *Cogent Food & Agriculture*, 2021, 7(1), 1914376.
[2] Waller J.M. et al., *CAB International*, 2001.

Acknowledgments: This research was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Grant numbers: 451-03-33/2026-03/200054, 451-03-34/2026-03/200116, 451-03-34/2026-03/200117, and 451-03-4551/2024-04/17)

YSP11

Characterization of Hydroxy Alpha Sanshool In North American Zanthoxylum Trees Via Ultrasound Assisted Extraction and UHPLC-MS/MS Analysis With Standard

Sims K., Lawson[1,2], Eric P., Burkhart[2], Joshua D., Lambert[3,4]

[1]*USDA NIFA Agriculture and Food Research Initiative- Predoctoral Fellow*
[2]*Department of Ecosystem Science and Management*
[3]*Food Science Department*
[4]*Center for Plant and Mushroom Foods for Health. College of Agricultural Sciences. Pennsylvania State University, University Park, PA 16802.*
Kirk@psu.edu; ORCID: 0000-0002-4100-576X

There is a thriving international market for the spice and traditional herbal medicine "Sichuan (or Szechuan) Peppers", which is what the pericarps of the fruits of Asian *Zanthoxylum* species, (Rutaceae) "prickly-ash" trees are called. They are widely available in local and online retail markets, worldwide. The most notable attribute of these *Zanthoxylum* fruits is their pungency, which presents multiple organoleptic properties such as anesthetic and paresthetic sensations. These sensations are caused by molecules known as sanshools. Sanshools belong to a class of molecules known as fatty acid amides (alkamides). Sanshools are some of the most interesting molecules found in the *Zanthoxylum* genus, from a drug discovery and development perspective because they cross the blood brain barrier and have multiple potential areas of neural protective activity. Sanshool compounds are structurally similar to anandamide, the endogenous neurotransmitter associated with cannabinoid receptors, thus giving the sanshools vast potential as target compounds for psychopharmaceutical drugs. The cannabinoid receptors can also play a role in blood pressure and diabetes regulation, outside of the brain. The fact that these compounds also block pain at nerve endings makes them candidates for non-opioid pain relief. Their potassium ion-channel activity also makes them potential drug targets for novel cardiovascular drugs, among other areas of natural product research and development.
To date, no studies analyzing/characterizing the sanshool content of North American *Zanthoxylum* species can be found in scientific literature. Our study used the commercial standard for hydroxy alpha sanshool and UHPLC-MS/MS analysis to putatively characterize this compound in two North American *Zanthoxylum* trees (*Z. clava-herculis* L. and *Z. coriaceum* A. Rich.) and in which plant tissues they were most abundant.

Acknowledgments: We would like to acknowledge the Huck Metabolomics Core Research Center at Penn State University for their work with the analytical instruments (UHPLC); the Kellogg Lab at Penn State University for their assistance with ultrasound assisted extraction of plant material; the Garden Club of America – Anne S. Chatham Fellowship in Medicinal Botany, and the Penn State - Competitive Graduate Research Grant, for their funding of this research.

YSP12

Glucose-mediated thermal transformation of EGCG under weakly alkaline low-moisture conditions

Wanning Ma[1], Jingyimei Liang[1,2], Yuxuan Zhao[1], Rui Lu[1], Hui Cao[1,*], Jianbo Xiao[1,*]

[1] *Universidade de Vigo, Nutrition and Bromatology Group, Department of Analytical Chemistry and Food Science, Instituto de Agroecoloxía e Alimentación (IAA) – CITEXVI, 36310 Vigo, Spain*

[2] *College of Food Science and Technology, Northwest University, Xi'an, 710069, China*

jianboxiao@yahoo.com ; ORCID 0000-0003-3311-770

Epigallocatechin gallate (EGCG) is highly reactive during thermal processing, and previous studies have reported the formation of EGCG–glucose adducts in roasted tea powder models [1]. However, the thermal degradation behavior of EGCG and its reaction pattern with glucose under weakly alkaline, low-moisture, high-temperature processing conditions remain insufficiently understood. In this study, a weakly alkaline low-moisture-like roasting model was established to investigate the transformation of EGCG at 100, 120, 150, and 180 °C in the absence or presence of glucose. In the absence of glucose, EGCG mainly underwent epimerization to gallocatechin gallate, oxidative dimerization, and subsequent cleavage into phenolic acids and trihydroxybenzene-type degradation products. In contrast, glucose redirected EGCG transformation toward the formation of temperature-dependent glucose-derived adducts. These adducts appeared at 100 °C after prolonged heating, accumulated markedly at 120 °C, reached the highest structural diversity at 150 °C, and declined at 180 °C, suggesting their further degradation or polymerization at excessive temperature. Control experiments excluded the presence of methylglyoxal-trapping products among the main detected adducts. These findings demonstrate that glucose reshapes EGCG thermal transformation from a degradation-dominated pathway toward an adduct-forming network under weakly alkaline low-moisture heating conditions, with potential implications for browning, flavor formation, and reactive carbonyl modulation in thermally processed tea-polyphenol-containing foods.

References

[1] J. Agric. Food Chem. 2021, 69, 38, 11417-11426

YSP13

Comparative analysis of nutritional quality and volatile compounds in hawthorn from different geographical origins and varieties

Fei, Liu[1], Kemin Mao[2], Chentaoyu, Shang[2], Yuqing Miao[2], Jianbo Xiao[1*], Yaxin Sang[2*]

[1] *Nutrition and Bromatology Group, Department of Analytical and Food Chemistry, Faculty of Sciences, University of Vigo, 32004 Ourense, Spain*
[2] *College of Food Science and Technology, Hebei Agricultural University, Baoding, PR China*
jianboxiao@yahoo.com, yxsang1418@163.com

Hawthorn, as a traditional medicine-food homologous resource, has attracted much attention due to its rich nutritional and health values. However, existing research mostly focuses on the extraction of monomeric active components and functional evaluation, lacking a systematic analysis of comprehensive quality differences among different geographical origins and cultivars. This study selected 19 representative hawthorn cultivars from 5 producing regions in China, compared the differences in their physicochemical properties, functional components, and in vitro activities, and conducted a comprehensive evaluation combined with multivariate statistical analysis. Results revealed significant differences in phenotypic and textural traits influenced by origin and cultivar, exhibiting distinct regional differentiation and cross-regional stability in specific cultivars. Regarding flavour profiles, citric and malic acids were the dominant organic acids. Fructose and glucose constituted the primary soluble sugars, whereas sucrose accumulation showed pronounced polarisation among varieties. Furthermore, the TOPSIS model effectively differentiated the comprehensive performance of in vitro activities and key functional components—specifically total polyphenols, total flavonoids, total proanthocyanidins, and vitamin C among cultivars. HPLC showed that various cultivars had significant differences in the contents of chlorogenic acid, hyperoside, vitexin and rutin, with samples from the Hebei region exhibiting overall superiority. Mineral profiling identified K, Ca, Mg, and P as core mineral elements, whose contents varied significantly depending on origin and cultivar. Specific cultivars from Hebei and Liaoning demonstrated targeted enrichment capabilities for K, Na, Fe, and Mn. Heavy metals (Cr, As, Pb, Cd) were detected at negligible levels, ensuring optimal consumption safety. Correlation analysis indicated that large-fruited hawthorns possessed an advantage in nutrient accumulation. Crucially, polyphenols were identified as the primary material basis governing antioxidant capacity and α-glucosidase inhibitory activity. Conclusively, this study provides a robust theoretical basis and data support for germplasm evaluation, superior cultivar screening, and the targeted development of high-value products.

Acknowledgments: This study was financially supported by the National Natural Science Foundation of China (Grant Number 32272274), the National Key Research and Development Program of China (2022YFD1600400).

YSP14

Rosin coatings for paper-based active food packaging

Inês S.L. Farias[1], N. Seixas[1], C. Vilela[1], S.A.O. Santos[1], C.S.R. Freire[1], A.J.D. Silvestre[1]

[1] *CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, Aveiro, Portugal*

ines.farias@ua.pt; ORCID: 0009-0002-5196-4902

The environmental impact of fossil-based plastics has intensified the search for sustainable and bio-based alternatives notably in the food packaging sector. While cellulose-based materials like paper have notorious advantages in terms of mechanical performance and biodegradability, their high hydrophilicity and air permeability limit their widespread application in food packaging. [1] Thus, the development of paper-based effective solutions to overcome these limitations and eventually bring new functional properties is crucial.

The present study reports the development of paper-based materials with improved barrier and antioxidant properties by application of novel bio-based functional coatings, composed of rosin or derivatives (glycerine and pentaerythritol esters), combined with ethyl cellulose (EC), along with sesamol. The coatings were applied by dip-coating and the obtained coated papers characterized in terms of.....envisioning their use as active packaging materials. [2]

The coated materials demonstrate a significant improvement in hydrophobicity, reaching water contact angles exceeding 120º. The synergy between rosin or rosin esters and EC led to a 99% reduction in air permeability and a 65% decrease in water vapor transmission rate (WVTR). Addition incorporation of sesamol into the coating formulations provided an antioxidant activity assessed by DPPH assay of over 93%. Food packaging practical validation using *Rocha* pears showed that these coatings effectively minimized weight loss and browning index over 7 days, outperforming uncoated paper and matching the performance of commercial PVC films. These findings suggest that rosin-based coated papers represent a high-performance, biodegradable, and sustainable alternative for active food packaging applications. [2]

References

[1] S. Basak. et al., *Prog. Org. Coatings*, 2024, **186**, 107938.

[2] Farias, et al. Rosin-based coating systems for cellulose-based active food packaging, 2026. Submitted.

Acknowledgments: This work was developed within the scope of the project CICECO – Aveiro Institute of Materials, UID/50011/2025 & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), financed by national funds through the FCT/MCTES (PIDDAC). The RN21 Integrated Project - Innovation in the Natural Resin Sector for the Reinforcement of the National Bioeconomy, is co-financed by the Environmental Fund through Component 12 - Promotion of Sustainable Bioeconomy (Investment TC-C12-i01 - Sustainable Bioeconomy No. 02 / C12-i01 / 202), European funds allocated to Portugal by the Recovery and Resilience Plan (PRR), under the European Union's (EU) Recovery and Resilience Mechanism (MRR), framed within the Next Generation EU, for the period from 2021 to 2026.

YSP15

Monosodium glutamate disrupts methionine metabolism to induce transgenerational infection susceptibility in C. elegans

Shiye Lin[1], Hui Cao[1], Jianbo Xiao[1]

[1]*Universidade de Vigo, Nutrition and Bromatology Group, Department of Analytical and Food Chemistry, Faculty of Sciences, 32004 Ourense, Spain*

Linshiye33@163.com

Monosodium glutamate (MSG) is a widely used food additive, and its potential health effects under excessive or chronic dietary exposure remain controversial. Here, using Caenorhabditis elegans as a model, we show that parental MSG exposure reduces host resistance to Pseudomonas aeruginosa PA14 infection and impairs learning behavior, with these effects persisting for two subsequent generations. Mechanistically, MSG perturbs one-carbon metabolism, reducing glucose-derived methionine and thereby suppressing S-adenosylmethionine (SAM) generation. This leads to reduced tri-methylation at the 4th lysine residue of the histone H3 protein (H3K4me3) levels and transcriptional downregulation of foxo/daf-16 in both parents and offspring. Dietary supplementation with SAM or tetrahydrofolate mixed with methionine improves immunity in F1 offspring. Furthermore, metabolic changes in MSG-exposed Escherichia coli suggest that microbial metabolism may contribute to transgenerational phenotype. Together, these results reveal a potential pathway by which parental dietary MSG intake can shape offspring health status by influencing microbial and host metabolism and epigenetic programming, highlighting evidence for how the potential long-term risks of food additives can negatively impact on transgenerational health.

Acknowledgments: This work was supported by the Ramón y Cajal grant (RYC2020-030365-I).

YSP16

Characterisation of lipophilic extracts from *Arthrospira Platensis* and their potential effect on cholesterol bioaccessibility

Mafalda S. F. C. O. Santiago, Adriana C. S. Pais[1,2], Helena Laronha[3], Filipe M. Coreta-Gomes[3,4], Sónia A. O. Santos[1]

[1] *CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, 3810-193 Aveiro, Portugal*
[2] *CESAM – Center of Environmental and Marine Studies, Department of chemistry; University of Aveiro, 3810-193 Aveiro, Portugal*
[3] *LAQV-REQUIMTE, Chemistry Department, University of Aveiro, 3810-193, Aveiro, Portugal*
[4] *Coimbra Chemistry Center - Institute of Molecular Sciences (CQC-IMS), Department of Chemistry, University of Coimbra, 3004-535 Coimbra, Portugal.*
mafalda.santiago@ua.pt

Spirulina (*Arthrospira platensis*) is a cyanobacterium widely recognised as a valuable source of bioactive compounds with potential health-promoting properties [1]. Among these compounds, lipophilic constituents such as fatty acids, terpenes, and sterols have attracted considerable attention due to their reported beneficial effects on lipid metabolism and cardiovascular health [2]. A primary mechanism underlying these effects involves the modulation of cholesterol bioaccessibility within the intestinal lumen, a crucial factor in managing circulating cholesterol levels and reducing cardiovascular disease risk [3,4]. Therefore, this study aimed to characterise the lipophilic extract of *A. platensis* and evaluate its potential impact on cholesterol bioaccessibility using an *in vitro* system that mimics the intestinal lumen.

Lipophilic compounds were extracted from *A. platensis* biomass by ultrasound-assisted extraction using ethyl acetate. The chemical profile of the resulting extract was characterised by gas chromatography–mass spectrometry (GC–MS). To assess the potential hypocholesterolemic effect of the extract, cholesterol bioaccessibility assays were performed in a simulated intestinal fluid containing cholesterol and glycodeoxycholic acid (GDCA). Two distinct approaches were evaluated: (i) the micellar solubilization of the lipophilic extract and cholesterol by bile salts, and (ii) the enzymatic hydrolysis of the extract with pancreatin prior to micellar solubilization. Following incubation, the aqueous micellar and insoluble phases were separated by filtration and analysed by GC–MS.

According to GC-MS characterisation, fatty acids were the predominant chemical family (115.5 mg/g extract), with unsaturated fatty acids (74.2 mg/g extract) exceeding saturated fatty acids (41.4 mg/g extract). Minor abundant families were also identified, such as terpenes (19.24 mg/g extract) and sterols (0.23 mg/ g extract). The cholesterol bioaccessibility assay was employed to evaluate the ability of these lipophilic compounds to interfere with micellar cholesterol solubilisation, a key step in intestinal cholesterol absorption. The predominance of unsaturated fatty acids, together with the presence of other lipophilic compounds, highlights the nutritional and functional potential of the extract.

Overall, these findings demonstrate that *A. platensis* (Spirulina) is a rich source of bioactive lipophilic compounds and support its potential application as a functional ingredient targeting lipid metabolism and cardiovascular health.

References

[1] Chaudhary, S., *et al*. *Discov. Food* 6, 140 (2026).
[2] Shah, M. A. R. *et al. Trends Food Sci. Technol.* 151, 104648 (2024).
[3] Silva, S. P., *et al.* LWT 197, 115934 (2024).
[4] Coreta-Gomes, F. M., *et al*. *Langmuir* 32, 4564–4574 (2016).

Acknowledgments: This work was developed within the scope of the project CICECO–Aveiro Institute of Materials, UID/50011 & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), and LAQV-REQUIMTE research unit UID/50006/2025 (DOI 10.54499/UID/50006/2025) financed by national funds through the FCT/MCTES (PIDDAC).

YSP17

Exploring the lipophilic-type components of *Arthrospira platensis* and antioxidant landscape of post-extraction residues

Irene, Pasero[1], Mariana, Kergoustin[1], Daniela P. Resende[1], Adriana C. S. Pais[1,2], Sónia A. O. Santos[1]

[1] *CICECO—Aveiro Institute of Materials and Department of Chemistry, University of Aveiro, 3810-193 Aveiro, Portugal*
[2] *CESAM-Centre for Environmental and Marine Studies, Department of Chemistry, Santiago University Campus, University of Aveiro, 3810-193 Aveiro, Portugal.*
irene.pasero@ua.pt; ORCID: 0009-0003-6041-0319

The sustainable Development Goals and circular bioeconomy strategies encourage the sustainable valorisation of renewable natural resources into high-value products, reducing dependence on fossil-based materials [1]. Microalgae have emerged as promising feedstocks due to their high diversity of bioactive secondary metabolites relevant to nutraceutical, cosmetic and pharmaceutical applications [2]. Among them, Arthrospira platensis is a commercially important cyanobacterium; however, a detailed characterization of its lipophilic composition is still limited [2].
In this study, the lipophilic extracts of A. platensis were obtained through Soxhlet, subjected to alkaline hydrolysis, and comprehensively characterized by gas chromatography–mass spectrometry (GC-MS). In parallel, the hydrophilic extracts were evaluated for their antioxidant activity using ABTS and DPPH radical scavenging assays. In addition, total phenolic content (TPC), and pigment contents were also determined by colorimetric assays.
A total of 42 compounds were identified in lipophilic extracts by GC-MS. Fatty acids represent the major family, with a high proportion of polyunsaturated fatty acids (29.21% and 36.49%, before and after hydrolysis, respectively), alongside saturated and monounsaturated species (23.75%-31.05% and 9.76%-16.26%, respectively). Terpenes and alkanes were detected in lower amounts, whereas sterols and long chain aliphatic alcohols were present only in trace amounts. The hydrophilic extracts exhibited antioxidant activity (ABTS IC50 = 0.20 mg ml^{-1} and DPPH IC50 >1 mg ml^{-1}). Additionally, the extracts showed a TPC of 11.24 mg GAE g^{-1} extract, and chlorophyll and carotenoid pigments at concentrations below1 mg ml-1.
Overall, this study provides a comprehensive characterization of the lipophilic profile and the antioxidant properties of the hydrophilic fraction of A. platensis, highlighting its potential as a sustainable source of valuable compounds for use in the development of new nutraceutical, cosmetic and/or pharmaceutical products.

References

[1] Grozdanić, N. et al. *Acta Poloniae Pharmaceutica – Drug Research*, 2019, 76, 833-844.
[2] Barros, L. et al., *Phytochemical Analysis*, 2011, 22(2), 181-188.

Acknowledgments: This work was developed within the scope of the project CICECO–Aveiro Institute of Materials, UID/50011 & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), financed by national funds through the FCT/MCTES (PIDDAC).

YSP18

Chemical Transformation of Plant Polyphenols during Food Processing and Digestion and Its Implications for Metabolic Regulation

Yuxuan, Zhao[1], Hui Cao[1], Jianbo, Xiao[1]

[1] *University of Vigo, Nutrition and Bromatology Group, Department of Analytical Chemistry and Food Science, Faculty of Science, Ourense E32004, Spain*

✉: jianboxiao@yahoo.com; ORCID: 0000-0003-3311-770X

Plant polyphenols undergo extensive structural transformation during food processing, fermentation, and digestion, generating newly formed derivatives with distinct biological activities. However, the contribution of these transformed products to metabolic regulation remains insufficiently understood. This doctoral thesis establishes a framework linking polyphenol transformation with metabolic and epigenetic regulation, with particular emphasis on methionine metabolism and the SAM-SAH balance[1].

Temperature-controlled catechin oxidation experiments showed that moderate heating promoted oxidative coupling and enhanced the formation of theaflavins, whereas excessive heating accelerated degradation and reduced antioxidant capacity. Fermentation further reshaped tea polyphenols through nitrogen-coupled remodeling. A nitrogen-containing catechin derivative, *N*-EGCG, was identified and structurally characterized, and its accumulation was associated with EGCG depletion and endogenous amino acid levels.

Digestive biotransformation was further investigated in a Drosophila melanogaster hyperhomocysteinemia model. EGCG restored methionine-cycle homeostasis and reduced homocysteine accumulation. Importantly, *N*-EGCG was formed in vivo through the reaction between EGCG and methionine in the intestinal environment, linking polyphenol transformation directly to metabolic regulation[2].

The transformation–function relationship was further supported in a fermented non-tea system, where Zhenjiang aromatic vinegar alleviated oxidative stress, inflammation, and lipid metabolic disorders in mice with alcoholic liver injury. Overall, these findings demonstrate that transformed polyphenol derivatives, rather than native compounds alone, are important mediators of the biological functions of plant-derived foods.

References

[1] Y. Zhao, et al., *Pharmacol,* 2026, *Res.*, vol. 225, p. 108114.

[2] Y. Zhao, et al., *Phytomedicine*, 2026, vol. 156, p. 158230.

Acknowledgments: This work was supported by National Natural Science Foundation of China (32472327), the Ramón y Cajal grant (RYC2020-030365-I to Jianbo Xiao), the Xunta de Galicia "Excelencia" program (ED431F2022/01 to Jianbo Xiao) and the Juan de la Cierva Incorporación grant (IJC2020-046055-I to Hui Cao), the project Center of Excellence in water management, materials, by-products and waste valorisation for circular bioeconomy implementation, contract 6 CoEx/08.02.2026 awarded to Gheorghe Asachi Technical University of Iasi, by UEFISCDI a public entity of Ministry of Education and Research.. Meanwhile, this work was supported by the China Scholarship Council (Grant No. 202308120008). This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CNCS/CCCDI-UEFISCDI, through the project Center of

Excellence in water management, materials, by-products and waste valorisation for circular bioeconomy implementation, proposal number PN-IV-P6-6.1-CoEx-2024-0056, contract 6 CoEx/08.01.2026.

YSP19

From Pre-Inca Medicinal Practices in Peru to Modern Phytochemistry: GC–MS Study of Gnaphalium dombeyanum (wira-wira) and Grindelia tarapacana (chiri- chiri)

Sheyla J., Figueroa-Valencia[1], Juan José, Vargas Mamani[1], Elizabeth, Figueroa-Valencia[1,2,3], Teresa, Cano de Terrones[1], Héctor Enrique, Terrones Díaz [1], Carlos, Areche Medina[4]

[1]*Facultad de Ciencias Naturales y Formales, Universidad Nacional de San Agustín de Arequipa, Avenida Independencia s/n, Arequipa 04001, Perú*
[2]*Laboratory of Algal Biotechnology, Centre ALGATECH, Institute of Microbiology of the Czech Academy of Sciences, Novohradská 237—Opatovický mlýn, 379 01 Třeboň, Czech Republic*
[3]*Department of Experimental Plant Biology, Faculty of Science, University of South Bohemia, Branišovská 1760, 370 05 České Budějovice, Czech Republic*
[4]*Department of Chemistry, Faculty of Sciences, University of Chile, Santiago 8320000, Chile*
sfigueroav@unsa.edu.pe ; ORCID: 0000-0001-6547-5830

Traditional Andean medicine represents an ancestral heritage of a millenary culture and constitutes a fundamental component of public health in many communities in Peru. It also serves as a valuable foundation for modern medicine in the search for novel chemical structures with significant structural diversity. Gnaphalium dombeyanum and Grindelia tarapacana, both belonging to the Asteraceae family, are Andean species widely used in therapeutic treatments due to their anti-inflammatory properties [1,2].
Gnaphalium dombeyanum is distributed in the southern Andes and was collected in Puno, while Grindelia tarapacana was collected in Arequipa. Non-volatile components were obtained using steam distillation. The chemical profiling was carried out by gas chromatography coupled with mass spectrometry (GC–MS). A total of 14 compounds were identified in Gnaphalium dombeyanum, with the major constituents being 2-naphthalenemethanol, 2,3,4,4a,5,6,7,8-octahydro-α,α,4a,8-tetramethyl (32.27%), ar-curcumene (27.3%), E-muurolol (10.92%), and (+)-β-eudesmol (6.3%), representing 76.79% of the total composition. In Grindelia tarapacana, 28 compounds were identified, with the predominant constituents being borneol acetate (14.4%), D-nerolidol (11.4%), bicyclo[3.1.1]hept-3-ene-2-formylmethyl-4,6,6-trimethyl (10.8%), and elixene (5%), accounting for 41.6% of the total composition. Additionally, grindelic acid was isolated from the methanolic extract of Grindelia tarapacana using a combination of size-exclusion chromatography on Sephadex LH-20 and thin-layer chromatography (TLC). Structural elucidation was performed by H^1 -NMR spectroscopic techniques.

References

[1] Santiváñez Acosta, R. et al., *Catálogo florístico de plantas medicinales peruanas*, *Instituto Nacional de Salud (INS)*, Perú.
[2] Krenn, L. et al., Fitoterapia, 2009, 80(5), 267–269.

Acknowledgments: Universidad Nacional de San Agustín de Arequipa, Schembiolab consultores SAC.

YSP20

Corema album subsp. *album as a multifunctional natural UV-protective ingredient*

Eliana, Fernandes[1], Julia, Vega[2], Eulogio J. Llorent-Martínez[3], Débora, Tomazi Pereira[2], Maria João, Rodrigues[1], Félix, L. Figueroa[2], Luísa, Custódio[1]

[1] *Centro de Ciências do Mar do Algarve (CCMAR/CIMAR LA), Campus de Gambelas, Universidade do Algarve, 8005-139 Faro, Portugal*
[2] *University of Malaga, Institute of Blue Biotechnology and Development (IBYDA, Grice-Hutchinson Experimental Centre, Lomas de San Julián,2, Málaga 29004, Spain*
[3] *Department of Physical and Analytical Chemistry, University of Jaén, Campus Las Lagunillas S/N, 23071, Jaén, Spain*
lcustodio@ualg.pt; ORCID: 0000-0003-4338-7703

The increasing interest in plant-derived cosmetic ingredients has promoted the search for natural extracts combining antioxidant properties with UV protection. In this context, the study aimed to evaluate the phytochemical composition, stability, and *in vitro* photoprotective performance of an ethanolic leaf extract of *Corema album* subsp. album incorporated into a topical cream formulation. Freeze-dried leaves collected in southern Portugal were extracted by ultrasound-assisted extraction with ethanol. Phytochemical profiling was performed by HPLC-ESI-Q-TOF-MS, while total phenolics, flavonoids, and antioxidant activity (DPPH, ABTS) were determined spectrophotometrically. Extract stability was evaluated under thermal and UV radiation exposure conditions. Photoprotective performance was assessed *in vitro* on PMMA plates through determination of SPF and UVAPF in formulations containing increasing extract concentrations (5-20%), alone or combined with a physical UV-filter. Phytochemical profiling by HPLC-ESI-Q-TOF-MS showed a predominance of flavonoid glycosides and flavan-3-ols, including epicatechin (15% of detected compounds), proanthocyanidins, laricitrin-O-hexoside (13%), and myricetin and quercetin glycosides (8% each). The extract presented high total phenolic (153 mg GAE/g DW) and flavonoid contents (44.6 mg QE/g DW), together with antioxidant activity (EC_{50}: 0.29 mg/mL for DPPH; 0.12 mg/mL for ABTS). Thermal treatments predominantly affected antioxidant capacity, while phototreatments induced more pronounced reductions in total phenolic and flavonoid contents. *In vitro* photoprotection assays on PMMA plates demonstrated a concentration-dependent increase in SPF (1.3–10.0) and UVAPF (0.99–4.46) across formulations containing increasing extract concentrations. The □critical ranged between 368 and 375 nm. Combination with a physical UV-filter further increased protection (SPF 18.6; UVAPF 10.3). The SPF/UVAPF ratio ranged between 1.6 and 2.2, indicating balanced UVB/UVA protection. Overall, the results demonstrate that *C. album* leaf extract contributes to *in vitro* UV protection and represents a potential natural ingredient for topical photoprotective formulations.

Acknowledgments: This research was supported by Biodiversa+, the European Biodiversity Partnership, through the SaltyBeats project under the 2023–2024 BiodivNBS joint call, co-funded by the European Commission (Grant Agreement No. 101052342) and by Portuguese national funds through FCT (DOI: 10.54499/BiodivNBS/0015/2023). Institutional support was further provided by Portuguese national funds from FCT – Foundation for Science and Technology through contracts UID/04326/2025 (DOI:10.54499/UID/04326/2025), UID/PRR/04326/2025 (DOI:10.54499/UID/PRR/04326/2025), and LA/P/0101/2020 (DOI:10.54499/LA/P/0101/2020)

attributed to CCMAR. Individual support to M.J.R. was provided by FCT through the programme contract UIDP/04326/2020, and E.F. acknowledges FCT for the PhD fellowship UI/BD/151301/2021.

YSP21

Oxidative Assemblies of Flavonoids (Quercetin, Morin) to Form Dimer in Weak Base Circumstances and Its Mechanism Analysis by UPLC-MS/MS

Pengren Zou [1,2], Jesus Simal-Gandara [1,3,4], Paz Otero [1,2,3,]

[1]*Universidade de Vigo, Nutrition and Bromatology Group, Analytical Chemistry and Food Science Department, Faculty of Science, 32004, Ourense, Spain.*
[2]*Instituto de Agroecoloxía e Alimentación (IAA), Universidade de Vigo, Campus Auga, 32004 Ourense, España.*
[3] *Agricultural and Food Research Group (AA1), Galicia Sur Health Research Institute (IIS Galicia Sur). SERGAS-UVIGO, 36213, Vigo, Spain.*
[4] *CISPAC, Fontan Building, City of Culture, 95001, Santiago de Compostela, Spain.*
paz.otero@uvigo.es

Flavonoid dimers are being studied due to their particular structure that links two units through C-C or C-O-C bonds. Given their unique bridging molecular structures and polyhydroxy groups, flavonoid dimers exhibit several reinforced bioactivities compared to their monomers, such as hypolipidemic, antidiabetic, and neuroprotective activities, as well as other potential [1]. Besides natural biflavonoids, the green, efficient, and sustainable preparation of dimers from flavonoid monomers using simple methods has sparked our research interest. Flavonoids are susceptible to autoxidation in aqueous solutions, which is largely dependent on pH, generating various free radicals and oxidation products. Building on the fact that flavonoids readily form quinones in alkaline solutions, this study selected several flavonoid monomers as research objects and evaluated their transformations and products in a weakly basic environment using UPLC-MS/MS to find an excellent precursor for synthesizing dimers. Quercetin and morin rapidly produced C-O-C linkage dimers in a pH 8 phosphate buffer solution, whereas catechin, kaempferol, fisetin, taxifolin, isorhamnetin, and luteolin exhibited finite dimerization. Low pH (6 and 7) hinders deprotonation, whereas high pH (9, 10, and 11) disrupts this process, leading to rapid monomer degradation. Deprotonation and oxidation of quercetin (QuH_2^{2-}, $QuH_2^{\bullet-}$, and $QuH^{\bullet 2-}$) and morin (MoH_2^{2-} and $MoH^{\bullet 2-}$) generate o-quinones QuH^- (B ring) and MoH^{2-} (C ring), respectively, which couple with nucleophilic monomers through distinct pathways to form dimers. Compared to the other concentrations, the 100 μM of quercetin and morin had significantly higher dimer yields at 4 h of incubation ($p < 0.05$). Moreover, morin outperformed quercetin both in terms of dimerization degree and diversity of oxidation products, where their highest yields at 100 μM were 29.90% and 25.77%, respectively. In conclusion, quercetin and morin serve as high-quality precursors for sustainable dimer preparation, offering significant potential for application in food supplements or pharmaceuticals.

References

[1] Zou, P., et al. Food Chemistry, 2025 467, 142266.

Acknowledgements: The research leading to these results was supported by MICINN, supporting the Ramón y Cajal grant for Paz Otero (RYC2022-036690-I), as well as by Xunta de Galicia for supporting the program Excelencia-ED431F 2024/22 and GRC-ED431C 2022/25. Pengren Zou gratefully acknowledges the financial support provided by the China Scholarship Council (CSC).

YSP22

Mespilus germanica L. callus as a sustainable bioreactor for the production of bioactive triterpenoids

Rosa Emanuele[1], Parisi Valentina [1], De Tommasi Nunziatina [1], Donadio Giuliana [1], Fraternale Daniele [2]

1 Dipartimento di Farmacia, Università degli Studi di Salerno, Via Giovanni Paolo II 132, Fisciano (SA), Italia
2 Dipartimento di Scienze Biomolecolari, DISB, Università di Urbino Carlo Bo, Via Bramante 28, 61029 Urbino (PU), Italia
erosa@unisa.it

The medlar (*Mespilus germanica* L.) is a forgotten fruit that is attracting renewed interest thanks to its biological properties [1]. *In vitro* plant cell culture provides a sustainable way of producing bioactive compounds by bypassing environmental constraints. This study presents a protocol for producing medlar callus biomass using mature pulp as a novel source to promote this fruit [2]. Following growth optimisation, the metabolomic profiles of the callus and elicited callus were obtained using LC-HRMS and NMR and then compared with those of the fruit pulp and peel. The results revealed that the callus cultures were significantly enriched in ursane and oleanane-type triterpenoids, displaying a distinct chemical profile compared to the original fruit tissues. Furthermore, the extract was subjected to chromatographic separation to isolate and identify pure triterpenes, namely ursolic, oleanolic, tormentic, rotundic, maslinic, and isoyamuric acids. The antimicrobial potential of these triterpenoid-rich extracts was evaluated against a panel of Gram-positive and Gram-negative bacteria. The results showed that the growth of *Listeria monocytogenes* was affected by callus extract treatment. The minimum inhibitory concentration (MIC) of the extract was determined to be 250 µg/mL; however, sub-MIC concentrations were found to significantly alter the bacterial growth curve. The isolated compounds were then also tested, with ursolic and oleanolic acid proving to be the most active at 10 µg/mL. HR-LC-MS and NMR analyses of the endo- and exo-metabolome confirmed that these triterpenes enter the bacterial cells, affecting their metabolic activity. Furthermore, the extracts effectively inhibited biofilm formation, a key virulence factor, at 125 µg/mL, even under biofilm-inducing conditions involving glucose and sucrose supplementation. These findings demonstrate that *M. germanica* callus cultures could be a promising, controlled bioreactor for producing bioactive triterpenoids with potent antilisterial activity.

References

[1] Żołnierczyk, A. et al., Appl. Sci, 2021, 11(16), 7528.
[2] Lystvan, K. et al., J. Agric. Food Chem, 2018, 66, 3870–3879.

YSP23

Holistic biorefinery of *Fucus vesiculosus*: a sustainable cascade approach for high-value phytochemicals and food applications

Ana R., Circuncisão[1], Mariana, Nóbrega[1], Sónia S., Ferreira[1], Idalina, Gonçalves[2], Manuel A., Coimbra[1], Herminia, Domínguez[3], M. D., Torres[3], Susana M., Cardoso[1]

[1] *LAQV-REQUIMTE, Department of Chemistry, University of Aveiro, 3810-193, Aveiro, Portugal*
[2] *CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, 3810-193, Aveiro, Portugal;*
[3] *CINBIO – University of Vigo, Department of Chemical Engineering, Campus Ourense, Edificio Politécnico, As Alagoas s/n 32004, Ourense, Spain*
susanamcardoso@ua.pt; ORCID 0000-0002-7882-737X

The blue bioeconomy demands innovative strategies to harness the chemical diversity of marine resources while ensuring industrial sustainability [1]. This study explores a holistic, sequential extraction approach applied to the brown macroalga *F. vesiculosus*, aiming to recover multiple high-value-added compounds, namely phlorotannins, fucoxanthin, and bioactive polysaccharides, within a biorefinery framework. Two strategies were evaluated, differing in the initial solvent: water (Approach 1) versus 96% ethanol (Approach 2). Results demonstrate that the primary solvent acts as a critical "fractionation trigger." Approach 1 functioned as an efficient pre-washing step, removing water-soluble phenolics, laminarans, and mannuronic-rich alginates, thereby enhancing the purity of subsequent fucoxanthin-rich (1.34 g/100 $g_{extract}$) and fucoidan-rich fractions, and yielding alginates with lower M/G ratio (2.91). Conversely, Approach 2 maximized total phlorotannin recovery (3.01 g PGE/100 $g_{extract}$) but negatively affected pigment recovery and the purity of downstream fractions.
Moreover, the most balanced extract (aqueous, Approach 1) was incorporated (0.5% w/w) into ripened sheep cheeses, significantly modulating its properties: reduced moisture (32.1% vs. 42.1% in control) and water activity (0.89 vs. 0.92 in control), darker rind, and a 3-fold increase in hardness, with minimal impact on pH and titratable acidity. Residual biomass was further valorized through sodium alginate recovery. Once again, extraction history modulated M/G ratios: Approach 1 (1_NaAlg, 1.13) favored rigid, thermally stable networks, while Approach 2 (1.80) yielded higher apparent viscosity. In turn, films formulated with 1_NaAlg demonstrated enhanced thermal stability (T_{max}=250.8°C) and a more compact microstructure, outperforming commercial counterparts in specific mechanical parameters. Overall, this work underscores that cascade, sequential extraction preserves biopolymers integrity while enabling fine-tuning of functional properties, providing a robust framework for the sustainable integration of macroalgal phytochemicals aligned with circular blue economy principles.

References

[1] Blikra, M. J. et al. *Trends in Food Science & Technology,* 2021, 118, 765-776.

Acknowledgments: Thanks are due to the University of Aveiro and FCT/MCTES for the financial support to LAQV-REQUIMTE (UID/50006/2025; DOI: 10.54499/UID/50006/2025) and CICECO – Aveiro Institute of Materials (UID/50011 & LA/P/0006/2020; DOI: 10.54499/LA/P/0006/2020) through national funds, and the co-funding by FEDER, within the PT2020 Partnership Agreement and Compete 2020. The authors also acknowledge FCT/MCTES for the research contract of S. M. Cardoso under the Institutional Call to Scientific Employment Stimulus, and I. Gonçalves under the Individual Call to Scientific Employment Stimulus (DOI: 10.54499/CEECIND/00430/2017/CP1459/CT0032). A. R. Circuncisão thanks FCT/MCTES and ESF through NORTE 2020 for her PhD grant ref. SFRH/BD/147321/2019. M. D. Torres acknowledges to the Ministry of Science, Innovation and Universities of Spain for her post-doctoral grant (RYC2018-024454-I) and to the Consellería de Cultura, Educación e Universidade da Xunta de Galicia (ED431F 2020/01). S. S. Ferreira thanks to LAQV/REQUIMTE for her research contract.

YSP24

Sustainable valorisation of *Eucalyptus globulus* residual biomass as a natural source of high-value phytochemicals

Ana C. Jacinto[1,2], Carolina Gonçalves[2], Pedro C. Branco[3], Paula C. R. Pinto[3], Sónia A. O. Santos[1], Armando J. D. Silvestre[1]

[1] *CICECO – Aveiro Institute of Materials, University of Aveiro, 3810-193 Aveiro, Portugal*
[2] *CoLAB BIOREF – Collaborative Laboratory for Biorefineries, 4466-901 São Mamede de Infesta, Portugal*
[3] *RAIZ – Forest and Paper Research Institute, Eixo, 3801-501 Aveiro, Portugal*
aclarajacinto@ua.pt; ORCID: 0000-0003-3261-5758

Eucalyptus globulus is extensively cultivated as a fibre source for the pulp and paper industry, generating large amounts of harvesting residues that are commonly left in the field or used for energy production. However, eucalyptus leaves are a rich natural resource containing valuable phytochemicals, including essential oil (EO), triterpenic acids (TTAs), and phenolic compounds, with potential applications in health-related sectors. A recently patented sequential extraction process enables the integrated recovery of these fractions, improving resource efficiency [1]. In this approach, eucalyptus EO is used as a bio-based solvent for TTAs extraction, decreasing the need for external organic solvents and potentially lowering environmental and economic impacts. Nevertheless, industrial implementation remains limited by challenges related to process scalability and efficient TTAs recovery from the EO phase without compromising the quality of either fraction. This work aimed to develop and optimise scalable strategies for recovering TTAs from hydrodistilled *E. globulus* leaves. A Box-Behnken experimental design was applied to study temperature, extraction time, and solids loading in the solid-liquid extraction of TTAs using EO as a bio-based solvent. Pilot-scale validation reached 76% to 90% of the laboratory model-predicted responses, confirming good model predictive capacity and supporting process transferability. Vacuum fractional distillation recovered approximately 40% v/v of the initial EO-based extract as a rectified fraction containing ≥85% 1,8-cineole, meeting commercial quality requirements for higher-value applications, while increasing the TTAs concentration in the distillation residue by 5.4-fold. Ongoing work focuses on enriching TTAs from the distillation residue by preparative chromatography using macroporous polymeric adsorbents. Overall, this study supports the valorisation of forestry residues into high-value phytochemicals with health-promoting applications, contributing to circular bioeconomy strategies.

References

[1] Pinto, P. C. R. O. et al. European Patent EP 4186575 B1, 2023.

Acknowledgments: This work was developed within 'PRR - Investimento RE-C05-i02: Missão Interface – CoLAB', financed by the Recovery and Resilience Plan (PRR) and by the European Union - Interface Mission project. This work was developed within 'PRR - Investimento RE-C05-i02: Missão Interface – CTI', financed by the Recovery and Resilience Plan (PRR) and by the European Union - Interface Mission project. This work was developed within the scope of the projects CICECO-Aveiro Institute of Materials, UIDB/50011/2020+UIDP/50011/2020+LA/P/0006/2020, financed by national

funds through the FCT/MCTES (PIDDAC), which also financed the research contract under Scientific Employment Stimulus of S.A.O.S. (2021.03348.CEECIND).

YSP25

Extraction of Oleanolic Acid from grape pomace using Eutectic Solvents for Cosmetic Application

Lou, Zusatz[1], Adriana, C. S. Pais[2,3], Filipe, H. B. Sousa[2], João, A. P. Coutinho[2], Pierre-Eric, Campos[1], Sónia, A. O. Santos[2]

[1] *Institute of Organic and Analytical Chemistry (ICOA), UMR 7311, University of Orléans, Orléans, France*
[2] *CICECO-Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal*
[3] *CESAM-Centre for Environmental and Marine Studies, Department of Chemistry, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal*
lou.zusatz@etu.univ-orleans.fr

Grape pomace represents one of the most abundant by-products of wine industry and represents a valuable source of bioactive compounds with potential to be used in pharmaceutical, nutraceutical or cosmetic applications. Among these bioactive compounds, oleanolic acid (OA), a triterpenoid compound, has attracted increasing attention including cosmetic applications, due to its beneficial biological properties. However, its extraction requires solvents capable of solubilizing non-polar compounds while remaining safe for topical application. Eutectic solvents (ES) have emerged as promising alternatives, combining extraction efficiency with favourable safety and sustainable profiles [1].

This work aims to develop a sustainable extraction method of OA from grape pomace using ES. The proposed approach should incorporate the ES-based extract into cosmetic formulations without solvent removal and drying steps, thereby reducing energy consumption and process waste.

In order to select the most suitable ES to be used for the extraction of OA, an initial screening of ES was carried out using 214 Hydrogen Bond Acceptors (HBA) and 220 Hydrogen Bond Donors (HBD) with the conductor-like screening model for real solvents (COSMO-RS). Menthol-based ES with fatty alcohols were predicted to exhibit high affinity for OA while ensuring cosmetic safety requirements. For validation of the predictive model, solubilization assays using an OA standard were conducted in 7 selected ES samples.

The samples were then derivatized and analyzed in GC-MS for quantification. The preliminary results suggest the same solubilization trend as predicted by COSMO-RS.

As a future perspective, the selected ES will be used to extract OA from grape pomace harvested from three different countries in Europe. The obtained extracts will then be evaluated for their potential integration into cosmetic formulations, according to their promising biological activities. Overall, this study proposes developing new bio-based cosmetic products using greener processes.

References

[1] Zhang, Q.; Vigier, K. D. O.; Royer, S.; Jérôme, F. Deep Eutectic Solvents: Syntheses, Properties and Applications. *Chem. Soc. Rev*. 2012, 41 (21), 7108–7146.

YSP26

Natural Deep Eutectic Solvents for Long-term Stabilization of Phenolic Compounds

Ana R. S. Ferreira, Adriana C. S. Pais[1,2], Sónia A. O. Santos[1]

[1] *CICECO – Aveiro Institute of Materials, Department of Chemistry, university of Aveiro, 3810-193 Aveiro, Portugal*
[2] *CESAM – Center of Environmental and Marine Studies, Department of chemistry; University of Aveiro, 3810-193 Aveiro, Portugal*
anaritasf@ua.pt

Phenolic compounds (PCs) represent a particularly promising class of natural bioactive compounds (NBCs), exhibiting significant antioxidant, anti-inflammatory, and anticancer properties. However, their broader application is often hindered by limited chemical instability during storage [1]. Natural deep eutectic solvents (NADES), defined as low-melting mixtures of hydrogen-bond donors and acceptors, have emerged as a sustainable and tunable medium with the potential to enhance NBC stability [2]. The aim of this study was to evaluate the 90-day stability of caffeic acid (CA) and epigallocatechin gallate (EGCG) in 4 bio-based NADES: choline acetate:butan-1,2-diol (ChABut, 1:1), choline chloride:glycerol (ChClGly, 1:2), betaine:glycerol (BetGly, 1:2) and glycerol:sodium benzoate (GlyNaBz, 1:10), in comparison with a reference organic solvent (MeOH:H_2O, 80:20 v/v). Following a preliminary solubility screening of 7 phenolic compounds, CA and EGCG were selected for further evaluation. The formulations were stored under three conditions: ambient light at room temperature (RT); darkness at RT; and cold storage at 4ºC; over 90 days. PCs quantification was performed by ultra-high performance liquid chromatography with diode-array detection (uHPLC-DAD). Moreover, complementary stability indicators were evaluated through pH measurements and visual color monitoring. Throughout the stability study, EGCG remained quantifiable in all NADES. GlyNaBz provided the highest degree of stabilization, with EGCG concentrations reaching a plateau by day 7 and remaining unchanged until day 58 under all storage conditions, suggesting a protective effect associated with the aromatic benzoate moiety. In ChABut, a marked initial decrease (days 1-2) was followed by a period of stabilization under cold storage conditions, whereas samples stored in darkness underwent complete degradation by day 58. This unexpected behavior may be indicative of NADES-mediated oxidative pathways. ChClGly and BetGly exhibited intermediate stabilization effects, with concentration profiles strongly influenced by storage conditions. Conversely, CA exhibited substantial concentration variability across all systems (NADES under all conditions), impeding the reliability of quantification analysis. With regard to the visual monitoring, a darkening was observed in the ChABut formulations containing both compounds, occurring gradually for EGCG and more abruptly for CA between days 28 and 43. precluding kinetic modelling. Additionally, the pH values remained stable throughout the storage period. Overall, these results demonstrate that the NADES composition has a significant influence on the stability of PCs, thus highlighting GlyNaBz as a particularly promising formulation medium for EGCG stability during storage.

References

[1] Durazzo A, et al. Polyphenols: a concise overview on the chemistry, occurrence, and human health. 2019, 33(9), 2221-2243.

[2] Hansen BB, et al. Deep eutectic solvents: a review of fundamentals and applications. 2021, 121(3), 1232-1285.

Acknowledgments: This work was developed within the scope of the project CICECO–Aveiro Institute of Materials, UID/50011 & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), financed by national funds through the FCT/MCTES (PIDDAC).

YSP27

Valorization of Nut By-products as Bioactive Ingredients for Active Food Packaging: Characterization and Effectiveness

Inês Amaro[1], Estefanía Valero-Cases[2], Fernando Ramos[1,3], Ana Sanches-Silva[1,4,5]

[1]*University of Coimbra, Faculty of Pharmacy, Health Sciences Campus, Azinhaga de St. Comba, 3000-548 Coimbra, Portugal;*
[2] *Instituto de Investigación e Innovación Agroalimentaria y Agroambiental, Miguel Hernández University (CIAGRO-UMH), Ctra. Beniel, Km 3.2, 03312-Orihuela, Alicante, Spain*
[3]*REQUIMTE/LAVQ, Health Sciences Campus, Azinhaga de St. Comba, 3000-548 Coimbra, Portugal;*
[4]*Centre for the Study in Animal Science, Medical and Biomedical Sciences School, Fernando Pessoa University, Gondomar, Porto, Portugal;*
[5]*Associate Laboratory for Animal and Veterinary Sciences (AI4AnimalS), 1300-477 Lisbon, Portugal.*
asanchessilva@ff.uc.pt; 0000-0002-0226-921X

Nowadays, agri-food industries generate substantial amounts of processing residues. In particular, nut processing originates significant quantities of shells, skins and other by-products, that are often underexploited. The production of sustainable active packaging has attracted increasing attention, as it promotes the valorization of these natural resources while extending the shelf life of perishable foods. This study aimed to evaluate the potential of extracts obtained from chestnut, walnut, almond and acorn by-products for the production of antioxidant biodegradable films.
Initially, extracts were analyzed for its phenolic content and antioxidant activity, using Folin-Ciocalteau and aluminum chloride methods, as well as DPPH radical scavenging and β-carotene bleaching assays. The extract exhibiting the highest antioxidant capacity (chestnut inner skin extract) was selected for incorporation into whey protein-based films. The resulting films were then characterized for their physical, chemical and barrier properties, and a migration assay was performed using a food simulant to evaluate the release profile of the phenolic compounds into food. The effectiveness of the films in preventing lipid oxidation was also evaluated through the Thiobarbituric Acid Reactive Substances (TBARS) assay, using raw salmon as food model [1].
Results demonstrated that the incorporation of the selected extract significantly enhanced films' antioxidant functionality without compromising their physicochemical properties. TBARS analysis confirmed a delay in lipid oxidation compared to control samples, with films with 1% of extract showing the best results (0.20 mg MDA Eq./ kg of sample, at day 4) compared to the control films (0.45 mg MDA Eq./ kg of sample, at day 4) and the sample without film (0.24 mg MDA Eq./ kg of sample, at day 4). In conclusion, nut by-products, particularly chestnut inner skin, represent a promising and sustainable source of natural antioxidants, supporting both circular economy strategies and food waste valorization. Future studies will investigate the antimycogenic activity of chestnut inner skin ethanolic extracts to develop active packaging materials capable of controlling fungal growth and mitigating mycotoxin contamination in food products, especially cereals such as maize and wheat. Given that phenolic compounds are often associated

with both antioxidant and antimycogenic activities, the relationship between the antioxidant capacity of these extracts and their ability to inhibit fungal growth will also be investigated.

References

[1] Robalo, J. et al. Foods, 2022, 11, 1158.

Acknowledgments: This work was supported by the project PRIMA/0011/2024 (Bio-Team, DOI https://doi.org/10.54499/PRIMA/0011/2024), funded by the PRIMA Programme (Section 2) and with national funding provided by the Foundation for Science and Technology (FCT), Portugal. This work was supported by UIDB/00211/2025 and UIDB/50006/2025 (https://doi.org/10.54499/UID/50006/2025) with funding from FCT/MCTES through national funds.

POSTER PRESENTATIONS

PP1

Phytochemical and molecular insights into *Agrostemma githago* as bioactive compounds resource for medicine and food

Weronika Kozłowska.[1], Monika Bielecka[2], Izabela Nawrot-Hadzik[2], Aleksander Smakosz[2], Anna Choromańska [3], Reneta Gevrenova [4], Michał Dziwak[1], Adam Matkowski[2,5]

[1]*Department of Pharmaceutical Biology and Biotechnology, Division of Pharmaceutical Biotechnology, Wroclaw Medical University, Poland;*
[2]*Department of Pharmaceutical Biology and Biotechnology, Division of Pharmaceutical Biology and Botany, Wroclaw Medical University, Poland;*
[3] *Department of Cell and Molecular Biology, Wroclaw Medical University, Poland;*
[4] *Department of Pharmacognosy and Botany, Sofia Medical University, Bulgaria;*
[5] *Botanical Garden of Medicinal Plants, Wroclaw Medical University, Poland;*
pharmaceutical.biology@wp.eu; ORCID: 0000-0002-7283-2653

Agrostemma githago L (Caryophyllaceae) was once a noxious weed in cereal fields but the agriculture modernization led to its eradication. Now, this plant is rare and survived mainly in fringe habitats and as ornamental. However, it also has a history as medicinal herb a few centuries ago but nowadays it is not used [1].
The present study aimed at expanding knowledge about the corncockle phytochemistry and molecular biology in the context of potential for biosynthetic potential of bioactive biotechnological phytochemicals production.
The plant material was field-cultivated and cultured *in vitro* including temporary-immersion bioreactors.
Using an LC-High-Resolution-Mass-Spectrometry we were able to detect 49 triterpenoid glycosides (mono- and bidesmosides) where sapogenins were built of gypsogenin, quillajic acid, oleanolic acid and hydroxyoleanolic acid [2]. In the aerial parts, the predominant compounds were orientin and isoorientin, along with other flavone-C-glycosides. In the bioreactor cultures, orientin, isoorientin and vitexin were detected with at five derivatives with additional glycosylation. The content of triterpene saponins was significantly lower and less complex than in field-grown plants. To advance knowledge in crucial steps of flavonoid, saponin and RIP regulation at the molecular level, nucleotide sequences of homolog genes involved in the plant flavonoid biosynthetic pathway were identified by RNAseq for continued investigation into the transcriptional regulation using RT-PCR. Expression profiling under experimental *in vitro* conditions and during ontogenesis revealed differential regulation of saponin and flavonoid related genes, suggesting their involvement in stress-response influenced biosynthesis. Finally, the activity of the extracts and fractions were assessed for impact on cell lines *in vitro*, demonstrating various degree of cytotoxicity towards cancerous and non-transformed cell lines.
In conclusion, this fast growing, high-biomass herb can provide a feasible source of highly bioactive phytochemicals, such as flavone-C-glycosides, saponins and ribosome-inactivating proteins to possibly find its way to the food supplements and medicinal products.

Reference

[1] Smakosz, A et al. *Plants*, 2024, 13, 1673.

Acknowledgments: Funding by the National Science Center of Poland (NCN), grant no. 2020/39/I/NZ7/01515-RIPSAPO

PP2

Targeting the TLR-4/NF-κB pathway by the plant-derived sulfur-containing Sulforaphane (SFN) and S-allyl-cysteine (SAC) is associated with the inhibition of pro-inflammatory gene expression induced by *P. aeruginosa* in Cystic Fibrosis IB3-1 cells

Federica Di Padua[1], Giovanni Marzaro[2], Giulia Breveglieri[1], Giuseppe Sabbioni[1], Monica Borgatti[1], Enzo Agostinelli[3], Roberto Gambari[1] and Alessia Finotti[1]

[1]*Department of Life Sciences and Biotechnology, Ferrara University, I-44121 Ferrara, Italy;*
[2]*Department of Diagnostics and Public Health, University of Verona, I-37134 Verona, Italy*
[3]*Department of Sensory Organs, Sapienza University of Rome, Policlinico Umberto I, I-00161 Rome, Italy.*
federica.dipadua@unife.it

Sulforaphane (SFN) and S-allyl-cysteine (SAC) are potent sulfur-containing bioactive compounds derived from plants and exhibit significant antioxidant, anti-inflammatory, and anticancer properties. Sulforaphane is highly concentrated in broccoli sprouts (*Brassica oleracea*) and other cruciferous vegetables (cabbage, Brussels sprouts). S-allyl-cysteine is one of the major bioactive components present in garlic (*Allium sativum*). By performing docking and molecular dynamics (MD) simulations with SeeSAR 12.1.0 software (docking) and Gromacs 2021.1 (MD) software, we found that SFN stably interacts with the p60 NF-κB monomer, forming a ternary NF-κB/SFN/DNA complex and impairing the full interaction between the NF-kB and DNA molecules [1]. Docking experiments performed on S-allyl-cysteine suggested that a possible mechanism of action of SAC is an interference with the activity of Toll-like receptors (TLRs), particularly TLR4, thereby inhibiting NF-κB and NF-κB-regulated genes [2]. Considering the key role of NF-κB in regulating the expression of pro-inflammatory genes in cystic fibrosis (CF), the main purpose of the present study was to determine the effects of SFN and SAC on the expression of the pro-inflammatory genes in cystic fibrosis cells infected with *P. aeruginosa.* The employed cellular model system was the human bronchial epithelial IB3-1 cell line, derived from a CF patient with a ΔF508/W1282X mutant genotype and immortalized with adeno12/SV40. After 48 hours of treatment with 5 μM SFN or 50 μM SAC, the cells were infected with the *P. aeruginosa* PAO1 strain for 4 hours. Changes in the expression of the pro-inflammatory genes such as IL-6, IL-8, IL-1b and G-CSF were studied by RT-qPCR using b-actin sequences as internal controls. Proteins released into culture supernatants were measured using Bio-Plex Human Cytokine 27-plex Assay. The results obtained demonstrated that PAO1 infection induced the expression of pro-inflammatory genes, and that this increase was inhibited by SFN and SAC with different efficiency depending on the interleukins studied. In particular, the Bio-Plex data showed that SAC preferentially inhibits IL-6 and G-CSF, whereas SFN preferentially inhibits IL-6 and IL-8. Both compounds, however, are highly effective in inhibiting the IL-1β transcripts, as indicated by RT-qPCR results. This finding suggests that plant-derived

sulfur-containing bioactive molecules should be considered to mitigate the inflammatory state in cystic fibrosis.

References

[1] Gasparello, J et al. *Int J Mol Med.* 2023, 52(3):76.
[2] Gasparello, J et al. *Molecules* 2024, 29(24):5938.

Acknowledgments: This work was funded by Wakunaga Pharmaceutical Co. Ltd. (Hiroshima, Japan).

PP3

From Ellagitannins to Ellagic Acid: Thermal Processing and *In Vitro* Digestion Modulate the Bioactive Profile of *Quercus rubra* Acorns

Joanna Oracz[1], Katarzyna Owczarek[2], Aleksandra Popowska[1], Gabriela Kowalska[1], Karolina Niewinna[2], Dorota Żyżelewicz[1], Urszula Lewandowska[2]

[1]*Institute of Food Technology and Analysis, Faculty of Biotechnology and Food Sciences, Lodz University of Technology, 2/22 Stefanowskiego Street, 90-537 Lodz, Poland*
[2]*Department of Biochemistry, Faculty of Medicine, Medical University of Lodz, 5 Mazowiecka Street, 92-215 Lodz, Poland*
joanna.oracz@p.lodz.pl; ORCID 0000-0003-2469-3369

This study aimed to evaluate the effects of roasting and simulated in vitro digestion on the phenolic profile, 5-hydroxymethylfurfural (HMF) content, melanoidins, and biological activity of *Quercus rubra* L. acorns. Extracts obtained from unroasted acorns and acorns roasted at 180 °C and 200 °C were subjected to simulated gastrointestinal digestion, and dialyzable (potentially bioaccessible) and non-dialyzable fractions were obtained using dialysis.

Phenolic compounds and HMF were determined by UHPLC-DAD-ESI-MS/MS, while melanoidins were quantified using ultrafiltration. Antioxidant activity (TPC, DPPH, FRAP, TEMPO-EPR, Fe^{2+}-ion chelating capacity), anti-inflammatory potential (LOX inhibition), and cytotoxic effects against cancer (SW-480) and normal (CCD841CoN) cells were evaluated. In addition, *in silico* ADME and target prediction analyses were performed to support the interpretation of pharmacokinetic behaviour and potential molecular mechanisms.

Raw acorn extracts were rich in ellagitannins (ETs), particularly oenothein B and rugosin E isomers, whereas roasting significantly reduced their content and promoted the formation of low-molecular-weight phenolics, including ellagic acid (EA) and gallic acid, as well as Maillard reaction products such as HMF and melanoidins. Simulated digestion further enhanced ET hydrolysis, leading to a significant increase in EA, especially in dialyzable fractions, indicating improved bioaccessibility. Raw extracts exhibited the highest antioxidant and anti-inflammatory activity, while roasted samples showed increased cytotoxicity but reduced selectivity toward cancer cells. *In silico* analysis revealed more favourable absorption-related properties for low-molecular-weight compounds than for high-molecular-weight ETs.

Target prediction suggested that the major transformation product of ETs, ellagic acid, may exert anticancer effects through multi-target interactions, whereas ETs likely act indirectly due to limited bioavailability. Overall, thermal processing and digestion significantly modulate the composition and bioaccessibility of acorn polyphenols, linking chemical transformations with biological activity and highlighting the key role of ellagic acid in determining functional properties. These findings provide a basis for further studies aimed at elucidating the molecular mechanisms underlying the biological activity of bioactive compounds present in *Q. rubra* acorns.

PP4

Biotransformation of Abalone through *Cordyceps militaris* Fermentation: Increased Cordycepin and Amino Acid Content

Inseo, Song[1], Ayman, Turk[1], Beom Seok, Kim[2], Se Jeong, Kim[1], Hak Hyun, Lee[1], Bang Yeon, Hwang and Mi Kyeong, Lee[1]

[1] *College of Pharmacy, Chungbuk National University, Cheongju 28160, Republic of Korea*
[2] *Farmther Corp., Cheongju 28535, Republic of Korea*
mklee@chungbuk.ac.kr ; ORCID: 0000-0001-5814-2720

Abalone is a high-value marine food resource rich in proteins and amino acids, including taurine [1]. Mushroom-mediated biotransformation has the potential to enhance the functional properties of natural resources; therefore, this study was conducted to investigate abalone as a fermentation platform using *Cordyceps militaris*. *C. militaris* was successfully cultivated on abalone, enabling in situ production of cordycepin, a key bioactive compound with diverse pharmacological activities [2]. Cordycepin was detected in both the fruiting bodies and the abalone-based medium, reaching 0.30% and 0.26% on a dry weight basis, respectively. These values correspond to 25.1- and 29.0-fold increases compared with the conventional brown rice substrate, and 2.7- and 1.9-fold increases compared with the cricket-based medium. Fermentation on abalone also markedly enhanced amino acid composition. Compared with raw abalone prior to cultivation, essential amino acids increased by 10.3-fold in the medium and 7.1-fold in the fruiting bodies, while non-essential amino acids increased by 3.1-fold and 1.9-fold, respectively. Notably, taurine levels increased by 208.9-fold in the fruiting bodies and 89.8-fold in the medium. The abalone-based medium generally exhibited higher amino acid contents than the fruiting bodies. These findings demonstrate that abalone can serve as an effective fermentation platform for *C. militaris*, enabling simultaneous production of cordycepin and enhancement of amino acid content. This study highlights a biotransformation-based strategy to convert marine food resources into value-added functional materials, supporting the development of fermentation-driven nutraceutical applications.

References

[1] Shi, L. et al. Food Research International, 2020, 129, 108876.
[2] Turk, A. et al. *Natural Product Sciences*, 2021, 27, 187-192.

Acknowledgments: This work was supported by the National Research Foundation of Korea (NRF) (RS-2022-NR069422). We thank the Wando Agricultural Research Center for providing the abalone samples.

PP5

Isolation and Functionalisation of Natural Products from *H. novae-zealandiae*

Shuo Guo[1], Jonathan Sperry[1], Siew-Young Quek[1]

[1]*The University of Auckland, New Zealand*
sguo907@aucklanduni.ac.nz

Geranyl acetate (GA), a naturally occurring acyclic monoterpene ester present in the essential oils of several aromatic species, has emerged as a bioactive secondary metabolite with putative anti-inflammatory and cardioprotective activities. Despite these beneficial effects, its low solubility and high volatility limit its clinical applicability. Evidence suggests that complexation with β-cyclodextrin (β-CD) may enhance its bioavailability and improve its volatility. Thus, the aim of this study was to evaluate and compare the antihypertensive and cardioprotective effects of free and β-CD-complexed GA (GA+β-CD) in animal models. For antihypertensive study, blood pressure and heart rate were measured in male Wistar rats before and 48h after oral administration of free or complexed GA (50, 100, or 200 mg/kg). The cardioprotective effect was assessed in a murine model of doxorubicin-induced cardiotoxicity. After treatment, electrocardiographic parameters were analyzed. All experimental protocol was previously approved by the Animal Care Committee from UFS (#3618130423). Administration of free GA (50, 100, and 200 mg/kg) reduced blood pressure (8.5 ± 2.5%; 13.4 ± 1.1%, and 18.2 ± 0.3%, respectively) but induced reflex tachycardia. In contrast, GA+β-CD (200 mg/kg) significantly increased both the magnitude and duration of hypotension (24.1 ± 0.9 %) and induced bradycardia. In the murine model cardiotoxicity, doxorubicin prolonged the QTc interval (from 178 ± 3 to 262 ± 32 ms, $n = 5$, $p < 0.05$) and increased QRS duration (from 26 ± 3 to 37 ± 2 ms, $n = 5$, $p < 0.05$). These alterations were significantly ($p < 0.01$) attenuated by both free and complexed GA. In conclusion, GA, particularly when complexed with β-CD, demonstrates promising antihypertensive and cardioprotective effects, warranting further investigation.

References

[1] Rathee, S.et al., Farmacogn. 2012, 22, 459–474.
[2] Shimbo, M. et al., H. Nutr. Res. 2005, 25, 617–623.

Acknowledgment: This work was supported by the University of Auckland Doctoral Scholarship.

PP6

Olive Leaf Extract Supercritical Impregnation into Biodegradable Films for Active Food Packaging

Diego, Figueira[1], Noelia D., Machado[2], Lourdes, Casas[2], Carmen S. R., Freire[1], Cristina, Cejudo-Bastante[2], Carla, Vilela[1]

[1] *CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, Aveiro, Portugal*
[2] *Chemical Engineering and Food Technology Department, Wine and Agrifood Research Institute (IVAGRO), University of Cadiz, Puerto Real, Cadiz, Spain*
cvilela@ua.pt, ORCID: 0000-0002-9212-2704

The accelerating accumulation of food waste has intensified the search for sustainable food preservation strategies, particularly the development of active packaging systems capable of extending shelf-life [1]. In this context, biodegradable polymers derived from renewable resources and impregnated with natural bioactive extracts have emerged as a promising solution, especially when processed via eco-friendly supercritical solvent impregnation (SSI). This study utilizes olive leaf extract (OLE), an agri-food byproduct from the Mediterranean region, to exploit its well-documented antioxidant and antimicrobial properties [2]. OLE was incorporated into a poly (lactic acid) (PLA)-based film using SSI, a technique that operates under mild temperatures and facilitates efficient solvent recovery. The primary objective was to evaluate the impregnation kinetics of OLE in the PLA-based films, with the aim of optimizing the process conditions and supporting industrial scalability.

References

[1] Vilela, C. et al., *Trends in Food Science & Technology*, 2018, 80, 212–222.
[2] Verano-Naranjo, L. et al., *Journal of Food Engineering*, 2025, 397, 112582.

Acknowledgments: This work was developed within the scope of the project CICECO – Aveiro Institute of Materials, UID/50011/2025 (DOI 10.54499/UID/50011/2025) & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), financed by national funds through the FCT/MCTES (PIDDAC). This work is framed within the iM-PACK project, which is part of the PRIMA program supported by the European Union.

PP7

Targeting angiogenesis in fibroepithelial polyps: a phytotherapeutic approach using an oregano essential oil delivery system

Larisa, Bora[1,2], Stefana, Avram[1,2], Ioana-Zinuca, Magyari-Pavel[1,2], Daliana, Minda[1,2], Andreea, Alexandrescu-Bauer[1,2,3], Corina, Danciu[1,2]

[1] *„Victor Babes" University of Medicine and Pharmacy Timisoara, Faculty of Pharmacy, Department of Pharmacognosy-Phytotherapy*
[2] *Research and Processing Center for Medicinal and Aromatic Plants, „Victor Babes" University of Medicine and Pharmacy*
[3] *Doctoral School, „Victor Babes" University of Medicine and Pharmacy*
larisa.bora@umft.ro; ORCID: 0000-0002-9367-4770

Fibroepithelial polyps are benign cutaneous lesions characterized by fibrovascular cores and abnormal vascularization. *Origanum vulgare* L. essential oil (OEO) has attracted interest for cutaneous applications due to its biological activity, while modern delivery systems can improve its stability, bioavailability, and therapeutic performance [1].
This study evaluated, *in ovo*, the safety profile, angiogenic response, and histological changes induced by a polymeric micelles-based hydrogel containing OEO (OEO-PbH). In the HET-CAM test, OEO-PbH showed a good biocompatibility profile, with no signs of hemorrhage, coagulation, vascular lysis, or embryotoxicity, being classified as non-irritant. In the angiogenesis assay, OEO-PbH reduced the formation of new capillaries, producing a thinner and less interconnected vascular network compared with the blank formulation. Moreover, under leptin-stimulated conditions, OEO-PbH exerted a stronger inhibitory effect on vascular development, reducing the number of small-caliber blood vessels and limiting the leptin-induced angiogenic response. Histological examination of H&E-stained CAM sections supported these findings, revealing thinning of the allantoic ectoderm, changes in the mesodermal layer, and a reduced number and size of blood vessels after OEO-PbH treatment [2].
Concluding, the results indicate that OEO-PbH is a non-irritant and biocompatible formulation with promising anti-angiogenic activity *in ovo*, supporting its potential for further investigation in cutaneous pathologies associated with abnormal vascularization.

References
[1] Bora, L. et al., *Pharmaceuticals*, 2023, 16(7), 980.
[2] Avram, Ș. et al., *Pharmaceuticals*, 2023, 16(7), 940.

Acknowledgments: Project PN-III-P1-1.1-TE-2019-0130 funded this research.

PP8

Synergistic Antitumor Effects of Betulinic Acid Ionic Liquids and Paclitaxel in Breast Cancer Cells

Maya Guncheva[1], Paula-Ossowicz-Rupniewska[2], Yuliana Raynova[1]

[1] *Institute of Organic Chemistry with Centre of Phytochemistry, Bulgarian Academy of Sciences, Acad. G. Bonchev Str. Bl. 9, Sofia 1113, Bulgaria*
[2] *Department of Organic Chemical Technology and Polymer Materials, West Pomeranian University of Technology in Szczecin, Szczecin 71-065, Poland*
maya.guncheva@orgchm.bas.bg; https://orcid.org/0000-0003-2680-0105

Betulinic acid (BA), a pentacyclic triterpene found primarily in Betula species, demonstrates diverse bioactivities, including anticancer, antiviral, anti-inflammatory, immunomodulatory, anti-HIV, and anti-angiogenic effects [1]. Its clinical application is limited by poor aqueous solubility and low systemic bioavailability. Converting BA into organic salts offers a strategy to improve solubility and enable alternative delivery methods, potentially enhancing pharmacological efficacy [2]. Here, we report the synthesis and characterization of BA ionic liquids incorporating arginine ethyl ester, glutamine ethyl ester, choline, or 1-ethyl-3-methylimidazolium cations. While salt formation had minimal impact on water solubility, it significantly enhanced cytotoxicity and selectivity toward breast cancer cell lines, suggesting an altered bioactivity profile relative to the parent compound. Early treatment (5 h) with BA salts led to a mild, concentration-dependent increase in reactive oxygen species (1.2–1.6-fold). Importantly, combining low-toxic concentrations of BA (~1–10 μM) with sub-IC_{50} doses of paclitaxel synergistically inhibited the viability of MCF-7 and MDA-MB-231 cells, with the effect more pronounced in MCF-7 cells. These findings highlight the potential of BA ionic liquids in combination therapies to enhance anticancer efficacy in breast cancer models.

References

[1] Gheorgheosu, D. et al. *Anticancer Agents in Medicinal Chem*istry, 2014, 14(7):936-45.
[2] Suresh, C. et al. *Bioorganic and Medicinal Chemistry Letters,* 2012, 22(4):1734-8.

Acknowledgments: This work was supported by the Bulgarian National Science Fund under grant № KP-06-H69/2.

PP9

Anti-Leukemia Activity of Polysaccharide from *Sargassum fusiforme* via the PI3K/AKT/BAD Pathway *In Vivo* and *In Vitro*

Haomiao Ding[1,2] and Guoying Qian[1,2]

[1] *Hwamei College of Life and Health Sciences, Zhejiang Wanli University, Ningbo 315100, China*
[2] *College of Biological and Environmental Sciences, Zhejiang Wanli University, Ningbo 315100, China*
qiangy@zwu.edu.cn; ORCID:0000-0003-0917-9839

Marine sulfated polysaccharides have attracted considerable attention as functional food ingredients with potent antitumor activities. This study investigated the structural characteristics and anti-leukemic mechanism of a novel fucoidan (SFP 2205) extracted from the edible brown alga *Sargassum fusiforme*.
SFP 2205 was purified using DEAE-FF cellulose and Sephacryl S-200HR chromatography. Structural analysis revealed a molecular weight of 41.85 kDa and a monosaccharide composition of mannose, rhamnose, galactose, xylose, glucose, and fucose (14.2:9.4:11.8:13.7:11.0:38.3 molar ratio), with 19.64% sulfate content predominantly at the C-4 position of fucose residues as confirmed by FT-IR and NMR spectroscopy [1].
In vitro experiments demonstrated that SFP 2205 significantly inhibited human erythroleukemia (HEL) cell proliferation with an IC_{50} of 55.38 μg/mL, induced apoptosis, and arrested cell cycle at G0/G1 phase. Importantly, no cytotoxicity was observed against normal cells. In vivo studies using HEL xenograft mice showed dose-dependent tumor growth inhibition up to 79.29% at 80 mg/kg dosage, with >40 days survival extension and no discernible organ toxicity [1].
Mechanistically, Western blotting and qRT-PCR revealed that SFP 2205 downregulated PI3K and phosphorylated AKT, subsequently upregulating pro-apoptotic Bad and Caspase-9/3 while downregulating anti-apoptotic Bcl-xL. Rescue experiments using PI3K activator 740Y-P confirmed that SFP 2205 exerts anti-leukemic effects specifically through PI3K/AKT/Bad/Bcl-xL-mediated mitochondrial apoptosis [1].
These findings establish SFP 2205 as a potential functional food additive or adjuvant for leukemia prevention and treatment, highlighting the importance of sulfate groups in the biological activity of marine-derived polysaccharides.

References

[1] Du, H.F. et al., *Marine Drugs*, 2023, 21(5), 289.

Acknowledgments: This work was supported by General Scientific Research Project of Zhejiang Education Department (Y202249490) and Zhejiang Provincial Top Discipline of Biological Engineering

PP10

Cannabidiol as a Modulator of UV-Induced Sphingolipid Remodeling in Psoriatic Skin Cells

Wojciech, Łuczaj [1], Ernest, Gieniusz[1], M. Rosário, Domingues [2,3], Pedro, Domingues [2], Audrius Maruška[4], Elżbieta, Skrzydlewska [1]

[1] *Department of Inorganic and Analytical Chemistry, Medical University of Bialystok, Poland*
[2] *Mass Spectrometry Center,* LAQV-REQUIMTE*, Department of Chemistry, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal*
[3] *Department of Chemistry & CESAM, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal.*
[4] *Instrumental Analysis Open Access Centre, Faculty of Natural Sciences, Vytautas Magnus University, LT-44404 Kaunas, Lithuania.*
wojciech.luczaj@umb.edu.pl; ORCID 0000-0002-3992-1910

Sphingolipids, particularly ceramides, play a central role in maintaining epidermal integrity and regulating cellular signaling pathways involved in inflammation and barrier function. Dysregulation of ceramide composition has been implicated in the pathogenesis of psoriasis, a chronic inflammatory dermatosis characterized by impaired skin homeostasis.
Ultraviolet (UV) phototherapy remains a widely applied treatment strategy in psoriasis management; however, it is also associated with oxidative stress and alterations in lipid metabolism within the skin. These effects highlight the need for adjunctive agents capable of mitigating UV-induced damage. Naturally derived compounds with antioxidant and anti-inflammatory properties have gained attention in this context. Cannabidiol (CBD), a non-psychoactive constituent of *Cannabis sativa*, has emerged as a promising candidate due to its biological activity in skin-related disorders.
The present study investigated sphingolipid alterations in keratinocytes and fibroblasts derived from psoriatic patients in comparison to healthy controls. Additionally, the effects of topical CBD administration were evaluated in an experimental model involving UVA and UVB irradiation.
Lipidomic analysis using RPLC-QTOF-MS/MS revealed distinct shifts in ceramide subclasses in psoriatic cells, with increased representation of several ceramide species in both keratinocytes and fibroblasts, while others were reduced relative to controls. UV exposure further influenced sphingolipid metabolism, promoting ceramide accumulation and reducing sphingomyelin levels, suggesting activation of the sphingomyelin–ceramide pathway.
Application of CBD resulted in differential modulation of these lipid changes depending on the type of UV radiation. Notably, CBD influenced ceramide levels and was associated with alterations in sphingomyelin turnover, indicating a regulatory effect on enzymes involved in sphingolipid metabolism.
Overall, these findings highlight the interplay between UV radiation, sphingolipid dynamics, and natural bioactive compounds in the context of psoriasis. Cannabidiol may contribute to restoring epidermal balance and improving barrier function, supporting its potential as a complementary therapeutic agent in dermatological applications.

Acknowledgments: Cooperation between coauthors has been supported by the Polish National Agency for Academic Exchange under the “Strategic Partnerships” Programme (project no. BPI/PST/2024/1/00008).

PP11

Mechanistic Insights into the Osteoprotective Effects of *Clematis montana* on Glucocorticoid-Induced Osteoporosis via Systems Pharmacology and Zebrafish Phenotypic Assays

Wen-Ying Lin[1], Yi-Tzu Lin[2,3], Chia-Ying Li[4], Cheng-Huan Peng[5,6], Ming-Der Lin[1,3,7]

[1] *Institute of Medical Science, Tzu Chi University, Hualien 970374, Taiwan*
[2] *School of Pharmacy, Tzu Chi University, Hualien 970374, Taiwan*
[3] *Center for Herbal Medicine and Natural Products Research, Tzu Chi University, Hualien 970374, Taiwan*
[4] *Department of Applied Chemistry, National Pingtung University, Pingtung 90003, Taiwan*
[5] *Department of Orthopedics, Hualien Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Hualien 970473, Taiwan*
[6] *School of Medicine, Tzu Chi University, Hualien 970374, Taiwan*
[7] *Department of Molecular Biology and Human Genetics, Tzu Chi University, Hualien 970374, Taiwan*
mingder@gms.tcu.edu.tw; ORCID: 0000-0003-3411-5685

Clematis montana Buch.-Ham., commonly known as Chuan-Mu-Tong (CMT), is a Traditional Chinese Medicine (TCM) utilized for its diuretic and anti-inflammatory properties. In TCM theory, CMT is also used to treat “kidney essence deficiency,” a condition closely correlated with osteoporosis. In this study, we employed a systems pharmacology framework that integrates LC-MS/MS-based chemical profiling, in silico target prediction, and in vivo transcriptomic validation to systematically explore the therapeutic effects of *Clematis montana* on bone homeostasis using a zebrafish model of glucocorticoid-induced osteoporosis (GIOP) [1]. Zebrafish larvae were treated with dexamethasone (Dex) to induce GIOP, followed by administration of CMT water extracts. Bone mineralization and osteoblast activity were quantified via calcein staining and transgenic zebrafish expressing GFP-labeled osteoblasts. Six primary active components, including the lignan syringaresinol, were identified through LC-MS/MS analysis and found to exhibit synergistic effects on osteoblast differentiation and mineralization. Network pharmacology and transcriptomic analysis further revealed that CMT targets key regulators such as NF-κB, AP-1, EGFR, and HIF1A. These targets modulate several critical pathways, including IL-17, TNF-α, and estrogen signaling. This multifaceted approach underscores the therapeutic potential of CMT in restoring bone homeostasis. In conclusion, our findings demonstrate that CMT water extract enhances osteogenesis by suppressing the TNF-α/NF-κB signaling axis, effectively reversing the transcriptional repression of bone-formation genes and offering a robust scientific rationale for its clinical application in GIOP treatment.

Reference

[1] Peng, C.H., et al. *Journal of Ethnopharmacology*, 2022, 297, 115565.

Acknowledgments: This work was funded by the Collaborative Grant from the Tzu Chi Medical Foundation, Tzu Chi University, and Academia Sinica (Grant No. TCAS-112-03) to M.D.L. The authors acknowledge the technical support of UPLC/Q-TOF-MS/MS provided by TMU Core Facility; and are grateful for the support from the Core Facility Center, Tzu Chi University.

PP12

Enhanced bioactivity and terpene preservation in *Cannabis sativa* using sequential High-pressure-CO_2 extraction

Rita Silva-Reis[1,2], Catarina Cunha[3], Helena Oliveira[3], Miguel P. Batista[4], Agostinho Alexandre[4], Ana A. Matias[4], Artur M. S. Silva[1], Paula A. Oliveira[2,5], Susana M. Cardoso[1]

[1] *LAQV-REQUIMTE, Department of Chemistry, University of Aveiro, 3810-193 Aveiro, Portugal;*
[2] *CITAB, Inov4Agro, University of Trás-os-Montes and Alto Douro, 5000-801 Vila Real, Portugal;*
[3] *Department of Biology and CESAM, University of Aveiro, 3810-193 Aveiro, Portugal;*
[4] *Canna.Biz, 2560-580 Torres Vedras, Portugal;*
[5] *Clinical Academic Center of Trás-os-Montes and Alto Douro, University of Trás-os-Montes and Alto Douro, 5000-801 Vila Real, Portugal*
reis.rita@ua.pt ; ORCID 0000-0002-2463-5655

The medicinal application of *Cannabis sativa* relies on the efficient extraction of bioactive cannabinoids and terpenes [1]. As demand for safe formulations grows, evaluating sustainable alternatives to conventional organic solvents is critical. This study compares the impact of high-pressure-CO_2 extraction (HP-CO_2) against traditional hexane-based ultrasound-assisted extraction (UAE) on the phytochemical profile and *in vitro* bioactivity of *C. sativa*.

For UAE, flowers underwent thermal decarboxylation followed by hexane extraction. Conversely, the HP-CO_2 utilized sequential fractionation: an initial pure CO_2 phase captured volatile terpenes (HP-Terpene), followed by an ethanol co-solvent phase to extract cannabinoids, which were later decarboxylated (SFE-Cannabinoid). Profiles were characterized via GC-MS and LC-MS. Bioactivity was evaluated using MTT assays on human Caco-2 cells (2.5–160 µg/mL; 24–72 h).

While both methods achieved comparable yields (≈30%), phytochemical profiles diverged significantly. Pre-extraction heating in UAE caused substantial volatile loss, yielding an extract with 97% cannabinoids but only 0.89% terpenes. The HP-CO_2 successfully preserved these thermolabile compounds. The HP-Terpene fraction concentrated 70% of terpenes (predominantly β-caryophyllene and selina-3,7(11)-diene), while the HP-Cannabinoid fraction retained 95% cannabinoids (mainly Δ^9-THC) and 4% terpenes.

Both extracts induced time- and dose-dependent reductions in Caco-2 viability (<20% at ≥40 µg/mL). Notably, the HP-Cannabinoid fraction exhibited superior bioactivity compared to UAE, confirmed by consistently lower IC_{50} values (14.41 µg/mL vs. 15.80 µg/mL at 72 h).

Sequential HP-CO_2 selectively fractionated *C. sativa* while avoiding the thermal degradation inherent in conventional methods. This enhanced *in vitro* potency highlights the value of sustainable extraction technologies.

References

[1] Radwan, M.M. et al., Molecules 2021, 26, 604

Acknowledgments: We thank the financial support from PT national funds (FCT/MCTES, Fundação para a Ciência e Tecnologia and Ministério da Ciência, Tecnologia e Ensino Superior) through the projects UID/50006/2025-LAQV-REQUIMTE, and UID/04033/2025: CITAB and LA/P/0126/2020 (https://doi.org/10.54499/LA/P/0126/2020),to CESAM UID/50017/2025 (doi.org/10.54499/UID/50017/2025) and LA/P/0094/2020 (doi.org/10.54499/LA/P/0094/2020) by national funds through FCT. R.S.-R. thanks FCT/MCTES for the PhD grant ref. 2022.14518.BD. C.C. acknowledges BMRex project (funded by EU Horizon Europe Grant 101099528, supported by UK Innovation funding agency Grant 10062709) for the research Grant BI/UI88/11875/2024. Susana M. Cardoso thanks FCT/MCTES for the labour contract under the Scientific Employment Stimulus—Institutional Call. We acknowledge Vitalis Equipment Technology Inc., the manufacturer of the CO_2 high-pressure extraction and downstream processing equipment installed at Canna.Biz facilities and used to produce the full-spectrum extract studied herein.

PP13

Red Ginseng-Derived Extracellular Nanovesicles as a Modulator of Osteoblastogenesis and Osteoclastogenesis for Osteoporosis

Dong-ha Kim[1], Jae-Hee Kwon[1], Bum-Joon Koo[1], Young-Eun Cho[1]

[1] *Gyeongkuk National University, Andong 36729, Republic of Korea*
yecho@gknu.ac.kr; ORCID: 0000-0001-9864-0265

Osteoporosis is a skeletal disorder characterized by an imbalance between bone formation and resorption, which leads to progressive bone loss and increased fracture risk. While current treatments target either the inhibition of bone resorption or stimulation of bone formation, their long-term use is associated with adverse effects, necessitating alternative therapeutic approaches. To investigate the anti-osteoporotic potential of RGNVs, in vitro and in vivo studies were performed using MC3T3-E1 cells, primary mouse osteoblasts, and an ovariectomy (OVX)-induced osteoporosis model. Osteoblast differentiation and mineralization were examined by alkaline phosphatase activity, calcium deposition, and osteogenic gene/protein expression. In OVX mice, the effects of RGNVs on bone loss were assessed by bone microarchitecture, histological changes, and bone metabolism-related parameters. The RGNVs were successfully isolated and characterized, revealing a lipid bilayer structure enriched in bioactive ginsenosides and functional proteins. In vitro, RGNVs promote osteoblast proliferation, differentiation, and mineralization while suppressing osteoclast differentiation and bone resorption by modulating the BMP-2/Smad and MAPK signaling pathways. In an ovariectomy-induced osteoporosis mouse model, oral administration of RGNVs significantly restored bone volume and mineral density, and biodistribution studies confirmed their preferential accumulation in the bone tissue. Systemic toxicity evaluation indicated no adverse effects, supporting the safety of RGNVs for therapeutic use. These findings suggest that RGNVs regulate bone remodeling through a dual mechanism, to stimulate bone formation and inhibit bone resorption, thereby offering a promising and well-tolerated approach for osteoporosis management.

References

[1] Matsuo, K. et al. *Archives of biochemistry and biophysics,* 2008, *473*(2), 201-209.
[2] Hwang, J. H. et al *Journal of Controlled Release*, 2023, *355*, 184-198.

Acknowledgments: This work was supported by National Research Foundation of Korea (NRF) grant funded by Korea government (MSIT) (No. 2024-00340542).

PP14

From Microalgal Pigments to Photoprotection: Bioactive Potential of *Chlorella* sp. and *Raphidonema* sp. Extracts

Vera Castro[1,2,3], Bruna Silva[2,3], Franklin Chamorro[4], Celina Parreira[5], Sara M. Badenes[5], Luís Costa[5], Miguel A. Prieto[4] d, Rui Oliveira[4], Alberto C.P. Dias[2,3]

[1] *Centre for the Research and Technology of Agro-Environment and Biological Sciences, (CITAB), Inov4Agro, University of Trás-os-Montes and Alto Douro (UTAD), Quinta de Prados, 5000-801, Vila Real, Portugal*
[2] *Centre of Molecular and Environmental Biology (CBMA), Department of Biology, Campus of Gualtar, University of Minho, 4710-057, Braga, Portugal*
[3] *IBS, Institute of Science and Innovation for Bio-Sustainability, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal*
[4] *Nutrition and Bromatology Group, Department of Analytical Chemistry and Food Science, Instituto de Agroecoloxía e Alimentaci´on (IAA)—CITEXVI, Universidade de Vigo, 36310, Vigo, Spain*
[5] *A4F – Algae for Future, Campus do Lumiar, Estrada do Paço do Lumiar, Edif. E, R/C, 1649-038, Lisboa, Portugal*
albertocpdias66@gmail.com, ORCID: 0000-0003-3641-3248

The skin is continuously exposed to ultraviolet (UV) radiation and environmental stressors that promote the overproduction of reactive oxygen species (ROS), leading to oxidative stress associated with premature aging, inflammation, and extracellular matrix degradation. In this context, there is increasing interest in natural bioactive compounds with multifunctional antioxidant, enzyme-modulating, and photoprotective properties. Microalgae have emerged as sustainable sources of pigment-rich extracts with recognized biological activities.

This study aimed to evaluate the bioactive potential of pigment-enriched extracts from *Chlorella* sp. and *Raphidonema* sp., focusing on antioxidant activity, enzyme inhibition, photoprotective capacity, and cellular effects in HaCaT keratinocytes.

Pigment analysis confirmed the presence of chlorophylls, carotenoids, and xanthophylls in both species. Antioxidant activity revealed that *Raphidonema* sp. exhibited strong radical scavenging capacity (ABTS: 43%) and reducing power (FRAP: 21.28 µM Fe^{2+} equivalents), while *Chlorella* sp. showed pronounced iron-chelating ability (89%). Enzymatic assays demonstrated moderate inhibition of tyrosinase (around 15%) and hyaluronidase (around 57%) for both extracts. Additionally, both extracts exhibited relevant in vitro SPF values at 1 mg/mL (around 25), indicating UV-absorbing potential.

Cell-based assays confirmed their biological relevance. Both extracts were cytocompatible and significantly improved cell viability following UV-induced damage (approximately 60–70%), compared to UV-treated controls. Furthermore, intracellular ROS levels were markedly reduced, with values approaching those of non-irradiated cells under optimal conditions.

Overall, these results highlight the complementary and multifunctional bioactivities of Chlorella sp. and Raphidonema sp. extracts, supporting their potential as promising ingredients for the development of innovative skin care formulations.

Acknowledgments: V. Castro acknowledges Portuguese Foundation for Science and Technology (PD/BD/150264/ 2019) under the Doctoral Programme “Agricultural Production Chains – from fork

to farm" (PD/00122/2012) and the Financiamento Plurianual de Unidades de I&D UIDB/04050/2020 (https://doi.org/10.544 99/UIDB/04050/2020). Also grants to CITAB (UIDB/04033/2020) and CBMA (UIDB/04050/2020). Grant POCI-01-0247-FEDER-033784, Project N◦ 33784, Ram´on y Cajal grant for M.A. Prieto (RYC-2017-22,891), and Xunta de Galicia grant EXCELENCIAED431F 2020/12 that supports the work of F. Chamorro.

PP15

Deep Eutectic Propolis Extract as an ingredient in Natural Lip Balm

Nicolas A., Justus[1,2,3*], Maria F., Sousa[1,2,3], Sandra, Barbosa[1,4,5,6], Ana R., Circuncisão[6], Cristina, Almeida-Aguiar[5], Julie, Queffelec[8], Kai L., Baltrusch[8], Herminia, Domínguez[8], Paulo C., Kirnev[3], Maria J., Sousa[2], Susana M., Cardoso[6]

[1] *Montesino – Organic Beekeeping, 5300-358, Bragança, Portugal;*
[2]*Instituto Politécnico de Bragança, 5300-252, Bragança, Portugal;*
[3]*UTFPR,Universidade Tecnológica Federal do Paraná, 84017-220, Ponta Grossa, Brasil;*
[4]*CITAB, University of Trás-os-Montes and Alto Douro, 5000-801, Vila Real, Portugal;*
[5]*CBMA, Department of Biology, University of Minho, 4710-057, Braga, Portugal;*
[6]*LAQV-REQUIMTE, Department of Chemistry, University of Aveiro, 3810-193, Aveiro, Portugal;*
[7]*Research Centre for Active Living and Wellbeing (LiveWell), Instituto Politécnico de Bragança, 5300-252, Bragança, Portugal.*
[8]*CINBIO, Universidade de Vigo, Departament of Chemical Engineering, Faculty of Sciences, Campus Ourense, Edificio Politécnico, As Lagoas, 32004 Ourense, Spain*
susanacardoso@ua.pt, ORCID 0000-0002-7882-737

Propolis is a phenolic-rich bee product with antioxidant and antimicrobial properties, making it a promising natural ingredient for health applications [1]. This study investigated the use of Natural Deep Eutectic Solvents (NADES) for recovering bioactive compounds from propolis collected in Montesinho Natural Park, and its incorporation into a naturally derived lip balm formulation.

Biphasic NADES systems based on menthol:lauric acid (Men:LA, 4:1), combined either with proline:citric acid (1:1) or ultrapure water, were evaluated using ultrasound-assisted extraction with a UP400S ultrasonic probe (400 W, 24 kHz). Among the systems tested, the apolar phase composed of Men:LA (4:1) exhibited the highest antioxidant activity (DPPH 41–46 AAE/mL extract; ABTS ~45 mg AAE/mL extract). The phenolic richness of the optimized Men:LA extract was confirmed by UHPLC-ESI-DAD-MS analysis, revealing a high abundance of flavonoids (e.g., chrysin, pinobanksin derivatives, galangin, pinocembrin, naringin) and phenolic acids (e.g., caffeic, *p*-coumaric, and ferulic acids) and their esterified derivatives.

The extract was directly incorporated into a fully natural anhydrous lip balm (beeswax, coconut oil, almond oil), providing good emollience and sensorial properties, with physicochemical stability confirmed under accelerated conditions [2].

Overall, Men:LA proved to be a robust green solvent for producing propolis extracts that can be directly formulated into stable lip balms, offering a sustainable alternative to conventional ethanolic extracts.

References

[1] Machado, B.A.S. et al. PLoS One, 2016, 11 (1).
[2] ISO. ISO/TR 18811:2018 – Cosmetics — Guidelines on the stability testing of cosmetic products, 2018.

Acknowledgments: Financial support from PRR (Recovery and Resilience Plan, Adult Impulse Program, Mountain Consortium for Knowledge) through an Innovation Scholarship awarded to M.F. Sousa and N. Justus in collaboration with Montesino; BioCosMap project (COMPETE2030 – FEDER

- 02162400), co-financed by FEDER through COMPETE2030 under the PT2030 program. PT national funds (FCT/MECI), through the projects: UID/50006/2025, DOI 10.54499/UID/50006/2025 (LAQV) and UID/6157/2023 (LiveWell); Universidade da Xunta de Galicia (GRC-ED431C 2022/08). S.M. Cardoso thanks FCT/MCTES funding through the Institutional Call to Scientific Employment Stimulus.

PP16

Exploring the Functional Properties of *Fucus vesiculosus* as a Sustainable Source of Antioxidant and Antibacterial Ingredients

Marian, Nóbrega[1], Ana Calado, Ana R. Circuncisão, Sónia, S. Ferreira[1], Adelaide Almeida, Susana, Marcelo, D. Catarino[1], M. Cardoso[1]

[1] *LAQV-REQUIMTE, Department of Chemistry, University of Aveiro, 3810-193, Aveiro, Portugal*

mcatarino@ua.pt; 0000-0001-6571-7975s

Given the rising interest in substituting synthetic additives with natural alternatives, marine macroalgae have emerged as a prominent reservoir of bioactive molecules [1,2]. This investigation explored the biochemical profile and functional attributes of aqueous extracts derived from *Fucus vesiculosus* to determine their viability as natural food preservatives. Utilizing both cold and hot water extraction methods, the study quantified total phenolics and phlorotannins through Folin-Ciocalteu and DMBA assays, respectively, and carbohydrate concentrations by the Dubois method, with a specific emphasis on characterizing essential monosaccharides. The antioxidant efficacy was further tested through $ABTS^{\bullet+}$ scavenging and FRAP assays and the antimicrobial properties were tested against methicillin-resistant *Staphylococcus aureus* (MRSA), a critical pathogen in food safety.

The findings revealed that hot extraction yielded the highest recovery (43.2%) and a superior carbohydrate content. These extracts were particularly rich in fucose, suggesting a more effective liberation of fucoidans under heated conditions. Interestingly, both extraction temperatures resulted in comparable antioxidant effects (IC_{50} of approximately 300 µg/mL) and nearly identical levels of phenolic and phlorotannin constituents samples (approximately 2.3 g GAE/100 g and 0.4 g PGE/100 g of extract, respectively). Regarding antimicrobial performance, both extracts successfully suppressed MRSA growth at 20 mg/mL. For bactericidal effects higher dosages would be required. Collectively, these data suggest that *Fucus vesiculosus* could be exploited as a sustainable source of bioactive ingredients. The demonstrated antioxidant and antibacterial properties validate its potential integration into food systems as an effective natural preservative, offering a bio-based solution to extend shelf life and enhance safety.

References

[1] Afonso, N. C. et al. Antioxidants 2019, 8 (9), 365

[2] Surendhiran, D.; et al. International Journal of Food Microbioly 2021, 358, 109416

Acknowledgments: Thanks are due to the University of Aveiro and FCT – Fundação para a Ciência e a Tecnologia/MCT (Portugal) for the financial support for the research Unit LAQV/REQUIMTE (UID/50006/2025, DOI 10.54499/UID/50006/2025) through national funds and, where applicable, co-financed by the FEDER- Fundo Europeu de Desenvolvimento Regional, within the PT2020 Partnership Agreement.

Susana M. Cardoso thanks FCT/MCTES for the labor contract under the Scientific Employment Stimulus— Institutional Call. Marcelo D. Catarino acknowledge his research contract under the project COMPETE2030-FEDER-00782300

PP17

Bacteriophage-Based Biocontrol of Psychrotrophic *Pseudomonas* spp. in Low-Sodium Cheese Production

Inês, Mendonça[1], Jo, Matos[1], Inês, Chaves[1], Carla, Pereira[1], Simone, Lopes[2], Jaime, Fernandes[2], Nuno, Alvarenga[2], Joaquin, Rodriguez, Pinilla[3], Rafael, Tabla[3], Adelaide, Almeida[1]

[1] *CESAM, Department of Biology, University of Aveiro, Aveiro 3810-193, Portugal*
[2] *INIAVE, National Institute for Agrarian and Veterinary Research, 2780-157 Oeiras, Portugal*
[3] *CICYTEX, Instituto Tecnológico Agroalimentario de Extremadura, Badajoz 06071, Spain*
ineslm3@ua.pt; ORCID 0009-0003-6692-5356

The dairy industry's transition toward sodium-reduced cheeses, driven by global public health initiatives, may inadvertently compromise microbial stability and food quality. Reduced salt concentrations weaken the antimicrobial barrier, promoting the proliferation of psychrotrophic spoilage bacteria, particularly *Pseudomonas lundensis* and *Pseudomonas taetrolens*. These opportunistic microorganisms commonly dominate cold-stored milk and produce thermostable proteases and lipases that survive pasteurization, leading to severe structural defects, including curd softening, as well as the development of undesirable volatile off-flavours that markedly reduce product shelf-life.

To address this important food quality and safety challenge, the present study evaluated bacteriophage-based biocontrol as a targeted intervention strategy. Three strictly lytic bacteriophages (C7GGH, AR2_7H, and AR1_8) were successfully isolated from cheese processing environments. *In vitro* assays demonstrated strong antibacterial efficacy, with rapid bacterial inactivation, reducing bacterial counts by up to 7.03 log CFU/mL within 12 h. Importantly, the phages exhibited a highly specific, narrow host range, selectively targeting spoilage-associated strains without affecting beneficial starter and fermentation microbiota.

To assess their suitability for dairy applications, phage stability under processing-relevant physicochemical conditions was investigated. The phages retained high infectivity across cold-ripening temperatures (4-16 °C), a broad pH range, and elevated salinity conditions, including concentrations of up to 18% NaCl and KCl. In addition, whole-genome sequencing confirmed their genomic safety for food applications, revealing strictly virulent lifestyles and the absence of virulence factors, toxin-encoding genes, and antimicrobial resistance determinants. These findings demonstrate the potential of bacteriophage- based biocontrol as a safe and environmentally sustainable strategy to mitigate Pseudomonas-associated spoilage in low-sodium cheeses. The application of these phages may provide dairy producers with an effective tool to preserve structural integrity, sensory quality, and shelf-life while supporting the development of healthier, reduced-sodium dairy products that comply with stringent food safety standards.

Acknowledgments: This work was supported by national funds through FCT – Fundação para a Ciência e a Tecnologia I.P., which provides financial support to CESAM (Centre for Environmental and Marine Studies) UID/50006 + LA/P/0094/2020 (doi.org/10.54499/LA/P/0094/2020). The research was also supported by the TID4AGRO Project (0100_TID4AGRO_4_E). FCT also supported this work through funding the PhD grant 2025.05155.BD and through the attribution of a research contract to Carla Pereira within the scope of the project Phage@Kiwifruit—Bacteriophages in the control of kiwifruit canker caused by *Pseudomonas syringae* pv. actinidiae (Psa) (2024.05721.RESTART).

PP18

Toxicological evaluation of crude ethanolic extract of *Passiflora foetida*

Juliane, Silva[1,2], Everlaine, Santos[3], Fernanda, Silva[3], Jonata, Flor[3], Daniel, Almeida[1], Bianca, Campêlo[1], Cícero, Silva[1], Fernanda, Andrade[1], Nathália, Barbosa[1], Marcelo, Melo[1], Jorge, Oliveira[4], Danielle, Leal[1], Maria, Borges[1], Jamylle, Ferro[3], Laurent, Picot[5], Jackson, Almeida[6]

[1] *State University of Health Sciences of Alagoas, Brazil*
[2] *Federal University of Cariri, Brazil*
[3] *Federal University of Alagoas, Brazil*
[4] *University of São Paulo, Brazil*
[5] *La Rochelle University, France*
[6] *Federal University of the São Francisco Valley, Brazil*
juliane.cabral@uncisal.edu.br; ORCID:0000-0003-3098-1885

Passiflora species traditionally used in folk medicine contain a wide array of bioactive metabolites, including alkaloids and flavonoids, recognized for their therapeutic potential. In this context, the present study aimed to evaluate the toxicity of the crude ethanolic extract from the leaves of *Passiflora foetida*, to support its safe and evidence-based application in human health. Cytotoxicity was assessed in human keratinocytes (HaCaT) using the MTT assay after 72 hours of exposure (0.015–2 mg/mL), accompanied by morphological analysis. *In vivo* toxicity was examined in *Artemia salina* and mice (*Mus musculus*) using acute (2 g/kg) and subacute (300–900 mg/kg for 28 days) protocols [1.2], with monitoring of physiological parameters and histopathological evaluation of major organs. The study received CEUA approval and was registered in SISGen. Statistical significance was set at $p < 0.05$. The extract exhibited a concentration-dependent cytotoxic response, with cell viability preserved at concentrations ≤0.06 mg/mL and a significant reduction from 0.125 mg/mL onward, exceeding 50% inhibition at higher doses. Morphological alterations (cytoplasmic retraction, cell rounding, and loss of adhesion) were consistent with these findings. The *Artemia* assay also revealed dose-dependent toxicity, with an LD50 of 151.5 µg/mL. In mice, no clinical signs, behavioural alterations, or mortality were observed. Body weight, food intake, and water consumption remained stable throughout the experimental period. Histopathological analyses demonstrated preserved tissue architecture, without evidence of inflammation, necrosis, or degenerative processes. In summary, *Passiflora foetida* extract showed low toxicity under the evaluated conditions, while displaying dose-dependent cytotoxicity in vitro. These results support its preliminary safety profile and reinforce the importance of extract standardization for future applications in human health.

References

[1] OECD. Test No. 408: Repeated Dose 90-Day Oral Toxicity Study in Rodents. OECD Guidelines for the Testing of Chemicals, Section 4, 2018.
[2] OECD. Test No. 425: Acute Oral Toxicity: Up-and-Down Procedure. OECD Guidelines for the Testing of Chemicals, Section 4, 2022.

Acknowledgments: CAPES, CNPq e FAPEAL

PP19

Invasive Halophytes in Southern Portugal: From Ecological Challenge to Bioactive and Biotechnological Opportunities

Luísa Custódio[1], Maria João Rodrigues[1]

[1]*Centre of Marine Sciences (CCMAR/CIMAR LA), University of Algarve, Faculty of Sciences and Technology, Building 7, Campus of Gambelas, 8005-139 Faro, Portugal*
lcustodio@ualg.pt; ORCID 0000-0003-4338-7703

Biological invasions are among the major drivers of biodiversity loss and ecosystem degradation, particularly in coastal and transitional environments already affected by climate change, salinisation and anthropogenic pressure. In southern Portugal, several invasive or potentially invasive salt-tolerant plant species occur in coastal dunes, saltmarshes, wetlands, riparian areas and disturbed habitats, where they may alter native plant communities, ecosystem functioning and landscape dynamics. However, these species also represent abundant and underexplored biomass that may contain valuable phytochemicals with potential applications in food, feed, cosmetics, agriculture and biotechnology. Within the framework of the SaltyBEATS (BiodivNBS/0015/2023) and (REVALGAE EAPA_0130/2024, Interreg Atlantic Area) projects, this work presents a preliminary survey of invasive halophytes and salt-tolerant plants occurring in southern Portugal, with emphasis on *Carpobrotus edulis*, *Acacia saligna*, *Cotula coronopifolia*, *Arundo donax* and *Spartina densiflora*. The poster highlights their ecological distribution, invasive traits, ethnobotanical or historical curiosities, and potential impacts on local ecosystems. In parallel, available information on their chemical composition and biological activities is explored, including the presence of phenolic compounds, flavonoids, terpenoids, polysaccharides, fibres and other bioactive metabolites. Reported biological properties such as antioxidant, antimicrobial, anti-inflammatory, enzyme-inhibitory, phytotoxic or biostimulant activities are also discussed, whenever available. By combining ecological monitoring with biotechnological screening, this work aims to reframe invasive halophytes not only as environmental challenges, but also as potential sources of functional ingredients, bioactive extracts and value-added products. This approach may contribute to circular bioeconomy strategies, supporting the sustainable management of invasive biomass while generating new opportunities for blue and green biotechnology. Nevertheless, any valorisation pathway must be carefully aligned with ecological risk management, avoiding further dissemination and ensuring that biomass use contributes to control, restoration and conservation goals.

Acknowledgments: This study received portuguese national funds from FCT - Foundation for Science and Technology through contracts UID/04326/2025, UID/PRR/04326/2025, and LA/P/0101/2020 (DOI:10.54499/LA/P/0101/2020). This work also benefited from funding from the projects SaltyBeats (BiodivNBS/0015/2023, https://doi.org/10.54499/BiodivNBS/0015/2023) and REVALGAE (EAPA_0130/2024, Interreg Atlantic Area), co-funded by the European Union. In Portugal, national co-funding provided by APA—Agência Portuguesa do Ambiente. MJR was supported by FCT (DOI: 10.54499/UIDP/04326/2025). This work was also conducted under the framework of the COST Action CA22144 (Sustainable Use of Salt-Affected Land' - SUSTAIN), with support from COST (European Cooperation in Science and Technology).

PP20

From Toxic Weed to Bioactive Resource: Organ-Specific Phytochemical Diversity and Cytotoxic Profiling of *Agrostemma githago* L.

Izabela Nawrot-Hadzik[1], Aleksander Smakosz[1], Anna Choromańska[2], Adam Matkowski[1]

[1]*Division of Pharmaceutical Biology and Botany, Department of Pharmaceutical Biology and Biotechnology, Faculty of Pharmacy, Wroclaw Medical University, Poland*
[2] *Department of Molecular and Cellular Biology, Faculty of Pharmacy, Wroclaw Medical University, Poland*
izabela.nawrot-hadzik@umw.edu.pl; ORCID: 0000-0002-5797-7336

Agrostemma githago L., historically regarded as a toxic agricultural weed due to seed-associated triterpenoid saponins and ribosome-inactivating proteins, remains insufficiently explored in terms of the phytochemical composition and biological activity of its herb and roots.
Eighty-percent methanolic extracts from herb and roots were fractionated and analyzed using HPLC-DAD-ESI-HR-MS, revealing pronounced organ-specific metabolic differentiation. The herb extract contained both C-glycosyl flavonoids (orientin, isoorientin, vitexin derivatives) and diverse triterpenoid saponins, whereas root-derived fractions were predominantly enriched in gypsogenin-, oleanolic acid-, and quillaic acid-type saponins.
Biological activity was evaluated in vitro using the MTT assay on melanoma (A375) and squamous cell carcinoma (A431) cell lines, selected as skin-related cancer models with high sensitivity to oxidative and membrane-disruptive stress, alongside normal human fibroblasts and keratinocytes as non-malignant counterparts. A clear composition–activity relationship was observed: saponin-rich fractions demonstrated pronounced cytotoxic effects, while flavonoid-dominant fractions exhibited substantially weaker activity. Assessment of normal cells enabled preliminary characterization of cytotoxicity profiles and identification of concentration ranges associated with reduced adverse effects.
Selected fractions were further examined using ROS generation and apoptosis/necrosis assays to explore potential differences between membrane-interactive saponins and redox-modulating flavonoids.
These findings expand current knowledge of *Caryophyllaceae* phytochemistry and highlight *A. githago* as a chemically diverse and biologically active plant species with distinct organ-specific profiles.

Acknowledgments: Funding: This research was supported by the RIP-SAPO grant from the Polish National Science Center (NCN) No. 2020/39/I/NZ7/01515.

PP21

Microencapsulation of elderflower extract using inulin and polydextrose: A strategy for enhanced stability and bioactivity

Milica Radan[1], Anna Stasiłowicz-Krzemień[2], Zorana Mutavski[1], Jelena Mudrić[1], Ana Alimpić Aradski[3], Katarina Šavikin[1], Tatjana Stević[1], Judyta Cielecka-Piontek[2], Nada Ćujić Nikolić[1]

[1] *Institute for Medicinal Plants Research "Dr. Josif Pančić", Tadeuša Košćuška 1, 11000, Belgrade, Serbia*
[2] *Department of Pharmacognosy and Biomaterials, Faculty of Pharmacy, Poznan University of Medical Sciences, Rokietnicka 3, 60-806 Poznan, Poland*
[3]*University of Belgrade-Faculty of Biology, Institute of Botany and Botanical Garden, "Jevremovac", Studentski trg 16, 11000 Belgrade, Serbia*

mradan@mocbilja.rs

Elderflowers (*Sambuci flos* L.) has attracted considerable scientific and commercial interest due to its abundance of polyphenols and flavonoids, which confer anti-inflammatory, antimicrobial, and antioxidant properties supporting its traditional and potential therapeutic applications in respiratory health, atherosclerosis prevention, and diabetes management [1,2]. This study aimed to develop advanced delivery systems of elderflower extract for potential nutraceutical and pharmaceutical use through the establishment of a feasible encapsulation process employing the biocompatible polymers inulin and polydextrose. Microencapsulates obtained by spray-drying were evaluated in terms of stability, bioactivity, technological performance, and functional properties. Intermolecular hydrogen bonding enabled successful entrapment of bioactives within the polymer matrices, improving the thermal stability of the powders. The biological effects of elderflower extracts were primarily attributed to their high polyphenol content, with chlorogenic acid and rutin identified as major constituents. Stability studies demonstrated that inulin and polydextrose effectively preserved the phenolic profile of the powders during storage. Furthermore, the microencapsulated extracts exhibited strong antioxidant capacity, promising hypoglycemic potential, and notable antimicrobial activity. Overall, the findings highlight the efficiency of inulin and polydextrose as natural carriers for the stabilization and delivery of phenolic-rich elderflower extracts, supporting their application in functional food and pharmaceutical formulations.

References

[1] Nawirska-Olszańska, A. et al. *Foods*, 2024, 13(16), 2560.
[2] Studzińska-Sroka, E. et al. *Molecules,* 2024, 29(23), 5775.

PP22

Sulforaphane enhances the inhibitory activity of agomiR-93 on the expression of proinflammatory genes induced by *Pseudomonas aeruginosa* in Cystic Fibrosis IB3-1 cells

Alessia Finotti[1], Federica di Padua[1], Giulia Breveglieri[1], Giuseppe Sabbioni[1], Chiara Tupini[1], Ilaria Lampronti[1], Monica Borgatti[1], and Roberto Gambari[1]

[1]*Department of Life Sciences and Biotechnology, Ferrara University, I-44121 Ferrara, Italy;* alessia.finotti@unife.it

Cystic fibrosis (CF) is an inherited genetic disease characterized by the following clinical and biochemical features: (a) dysregulation of the cystic fibrosis transmembrane regulator (CFTR) gene, (b) a chronic hyperinflammatory state and (c) frequent and severe bacterial infections of the lungs. With respect to the molecular basis of the activation of pro-inflammatory genes, an increasing number of reports have been published showing a clear role of microRNAs in chronic *Pseudomonas aeruginosa* lung infection in cystic fibrosis. This observation was the rationale for proposing "microRNA Therapeutics" based on treatment of target cells with agomiR molecules mimicking the activity of down-regulated microRNAs, obtaining inhibitory effects on the expression of miRNA-regulated pro-inflammatory genes [1,2]. In this study, we aimed to determine whether this "miRNA therapeutics" approach can be combined with treatment with natural compounds, in order to maximize the biological effects on the expression of pro-inflammatory genes. Among the several anti-inflammatory natural compounds, we selected Sulforaphane (SFN), which is highly concentrated in broccoli sprouts (*Brassica oleracea*) and has been demonstrated to exhibit significant antioxidant, anti-inflammatory, antiviral and anticancer properties. In the present study, human bronchial epithelial IB3-1 cells were used, transfected with the anti-inflammatory agomiR-93 [2]. The cystic fibrosis IB3-1 cellular model system has been extensively employed to study the biochemical and molecular effects of *P. aeruginosa* infection. In our experimental plan, after 48 hours of treatment with 100 nM agomiR-93 or with 100 nM agomiR-93 plus 5 μM SFN (step "1"), the cells were infected with the *P. aeruginosa* PAO1 strain for 4 hours (step "2"). Changes in gene expression were studied by RT-qPCR and with Bio-Plex analyses (step "3") as described by Fabbri et al [2]. The results obtained demonstrated that PAO1 infection induced an increase in gene expression of the main pro-inflammatory cytokines involved in the cystic fibrosis inflammation sustained by PAO infection, such as IL-6, IL-8, IL-1β and G-CSF, as demonstrated by RT-qPCR analysis and the absolute quantification of proteins in cell supernatants obtained with Bio-Plex. This increase was inhibited by treatment with both the agomiR-93 and with SFN with different percentages depending on the selected pro-inflammatory protein. Notably, Bio-Plex results demonstrated that the inhibitory effect on the expression of IL-6, IL-8, G-CSF genes increased in the presence of both agomiR-93 and SFN. The same cooperative effect was also observed for IL-1β when analyzed by RT-qPCR. Since the expression of these genes play an important role in regulating the inflammatory state of cystic fibrosis, this finding suggests that the use of natural products can be combined with the "miRNA

Therapeutics" approach to obtain a cooperative effect in inhibiting the expression of pro-inflammatory genes involved in cystic fibrosis.

References

[1] Finotti, A and Gambari, R. *Noncoding RNA* 2025, 11(1):3.
[2] Fabbri, E et al. *Am J Respir Cell Mol Biol.* 2014, 50(6):1144-55.

PP23

From Waste to Value: Improving Protein Extraction and Antioxidant Functionality of Spent Coffee Grounds

Gabriela, Kowalska[1], Gabriela, Rzepkowska[1], Joanna, Oracz[1].

[1]*Institute of Food Technology and Analysis Faculty of Biotechnology and Food Sciences Lodz University of Technology 2/22 Stefanowskiego Street 90-537 Lodz Poland*

Gabriela.kowalska@p.lodz.pl; ORCID: 0000-0002-5476-7034

Spent coffee grounds (SCG) represent a significant agro-industrial by-product, containing approximately 12–17% protein, largely composed of the 11S globulin fraction [1]. This study investigated the efficiency of protein recovery from SCG and evaluated the impact of ultrasound-assisted extraction (UAE) and hexane defatting on isolation yield, chemical structure (FT-IR), and antioxidant properties (EPR).

Protein isolation was performed at pH 11 using tri-sodium orthophosphate [2]. Conventional extraction (CE) at 25 °C and 50 °C was compared with a hybrid approach using UAE as a pretreatment (60% amplitude, 5 min, pulse mode). Additionally, the effect of prior defatting with hexane (1:10 ratio) was assessed. For the non-defatted CE samples, protein isolation yield was significantly higher at 25 °C (23.5–28.4%) compared with the yields obtained at 50 °C (20.5–21.6%), suggesting that lower temperatures better maintain protein solubility by preventing excessive complexation with fiber components or thermal denaturation.

Hexane defatting significantly improved isolation efficiency, increasing the protein concentration to approximately 34.5–37.2%. FT-IR analysis confirmed the integrity of the protein structure, showing characteristic Amide I and Amide II bands. EPR spectroscopy revealed that defatted samples exhibited superior antioxidant capacity (780–850 µmol TE/g protein) compared with non-defatted samples. This enhanced activity is attributed to the more efficient recovery of protein–melanoidin complexes, known for their potent free radical-scavenging properties.

In conclusion, optimizing extraction parameters through UAE and prior defatting enables the effective recovery of functional protein isolates from SCG, supporting their potential use as sustainable, health-promoting ingredients.

References

[1] Campos-Vega, R., et al., Trends in Food Science & Technology, 2015 45(1), 24-36.

[2] Valdés, A, et al., Food Research International, 2020, 137, 109368.

PP24

Effects of Different Preservation Methods on the Color and Bioactive Compounds of Rosemary (*Salvia rosmarinus* Spenn.) Leaves

Beáta, Gosztola[1], Nóra, Várallyay[1], Urbashi, Hazarika[1]

[1] *Department of Medicinal and Aromatic Plants, Institute of Horticultural Sciences, Hungarian University of Agriculture and Life Sciences (MATE), Budapest, Hungary*

Gosztola.Beata@uni-mate.hu; ORCID 0000-0001-6136-9627

Rosemary (*Salvia rosmarinus*) is a well-known medicinal and aromatic plant valued in the food and pharmaceutical industries due to its characteristic flavor and pronounced antioxidant, antiseptic, anti-inflammatory, and digestive properties. Its aromatic leaves are usually used in dried form (as a spice); however, the applied drying method can substantially affect product quality. Therefore, this study aimed to identify preservation methods that most effectively retain the original color and bioactive compounds of rosemary.

The experiment was conducted using the rosemary cultivar 'Harmat', grown in Soroksár, Hungary. Approximately 4 kg of fresh leaves were harvested in July after flowering. The homogenized plant material was divided into 9 portions according to the applied preservation methods (sun drying, shade drying, oven drying at 40 and 60ºC, lyophilization, microwave drying at 250 and 700 W, freezing at -18ºC), and compared with fresh plant material.

Freeze-drying best preserved the green color of the leaves, although noticeable fading occurred. Shade drying and drying at 40 °C were also effective.

Regarding essential oil (EO) content, most preservation methods maintained the original accumulation level (1.78–2.01 ml/100 g d.w.), except for microwave drying, during which volatiles almost completely disappeared (0.16-0.25 ml/100 g d.w.).

The main EO components in fresh leaves were camphor (21.2%), α-pinene (16.4%) and 1,8-cineole (15.6%). The relative composition of EO components was not significantly altered by most treatments; however, microwave drying significantly reduced the proportion of smaller, more volatile compounds while increasing that of larger molecules.

The total phenolic content (TPC) and total antioxidant capacity (TAC) of aqueous extracts prepared from fresh leaves were 142.4 mg GAE/g d.w. and 310.6 mg AAE/g d.w., respectively. Drying at 40°C and microwave drying at 700 W preserved the examined components the most, whereas freezing resulted in a pronounced reduction of 70–85%.

A similar trend was observed for rosmarinic acid (RA) content as well. Fresh leaves contained 1.72 g/100 g d.w., which was most effectively preserved by microwave drying at 700 W. Sun drying, shade drying, and drying at 40 °C also proved to be effective. In contrast, freezing dramatically reduced RA level.

Overall, gentle drying methods (shade drying, drying at 40 °C), freezing, and lyophilization were the most effective for preserving volatiles. For the retention of water-soluble phenolic compounds with antioxidant activity, microwave drying was also suitable. However, freezing was inadequate for preserving phenolic constituents of rosemary leaves.

PP25

Organ- and Harvest Time-Dependent Variation of Bioactive Constituents in *Anthriscus sylvestris*

Se Jeong, Kim[1], Sang Won, Yeon[1], Hak Hyun, Lee[1], Jin Gyu, Han[2], Sung Wook, Kang[2], Bang Yeon, Hwang[1], Mi Kyeong, Lee[1]

[1] *College of Pharmacy, Chungbuk National University, Cheongju 28160, Republic of Korea*
[2] *Forest Microbiology and Application Division, National Institute of Forest Science, Suwon 16631, Republic of Korea*

mklee@chungbuk.ac.kr; ORCID: 0000-0001-5814-2720

Anthriscus sylvestris has traditionally been used as an herbal remedy for bronchitis and colds, with its roots primarily utilized as the medicinal organ [1]. However, comparative studies on the distribution of bioactive constituents across different plant organs and harvest time remain limited. In this study, the major constituents in the roots, stems and leaves of *A. sylvestris* were systematically investigated and their content was quantified across different plant organs and harvest time. A total of seven compounds, including lignans, flavonoids and phenolic compounds, were isolated and identified. Quantitative analysis revealed distinct organ-specific distribution patterns. The major lignans were present in all plant organs, with the highest concentrations observed in the roots. In contrast, a flavonoid glycoside was exclusively detected in the leaves, while a lignan derivative was restricted to the roots. Seasonal variation analysis further demonstrated that compound accumulation was strongly influenced by harvest time. In particular, the flavonoid glycoside accumulated abundantly in leaves collected in March and May, but was not detected in October. Overall, both plant organ and harvest time significantly affected the content and distribution of bioactive constituents. These findings highlight that not only roots but also aerial organs, including leaves and stems, can serve as valuable sources of bioactive compounds. Furthermore, optimizing the selection of plant organs and harvest time is essential for the efficient utilization of *A. sylvestris* as a medicinal resource.

References

[1] Jeong, G. et al. *Biological and Pharmaceutical Bulletin*, 2007, 30(7), 1340-1343.

Acknowledgments: This work was supported by the Research Program (FP0802-2023-03-2024) for Forest Science & Technology Development of the National Institute of Forest Science.

PP26

A New Natural Strategy for Modulating Oxidative and Inflammatory Responses to UVA in Melanocytes

Iwona Jarocka-Karpowicz[1], Agnieszka Gęgotek[1], Neven Žarković[2], Audrius Maruška[3], Elżbieta Skrzydlewska[1]

[1] *Department of Inorganic and Analytical Chemistry, Medical University of Bialystok, Poland*
[2]*Ruđer Bošković Institute, Laboratory for Oxidative Stress (LabOS), HR-10000 Zagreb, Croatia*
[3]*Instrumental Analysis Open Access Centre, Faculty of Natural Sciences, Vytautas Magnus University, LT-44404 Kaunas, Lithuania.*

iwona.jarocka-karpowicz@umb.edu.pl; ORCID 0000-0001-8923-3529

Constant exposure of human skin to solar radiation simultaneously leads to exposure to UVA radiation, which, despite its important role in photo-neuro-immunoendocrine signaling, remains a critical stressor. Oxidative stress and UVA-induced DNA damage facilitate the malignant transformation of melanocytes into melanoma—one of the most aggressive forms of skin cancer. Therefore, protecting skin cells from the harmful effects of UVA radiation and the ongoing search for effective protective compounds are crucial. Natural compounds are of particular interest, as they often offer a more favorable safety profile with fewer side effects than synthetic alternatives. This study focused on assessing the cytoprotective potential of the phytocannabinoid-cannabigerol (CBG) on human melanocytes exposed to UVA.

CBG has been shown to effectively alleviate oxidative stress and significantly reduce lipid peroxidation, as evidenced by lower levels of 4-hydroxynonenal and its protein adducts. The mechanism of action of CBG involves precise modulation of the Nrf2-dependent antioxidant system and inhibition of the proinflammatory NFκB pathway. CBG has been found to influence antioxidant biosynthesis even when administered post-irradiation, regulating the levels of Nrf2 inhibitors and activators (Keap1, Bach1, p21, KAP1, and p62). Simultaneously, NFκB signaling is partially inhibited through a reduction in the pIκB activator and a corresponding increase in IKKα/β inhibitors.

The obtained results suggest that CBG protects melanocytes from the prooxidant and proinflammatory effects of UVA radiation, supporting the maintenance of physiological functions and consequently reducing the risk of skin cancer development. Therefore, due to its demonstrated metabolic efficacy, CBG may be a promising candidate for further research into photoprotective strategies and skin cancer prevention.

Acknowledgments: The study and international cooperation has been supported by the Polish National Agency for Academic Exchange under the “Strategic Partnerships” Programme (project no. BPI/PST/2024/1/00008).

PP27

Sustainable production of rosin and rosin esters with bio-based antioxidants for further food applications

Nalin Seixas[1], João Serrano[2], Carla Vilela[1], Sónia A. O. Santos[1], Carmen S. R. Freire[1], Armando J. D. Silvestre[1]

[1] *CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, 3810-193 Aveiro, Portugal*
[2] *PinoPine – Produtos Químicos S.A., R. da Carreira Branca Nº 26, 3800-373 Aveiro, Portugal*
nalinseixas@ua.pt; ORCID: 0000-0001-7307-6418

Rosin, a natural product from pine trees, finds use in many areas, including food applications, especially as emulsion stabilizer in chewing gum and beverages [1]. However, during industrial processing, rosin is prone to oxidation, leading to quality decrease, especially undesirable darkening, a critical parameter in food applications where color is essential. Nowadays, synthetic antioxidants, such as 4,4'-thiobis(2-tert-butyl-5-methylphenol) (Lowinox TBM-6), are used to produce light-colored rosin or rosin esters with improved oxidative stability [2]. However, concern over synthetic antioxidants has led to a search for safer alternatives. Hence, this work aims to replace synthetic antioxidants with natural alternatives in rosin industrial processing.

A screening of several natural antioxidants, namely gallic, ascorbic, oxalic, caffeic, and lipoic acids, as well as α-tocopherol, thymol, vanillin, and eugenol, was performed. These compounds were chosen for their potent antioxidant activity. Since the color is the most important parameter for rosin quality, the Gardner color of rosin thermally processed at 265 ºC for 8 h was determined. Some of these natural antioxidants produced rosins with colors like Lowinox TBM-6 and within the acceptable industrial range (4-8), making them suitable for further optimization.

Optimized rosins achieved Gardner color below 6.0, outperforming those produced with Lowinox TBM-6 (6.4). This improvement is relevant for maintaining desirable visual and physicochemical properties in food-related materials. To further validate the potential of the selected natural antioxidants and conditions, rosin esterification with glycerol was performed and the results showed Gardner colors lower or like Lowinox TBM-6. Moreover, acid number, softening point and detailed composition analysis by gas chromatography coupled with mass spectrometry and infrared spectroscopy were performed to demonstrate the quality of the samples. This process demonstrates that rosin can be efficiently stabilized using natural antioxidants, enabling the production of high-quality, light-colored rosins suitable for food applications. This work is under a patenting process.

References

[1] Kugler, s. et al. *Molecules*, 2019, 24(9), 1651
[2] Seixas, N. et al., *Ind. Crops Prod*., 2025, 238, 122345.

Acknowledgments: This research was developed within the scope of Integrated Project RN21, co-financed by Environmental Fund through Component 12 – Promotion of the Sustainable Bioeconomy (Investment TC-C12-i01– Sustainable Bioeconomy No. 02/C12- i01/202), of European funds allocated to Portugal by the Recovery and Resilience Plan, within the scope of the Recovery and Resilience Mechanism of the European Union, framed in the Next Generation EU, for the period

2021–2026. The Project CICECO- Aveiro Institute of Materials, UID/50011/2025 (DOI 10.54499/UID/50011/2025) & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), financed by national funds through FCT/MCTES (PIDDAC) is acknowledged.

PP28

Volatile Organic Compounds from *Michelia x alba* Attenuate Airway Inflammation in an Asthmatic Mouse Model

Qianjun Yang[1], Zhang Xia[1], Wenmeng He[2], Allen Ka Loon Cheung[1,] and Pan Liao[1,3,4,5]

[1]*Department of Biology, Hong Kong Baptist University, Kowloon Tong, Hong Kong SAR, China*

[2]*Department of Life Science, Faculty of Science and Technology, Beijing Normal-Hong Kong Baptist University, Zhuhai, Guangdong, China*

[3]*State Key Laboratory of Agrobiotechnology (CUHK), Hong Kong SAR, China*

[4]*AoE Centre for Plant Vacuole Biology and Biotechnology, The Chinese University of Hong Kong, Shatin, Hong Kong SAR, China*

[5]*Institute of Systems Medicine and Health Sciences, Hong Kong Baptist University, Kowloon Tong, Hong Kong SAR, China*

panliao@hkbu.edu.hk ORCID: 0000-0002-1156-8916 Allen KL Cheung: akcheung@hkbu.edu.hk ORCID : 0000-0001-8989-0537

Flowers are appreciated for their aesthetics value but their therapeutic benefits with emitted volatile organoid compounds (VOC), especially against inflammatory respiratory diseases, are often overlooked. Here, we investigated *Michelia* × *alba (M. alba)* VOC (MA-VOC) for anti-inflammatory functions in in vitro experiments using human monocytic THP-1 cells, and in an ovalbumin (OVA)-induced asthma BALB/c mice model following inhalation. MA-VOC could significantly reduce the expression of inflammatory cytokine genes (*TNFA*, *IL6*, *IL1B*). Moreover, inhaled MA-VOC reduced asthma-related inflammatory cytokines, IgE antibody level, and infiltration of immune cells in the bronchoalveolar lavage fluid (BALF). Additionally, asthma-related genes showed reduced expression upon MA-VOC treatment in mice splenocytes. Gas chromatography mass spectrometry (GC-MS) analysis found that two sesquiterpenoids, a aromatic and aliphatic compound are the major constituents that may have contributed to the therapeutic effect. Altogether, our findings demonstrate that *M. Alba* floral VOCs have the potential for development as an inhaled biologic against asthma.

Acknowledgments: This work was supported by the Theme-based Research Scheme (TBRS, T12-712/21-R) and General Research Fund (GRF, 1120222) of Research Grant Council (RGC), and Incentive Award for External Competitive Research Grants of Hong Kong Baptist University (to A.K.L.C). The Areas of Excellence Scheme from the RGC (AoE/M-402/25-N), Early Career Scheme grant from the RGC (Project No. 22100923), the NSFC/RGC Joint Research Scheme (Project No. N_HKBU201/23), the PROCORE-France/HK Joint Research Scheme (Project No. F-HKBU201/23), the Department Start-up fund of Hong Kong Baptist University (Project No. BIOL-22-23-01), Hong Kong Baptist University, Research Committee, Initiation Grant - Faculty Niche Research Areas (IG-FNRA) 2022/23 (RC-FNRA-IG/22-23/SCI/01), and the Innovation and Technology Fund of Innovation Technology Commission: Funding Support to State Key Laboratory of Agrobiotechnology (to P.L.), and Guangdong and Hong Kong Universities 1 + 1 + 1 Joint Research Collaboration Scheme (to P.L., A.K.L.C and W.H.). Any opinions, findings, conclusions or recommendations expressed in this publication do not reflect the views of the Government of the Hong Kong Special Administrative Region or the Innovation and Technology Commission.Prof Liao Pan please add your grants. We thank Dr Xiaoman Zhang and Mr Peter Hok Chun Lee for their support in securing various resources

for the experiments, and Dr Keith Ho for his support on the use of GC-MS at the Wu Jieh Yee Institute of Translational Chinese Medicine Research of HKBU. The authors acknowledge the facility support from the Advanced Life Sciences and Mass Spectrometry Laboratory (LSMS) of Hong Kong Baptist University and the Wu Jieh Yee Institute of Translational Chinese Medicine Research, HKBU.

PP29

Multi-level Mechanistic Insights into the Anti-osteoporotic Potential of *Polygonatum odoratum* via Chemical Profiling and Network Pharmacology in a Zebrafish Model

Wen-Ying Lin[1], Cheng-Huan Peng[2,3], Yu-Kai Huang[4], Chia-Ying Li[5], and Ming-Der Lin[1,4,6]

[1] *Institute of Medical Science, Tzu Chi University, Hualien 970374, Taiwan*
[2] *Department of Orthopedics, Hualien Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Hualien 970473, Taiwan*
[3] *School of Medicine, Tzu Chi University, Hualien 970374, Taiwan*
[4] *Department of Molecular Biology and Human Genetics, Tzu Chi University, Hualien 970374, Taiwan*
[5] *Department of Applied Chemistry, National Pingtung University, Pingtung, 900393, Taiwan*
[6] *Center for Herbal Medicine and Nature Products Research, Tzu Chi University, Hualien 970374, Taiwan*

mingder@gms.tcu.edu.tw; ORCID: 0000-0003-3411-5685

Osteoporosis significantly diminishes the quality of life in the elderly and imposes an escalating global socioeconomic burden. While current pharmacotherapies enhance bone mass, their long-term efficacy is often hampered by adverse effects, necessitating safer alternatives. Traditional Chinese medicine, known for its multi-component and multi-target synergy, presents a promising strategy for modulating bone metabolism. This study investigates the anti-osteoporotic potential of *Polygonatum odoratum* (Yuzhu, YZ) and aims to elucidate its underlying molecular mechanisms. Using a glucocorticoid-induced osteoporosis (GIOP) zebrafish model, we demonstrated that YZ methanol extracts significantly rescued glucocorticoid-induced bone loss. To further evaluate osteoblast differentiation, the transgenic line *Tg(Ola.sp7:EGFP)*^{cy25} was utilized. Bioactivity-guided fractionation subsequently revealed that the n-butanol subfraction exhibited the most potent effect in mitigating glucocorticoid-induced bone impairment, providing a strategic basis for further chemical profiling. To dissect the underlying pharmacological mechanisms, we integrated the chemical profiling of this bioactive fraction with network pharmacology. This approach identified a diverse spectrum of putative bioactive compounds and highlighted key protein targets and signaling pathways associated with osteogenesis and bone remodeling. Collectively, this integrated, multi-level framework provides comprehensive mechanistic insights into the bioactive fractions of YZ, supporting its potential as a scientifically-validated complementary therapeutic for osteoporosis.

Acknowledgments: We are grateful for the support from the Core Facility Center, Tzu Chi University. Funding for this study was provided by Tzu Chi University (Grant No. 11411507000-70-01E) to M.D.L.

PP30

Quercetin orally or nasally administered restores brain insulin signalling and exerts neuroprotective effects in a murine model of obesity-associated neurodegeneration

Pollara F.M.[1], Massaro A.[2], Calandrino A.[3], Restivo I.[4], Sciarrino D.I.[5], Mangiapane L.[6], Gambino G.[7], Allegra M.[8], Tesoriere L[9].

[1]*Department of Biological, Chemical and Pharmaceutical Sciences and Technologies, University of Palermo, ITALY*

Francescomaria.pollara@unipa.it; ORCID: 0009-0006-4158-0525

Chronic caloric overload and high intake of saturated fatty acids promote metabolic syndrome (MetS), characterized by systemic insulin resistance and persistent metabolic dysregulation. Beyond peripheral alterations, MetS contributes to central nervous system dysfunction and neurodegeneration, mainly through impaired brain insulin signalling, oxidative stress, and neuroinflammation. Quercetin, a dietary flavonoid, exhibits antioxidant, anti-inflammatory, and insulin-sensitizing properties [1], although its clinical potential is limited by its poor bioavailability and restricted blood–brain barrier permeability. This study investigated the neuroprotective effects of orally and intranasally administered quercetin, focusing on its ability to restore brain insulin signalling.

Thirty-six male Wistar rats were fed for 20 weeks with either a standard diet (STD) or a high-fat diet (HFD) to induce metabolic syndrome. After 14 weeks, STD animals continued their diet, while HFD rats were either left untreated or treated with quercetin for six weeks. Quercetin was administered orally (15 or 50 mg/kg) or intranasally (0.1 mg/kg) using a thermoresponsive liposomal gel. Peripheral glucose metabolism and insulin resistance were assessed by colorimetric assays, while brain insulin signalling was evaluated by Western blot analysis.

Our results indicate that HFD feeding markedly impaired brain insulin signalling, as shown by reduced insulin receptor expression, increased IRS-1 serine phosphorylation, decreased AKT activation, and reduced GSK-3β inhibition compared to STD animals. Quercetin treatment significantly counteracted these alterations, improving insulin signalling pathway. Interestingly, intranasal administration produced the most pronounced effects, whereas oral treatment showed dose dependent but less robust improvements. Both administration routes significantly improved peripheral glucose dysmetabolism.

These findings demonstrate that quercetin effectively ameliorates HFD-induced disruption of brain insulin signalling. Intranasal delivery appears particularly effective, suggesting a promising strategy to enhance its central bioavailability. Overall, quercetin-mediated modulation of insulin pathways may represent a potential neuroprotective approach against metabolic stress-related neurodegeneration.

Reference

[1] Shi, Guang-Jiang, et al. *Biomedicine & Pharmacotherapy*, 2019 vol. 109, gennaio, pp. 1085–99.

PP31

Unlocking the Potential of fungal *Penicillium cavernicola* LL-1 as Biosurfactant Producer

Boryana Yakimova[1], Ivanka Stoineva[1], Lilyana Nacheva[2], Lyudmila Kabaivanova[2], Ralitza Alexova [3], Ivanka Boyadzhieva[2] and Kaloyan Berberov[2]

[1] *Institute of Organic Chemistry with Centre of Phytochemistry, Bulgarian Academy of Sciences, Sofia, Bulgaria;*
[2] *"Stephan Angeloff" Institute of Microbiology, Bulgarian Academy of Sciences, Sofia, Bulgaria;*
[3]*Department of Medical Chemistry and Biochemistry, Faculty of Medicine, Medical University, Sofia, Bulgaria*

Ivanka.Stoineva@orgchm.bas.bg;, ORCID; 0009-0003-3261-4082

Biosurfactants are amphiphilic compounds synthesized by bacteria, yeasts, and filamentous fungi. The high biodegradability, low toxicity, and stability under extreme conditions, making them attractive for environmental and biotechnological applications. Their ability to reduce surface tension and enhance emulsification highlights biosurfactants potential as sustainable alternatives to synthetic surfactants.

In the present study, the capacity of filamentous fungal strain *Penicillium cavernicola LL-1* to produce and extracellularly secrete biosurfactants was demonstrated. Molecular identification of the strain was performed using ITS sequencing in combination with 28S rRNA gene analysis.

Fungal isolates were cultivated in Czapek–Dox broth and potato dextrose broth media supplemented with 2% *n*-hexadecane and 2% sunflower seed oil at pH 7. According to the specific physiological characteristics *of P. cavernicola* LL-1 exhibited optimal biosurfactant production at 28°C over a cultivation period of 144–168 h. The sdudied strain showed good biosurfactant production, achieving strong emulsifying activity E_{24} = 54% for motor oil and lowering surface tension to 34.8 mN/m estimated by Force Tensiometer K20, based on the DuNouy ring method.

After the end of fermentation the fungal cells were removed by centrifugation at 5,000 rpm for 15 min. The resulting cell-free supernatant was subsequently extracted with an equal volume of ethyl acetate. The combined organic phases were collected, and the solvent was evaporated by vacuum drying at 40 °C.

The crude bioproduct was purification by column chromatography and analyzed by different analytical methods and technics (TLC, FTIR, ^{1}H and ^{13}C NMR and MS). The obtained preliminary results suggested a sophorolipid structure for the biosurfactant producing by studied strain.

Filamentous fungi, particularly *Penicillium cavernicola LL-1* represent a alternative source for sophorolipids production, offering potential applications in bioremediation, pharmaceuticals, and the food industry.

Acknowledgments: This work was supported by the Bulgarian National Science Fund, Grant КП-06-Н 87/2.

PP32

Human Breast Milk-Derived Extracellular Vesicles Protect the Gut–Liver Axis in Colitis

Jae-Hee, Kwon[1], Dong-ha, Kim[1], Bum-Joon, Koo[1], Young-Eun, Cho[1]

[1] *Department of Food and Nutrition, Gyeongkuk National University, Andong 36729, Republic of Korea*

yecho@gknu.ac.kr; ORCID: 0000-0001-9864-0265

Inflammatory bowel disease (IBD) is characterized by chronic intestinal inflammation and epithelial barrier disruption, leading to increased intestinal permeability and inflammatory damage along the gut–liver axis. Human milk-derived extracellular vesicles (HMEVs) are known to exert immunomodulatory and anti-inflammatory effects; however, their protective role in DSS-induced colitis remains unclear. Therefore, this study aimed to evaluate the effects of HMEVs on intestinal barrier function and gut–liver axis protection in a DSS-induced colitis model. HMEVs were isolated and characterized by NTA and ONi nanoimaging. DSS-induced colitis mice were orally administered HMEVs for 7 days, followed by evaluation of colon damage, intestinal permeability, biodistribution, and inflammation-related protein expression. Oral administration of HMEVs significantly alleviated DSS-induced colon shortening and epithelial tissue damage. Biodistribution analysis confirmed that HMEVs were safely absorbed into multiple organs and improved intestinal barrier function in both in vivo and in vitro models. In addition, HMEVs reduced oxidative stress-related protein expression and suppressed DSS-induced intestinal permeability, endotoxemia, and inflammatory damage in intestinal and hepatic tissues. These findings demonstrate that HMEVs effectively alleviate DSS-induced colitis by strengthening epithelial barrier function and regulating gut–liver axis homeostasis. Therefore, HMEVs may serve as a promising natural nanovesicle-based therapeutic candidate for the management of inflammatory bowel disease and protection of the gut–liver axis.

References

[1] Welsh, JA. et al. *Journal of Extracellular Vesicles*, 2024, 13(2), e12404.
[2] He, S. et al. *Pediatric Research*, 2024, 90(2), 366-372.

Acknowledgments: This work was supported by National Research Foundation of Korea (NRF) grant funded by Korea government (MSIT) (No. RS-2024-00340542). This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (No. RS-2024-00413825)

PP33

Nature's surfactants: Sophorolipids as sustainable compounds from fungi

Boryana Yakimova[1], Ivanka Stoineva[1], Lilyana Nacheva[2], Lyudmila Kabaivanova[2], Hristina Petkova[3], Ivanka Boyadzhieva[2] and Kaloyan Berberov[2]

[1] *Institute of Organic Chemistry with Centre of Phytochemistry, Bulgarian Academy of Sciences, Sofia, Bulgaria;*
[2] *"Stephan Angeloff" Institute of Microbiology, Bulgarian Academy of Sciences, Sofia, Bulgaria;*
[3] *Institute of Physical Chemistry 'Rostislaw Kaischew', Bulgarian Academy of Sciences, Sofia, Bulgaria;*

Boryana.Yakimova@orgchm.bas.bg; ORCID: 0009-0006-0136-4692

Biosurfactants are surface-active compounds produced by microorganisms that have gained significant attention due to their biodegradability, low toxicity, and environmental compatibility compared to synthetic surfactants. Among them, sophorolipids are a well-studied class of glycolipid biosurfactants, valued for their effectiveness in reducing surface and interfacial tension, and for their applications in pharmaceuticals, cosmetics, food processing, and environmental remediation. While sophorolipids are predominantly produced by yeast species, there is growing interest in identifying alternative microbial producers to improve production efficiency and diversify structural variants.

This study aims to evaluate the biosynthetic potential of *Trichoderma longibrachiatum* LL-2 for biosurfactants production under optimized fermentation parameters, including carbon substrate composition, initial pH, incubation temperature, and cultivation time. The culture supernatant derived from this fungal strain demonstrated significant emulsification activity (E_{24} = 55%) and reduced the surface tension to 31.8 $mN \cdot m^{-1}$ following 9 days of batch cultivation.

The extracted biocomponents were characterized by thin-layer chromatography (TLC), Fourier transform infrared (FTIR) spectroscopy, and nuclear magnetic resonance (^1H and ^{13}C NMR) spectroscopy. Spectral and chromatographic analyses confirmed the biosynthesis of sophorolipid-like glycolipid compounds by *Trichoderma longibrachiatum* LL-2, exhibiting pronounced surface-active behavior.

These results demonstrate that *T. longibrachiatum* LL-2, isolated from petrochemical-contaminated soil, constitutes a viable promising microbial platform for sophorolipids production. The observed emulsification activity and reduction in surface tension indicate the functional efficacy of the produced biosurfactants, supporting their potential application in industrial processes such as bioremediation, enhanced oil recovery, and formulation of eco-friendly surfactants for biomedicine and food additives.

Acknowledgments: This work was supported by the Bulgarian National Science Fund, Grant КП-06-Н 87/2.

PP34

From Traditional Food to Functional Potential: Anti-Inflammatory Activity and Phenolic Characterization of *Tragopogon buphthalmoides* (DC.) Boiss. Var. *Buphthalmoides*

Tuğçe Dikpınar[1], Ayşe Nur Hazar-Yavuz[2], Muammer Kaplan[3], Melike Bayrak[1], Ahmet Doğan[4]

[1] *Marmara University, Faculty of Pharmacy, Department of Pharmacognosy, Istanbul, Türkiye*
[2] *Marmara University, Faculty of Pharmacy, Department of Pharmacology, Istanbul, Türkiye*
[3] *TUBITAK Marmara Research Center (MAM), Gebze-Kocaeli, Türkiye*
[4] *Marmara University, Faculty of Pharmacy, Department of Pharmaceutical Botany, Istanbul, Türkiye*

tugce.dikpinar@marmara.edu.tr; ORCID: 0000-0002-3994-3888

The Asteraceae family comprises over 20,000 species and includes the genus *Tragopogon*, which is widely distributed across Europe and Asia. In Türkiye, several *Tragopogon* species, locally known as “yemlik” or “teke sakalı”, are consumed as vegetables either fresh or cooked, and are also used in traditional medicine. Phytochemical studies of the genus have reported the presence of flavonoids, terpenoids, and phenolic acids [1,2]. In this study, in vivo anti-inflammatory activity of the ethanol extract obtained by maceration from the aerial parts of *Tragopogon buphthalmoides* var. *buphthalmoides* (TBE), collected from Tunceli, Türkiye, was evaluated using the carrageenan-induced paw edema model. Body weight measurements showed no significant differences among groups. Inflammation significantly increased paw edema compared to the control group at all time points. TBE showed a time-dependent anti-inflammatory effect with a non-linear dose-response pattern. The 100 mg/kg dose reduced edema at 30 min and 3 h ($p<0.05$), while the 400 mg/kg dose was effective at 1–3 h ($p<0.05$–0.01). The effect diminished at 4 h. Phytochemical profiling using LC-MS/MS analysis revealed the presence of phenolic compounds in the extract, including protocatechuic acid and chlorogenic acid. Overall, TBE exhibited significant anti-inflammatory activity, particularly during the acute phase of inflammation, suggesting that its bioactivity may be associated with its phenolic constituents. Further studies are needed to isolate bioactive compounds and elucidate the underlying anti-inflammatory mechanisms to fully validate its functional food and phytotherapeutic potential.

References

[1] Uysal, S. et al., *Journal of Biomolecular Structure and Dynamics*, 2018, 30, 1-39.
[2] Abdalla, M. et al., *Journal of Ethnopharmacology*, 2020, 250, 112466.

Acknowledgments: This study was supported by TUBITAK 2209-A Research Project Program (Project No: 1919B012321277).

PP35

Extraction of Phenolic Compounds from Chestnut Burr Using Bio-based solvents

João, Lima[1], Flávia, N. Braga[1,2], Joana, Lains[1], Isabel, Martins[1], Helena, Passos[1]

[1] *LSRE-LCM, ALiCE, Faculty of Engineering, University of Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal;*
[2] *CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, 3810-193 Aveiro, Portugal*
hpassos@fe.up.pt; ORCID: 0000-0002-0573-093X

Portugal ranks among the major European producers of *Castanea sativa*, a chestnut species widely used in the food industry [1]. Chestnut processing generates large amounts of agricultural residues (shells, burrs, and leaves), which are often discarded or burned, resulting in environmental impacts. From these residues, burrs, produced at 10–15 thousand tons annually [2], are particularly rich in phenolic compounds. These compounds have antioxidant, antimicrobial, and anti-inflammatory properties, making them valuable for food, pharmaceutical, and cosmetic industries. Conventional polyphenol extraction relies on organic solvents, such as benzene, hexane, and acetone, which present toxicity and environmental concerns. In this regard, bio-based solvents emerge as promising, eco-friendly alternatives. This work evaluates the performance of bio-based solvents in the solid-liquid extraction of bioactive compounds from chestnut burrs. A pretreatment step was performed to compare particle size reduction using a coffee mill alone and a combination of a coffee mill and a ball mill. Next, solid-liquid extractions were performed using water, ethanol, selected bio-based solvents suitable for the cosmetics industry (e.g., gamma-valerolactone, cyrene, ethanediol, propanediol, hexanediol), and binary mixtures of water and bio-based solvents. Each extract was analyzed using TPC, FRAP, and ABTS assays to determine total phenolic content and antioxidant activity. The most promising solvent was selected for process optimization using the response surface methodology. Based on the results, the decrease in particle size of the sample positively affects extraction results, and ethanediol is a promising solvent emerging as an alternative for the extraction of bioactive compounds.

References

[1] Lains, J. et al., *International Journal of Biological Macromolecules*, 2026, 343, 150438.
[2] Rodrigues, M.A. et al., *Revista de Ciências Agrárias*, 2020, 43, 57-63.

Acknowledgments: This work was financially supported by the Calouste Gulbenkian Foundation, under the Gulbenkian New Talents Scholarship programme and by the Promove Programme through Fundação “La Caixa”, in collaboration with the BPI and Fundação para a Ciência e a Tecnologia (FCT), under the project CyChest - Gestão integrada do ciclo do castanheiro no Parque Natural de Montesinho. This work was also financially supported by FCT, I.P. /MCTES through national funds: LSRE-LCM, UID/50020/2025 (DOI: 10.54499/UID/50020/2025); ALiCE, LA/P/0045/2020 (DOI: 10.54499/LA/P/0045/2020); and CICECO-Aveiro Institute of Materials, UID/50011/2025 & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020). F. Braga acknowledges FCT for the Ph.D. grant 2023.01749.BD (DOI:10.54499/2023.01749.BD).

PP36

Bioactivity and toxicity evaluation of *Cistus incanus* extract

Mariana Alves[1,2], Bárbara Ferreira[1,2], Alberto C.P. Dias[1,2]

[1]*Centre of Molecular and Environmental Biology (CBMA), Department of Biology, Campus de Gualtar, University of Minho, 4710-057 Braga, Portugal*
[2]*IBS, Institute of Science and Innovation for Bio-Sustainability, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal*
albertocpdias66@gmail.com; ORCID: 0000-0003-3641-3248

The *Cistus* genus has a long history in traditional medicine, with various species being utilized as herbal infusions [1]. These species have been associated with a variety of health-related properties, including antioxidant, antimicrobial, and anti-inflammatory effects [1]. The underlying mechanism for these properties is believed to be largely attributed to the rich polyphenolic composition of these plants [1]. Despite their traditional use and increasing commercial interest, *Cistus* species are not yet fully characterized in terms of their biological activity and safety profiles. *Cistus incanus* L. is widely distributed across the Mediterranean basin [1, 2]. In this study, the bioactive potential of a *Cistus incanus* extract (CIS) was evaluated using complementary *in vitro* and *in vivo* approaches. The antioxidant capacity of CIS was assessed through radical scavenging assays, which demonstrated strong activity consistent with a high content of bioactive phytochemicals. The antimicrobial activity of CIS was evaluated against *Staphylococcus aureus* and *Staphylococcus epidermidis*, revealing inhibitory effects indicative of moderate antibacterial potential. To further assess its biological relevance and safety, the extract was tested in the *in vivo* model organism *Caenorhabditis elegans*. Exposure to increasing concentrations of the extract resulted in mild toxic effects, suggesting that bioactivity may be accompanied by concentration-dependent physiological stress in a whole-organism system. Overall, the *C. incanus* extract demonstrated significant antioxidant activity and substantial antimicrobial effects against clinically relevant Gram-positive bacteria, thereby substantiating its traditional utilization. However, the observed toxicity highlights the importance of careful evaluation of safety and dose-dependent effects. These findings reinforce the necessity for further studies to be conducted on bioactive compound characterization and mechanistic insights. This will facilitate a more comprehensive understanding of the therapeutic potential and limitations of *Cistus*-derived preparations.

References

[1] Tomou, E.M. et al., Phytochemistry Reviews, 2022, 21(6), 2049–2087.
[2] Starzec, A. et al., Antioxidants, 2023, 12(3), 553.

Acknowledgments: This work is supported by National Funds by FCT – Portuguese Foundation for Science and Technology, under the projects https://doi.org/10.54499/UIDB/04050/2020 (CBMA) as well as by the ETHNOHERBS project (Horizon 2020, Grant Agreement No. 823973, DOI: 10.3030/823973).

PP37

Taste Fingerprints of Maltese Honeys

Anna Gościniak[1], Anna Stasiłowicz-Krzemień[1], Everaldo Attard[2], Adrian Bugeja Douglas[2], Judyta Cielecka-Piontek[1]

[1]*Poznan University of Medical Sciences, Department of Pharmacognosy and Biomaterials, Rokietnicka 3, 60-806 Poznan, Poland*
[2] *Division of Rural Sciences and Food Systems, Institute of Earth Systems, University of Malta, MSD 2080 Msida, Malta*
astasilowicz@ump.edu.pl; ORCID: 0000-0001-5211-661

Malta represents a unique environment for honey production, characterized by endemic flora, limited geographical scale, and pronounced seasonal variability. These conditions result in distinctive honeys dominated by botanical sources such as carob (*Ceratonia siliqua*), eucalyptus (*Eucalyptus* spp.), and wild thyme (*Thymus capitatus*), alongside multifloral varieties. The aim of this study was to evaluate the applicability of an electronic tongue as an objective tool for discrimination of Maltese honeys and to explore the relationship between botanical origin and taste profile.
Nine honey samples collected from different regions and seasons were analyzed using an Astree electronic tongue equipped with a multisensor array (AHS, PKS, CTS, NMS, CPS, ANS, SCS). The obtained signals were processed using chemometric methods, including principal component analysis (PCA) and discriminant function analysis (DFA).
PCA demonstrated effective discrimination of samples, explaining 86.8% of total variance (PC1: 49.5%, PC2: 37.3%) and yielding a high discrimination index (91), indicating strong differentiation among honey types. Distinct clustering was observed according to botanical origin, particularly for thyme- and eucalyptus-dominant honeys. DFA confirmed these findings, with the first discriminant function explaining 89.8% of variance, demonstrating robust classification capability.
Sensor response analysis revealed diverse taste profiles associated with sweetness, sourness, bitterness and saltiness. Thyme-based honey exhibited a clearly distinct profile, while multifloral samples showed intermediate characteristics, reflecting compositional complexity.
These results indicate that the electronic tongue is a reliable tool for rapid and objective honey characterization. The study highlights the exceptional diversity of Maltese honeys and supports the use of taste profiling as a proxy for botanical origin, with potential applications in food authentication and quality control.

PP38

Pueraria lobata-derived peptides hold promise as a novel antioxidant source by mitigating ethanol-induced oxidative stress in HepG2 cells through regulating the Keap1/ Nrf2 pathway

Lin Liu[1], Jiehua Liang[1], Minjie He[1], Bingyan Jiang[1], Junsong Wu[2], Pan Li[1], Bing Du[1]

[1] *College of Food Science, South China Agricultural University, 483 Wushan Road, Guangzhou 510642, China;*
[2] *Guangzhou Songyuan Agricultural Technology Co., Ltd, Guangzhou, China*

Oxidative stress plays a key role in cellular signaling and balance, but prolonged stress can disrupt function and lead to chronic diseases. Pueraria lobata protein (PLP) is a promising source of antioxidant peptides that may help reduce oxidative stress and treat related conditions, although the mechanisms remain unclear. Therefore, this study aimed to investigate the antioxidant potential of PLP-derived peptides on oxidative stress in HepG2 cells. PLP was hydrolyzed and purified using ultrafiltration, gel chromatography, cellulose anion exchange chromatography, and RP-HPLC. LC-MS/MS analysis and molecular docking identified four candidate peptides-YLWVGA, LLVYY, VLSALP, and DVLPLA. Among these, YLWVGA demonstrated the strongest antioxidant activity, likely attributed to its lowest CDOCKER energy, additional key binding sites and hydrogen bonds with Keap1 compared to other peptides, along with a T-type π-π stacking interaction. This resulted in decreased levels of ROS and MDA in the ethanol-induced HepG2 liver cell injury model, along with reduced liver injury markers (AST, ALT, LDH), indicating improved cellular integrity. The protection of YLWVGA were primarily mediated by activating the Nrf2/Keap1 signaling pathway, which upregulated antioxidant enzymes (CAT, GSH-Px, SOD), enhancing defenses against oxidative stress. The outcomes would provide guidance for the potential utilization of YLWVGA as a functional food additive in the prevention and management of oxidative stress-related diseases.

References

[1] Abramson, J., Adler, J., Dunger, J., Evans, R., Green, T., Pritzel, A., & Jumper, J. M. (2024). Accurate structure prediction of biomolecular interactions with AlphaFold 3. Nature, 630(8016), 493-500. https://doi.org/10.1038/s41586-024-07487-w.

Acknowledgments: This research was financially supported by the China Agriculture Research System of MOF and MARA (grant number: CARS-21)

PP39

Biocatalytic diversification of a bioactive benzophenone from Brazilian red propolis using fungal laccases

Matheus Hikaru Tanimoto[1,2,3], Winner Duque Rodrigues[1,2,3], Laurence Marcout[2,3], Ana Maria de Freitas Pinheiro[1], Isabela Macêdo dos Santos[1], Jairo Kenupp Bastos[1], Jean-Luc Wolfender[2,3], Katia Gindro[4], Emerson Ferreira Queiroz[2,3]

1 University of São Paulo, School of Pharmaceutical Sciences of Ribeirão Preto, Av do Café S/N, Ribeirão Preto, Brazil;
2 Institute of Pharmaceutical Sciences of Western Switzerland, University of Geneva, CMU, 1211 Geneva, Switzerland;
3 School of Pharmaceutical Sciences, University of Geneva, CMU, 1211 Geneva, Switzerland
4 Agroscope, Plant Protection Research Division, Mycology group, Route de Duillier 60, 1260 Nyon, Switzerland
tanimoto@usp.br; ORCID 0000-0002-1063-3026

Brazilian red propolis is recognized as a rich source of prenylated benzophenones exhibiting diverse biological activities, including antimicrobial, anti-inflammatory, and cytotoxic effects [1]. Despite their pharmacological potential, strategies to expand the chemical diversity of these compounds remain limited. In this context, fungal laccases have emerged as attractive biocatalysts capable of promoting oxidative transformations under mild and environmentally friendly conditions, enabling access to structurally novel derivatives. In the present study, a bioactive benzophenone isolated from Brazilian red propolis was subjected to biocatalytic transformation using a laccase preparation from *Trametes versicolor*. Initial microscale experiments were conducted to establish suitable reaction conditions, followed by scale-up in a 1 L reactor containing 500 mg of substrate. The reaction was performed in an acetone/water (4:6, v/v) system and monitored by UHPLC–PDA–ELSD–MS analysis. LC–MS profiling revealed progressive substrate conversion accompanied by the formation of multiple new metabolites not detected in the starting material. Several transformation products exhibited mass spectral features consistent with increased molecular complexity, suggesting the occurrence of laccase-mediated coupling and oxidation reactions. Following extraction, chromatographic purification was achieved through analytical HPLC method optimization followed by transfer to semi-preparative HPLC. To maintain chromatographic performance, samples were applied using a dry-load procedure recently developed in our laboratory [2]. This approach enabled the isolation of the major biotransformation products, which are currently undergoing structural elucidation by high-resolution mass spectrometry and NMR spectroscopy. These findings demonstrate the potential of fungal laccases as versatile biocatalysts for the diversification of structurally complex natural products and highlight biotransformation as a sustainable strategy for expanding the chemical space of bioactive constituents from Brazilian red propolis.

References

[1] Ccana-Ccapatinta G.V. et al., *Molecules*. 2020; 25(9):2060.
[2] Queiroz, E.F. et al., *Journal of Chromatography A*. 2019; 1598, 85-91.

Acknowledgments: Swiss National Science Foundation for providing financial support for this project (Grant N°205320_215078, EFQ, and KG). Also, The São Paulo Research Foundation Grant Nº2025/13628-5, MHT, and JKB.

PP40

In Vitro Characterization of a Lytic Bacteriophage Against *Pseudomonas fluorescens* for Application in Low-Sodium Cheeses

Ivan, Lira[1], Inês, Mendonça[1], Carla, Pereira[1], Jaime, Fernandes[2], Simone, Lopes[2], Nuno, Alvarenga[2], Joaquin, Rodriguez, Pinilla[3], Rafael, Tabla[3], Adelaide, Almeida[1]

[1] *CESAM, Department of Biology, University of Aveiro, Aveiro 3810-193, Portugal*
[2] *INIAVE, National Institute for Agrarian and Veterinary Research, 2780-157 Oeiras, Portugal*
[3] *CICYTEX, Instituto Tecnológico Agroalimentario de Extremadura, Badajoz 06071, Spain*
ineslm3@ua.pt; ORCID 0009-0003-6692-5356

Consumer demand for healthier and more natural foods has encouraged the dairy industry to reduce sodium levels in cheese products. However, salt plays a critical role in controlling spoilage microorganisms, and sodium reduction may weaken the natural antimicrobial barrier of cheese, promoting the growth of psychrotrophic bacteria such as *Pseudomonas fluorescens*. This microorganism can negatively affect cheese quality, texture, flavour and safety. To address this challenge, bacteriophage therapy has emerged as a sustainable and targeted biocontrol strategy. By selectively targeting spoilage bacteria without affecting beneficial microbiota, bacteriophages represent a promising alternative for controlling *P. fluorescens* in low-sodium cheeses while preserving product quality and supporting public health objectives.
Liquid milk serum samples collected from cheese-processing facilities were used for bacteriophage isolation. A lytic phage capable of infecting *P. fluorescens* was isolated and characterized *in vitro*. The phage was evaluated for adsorption rate, bacterial inactivation at different multiplicities of infection (MOIs 0.1, 1, 10 and 100) and stability under different pH conditions (4, 5 and 7), temperatures (4, 16 and 25 ºC) and salt concentrations (3, 12 and 18%). *In vitro* assays demonstrated strong antibacterial activity, with bacterial reductions of 4 log CFU/mL after 12 h at MOIs 1 and 10. The phage also exhibited high stability and infectivity over a two-month period under cold temperatures, high salinity conditions, and acidic pH values. Adsorption assays revealed an adsorption constant of $K = 1.64 \times 10^{-10}$ mL^{-1} min^{-1}, with approximately 85% of the phage particles being adsorbed to the host cells after 45 min. Further studies are required to evaluate the phage host range against other *Pseudomonas* spp. and to assess its efficacy and safety directly in milk and cheese matrices. Nevertheless, these findings highlight the potential of this bacteriophage as an effective biocontrol agent against *P. fluorescens*-associated spoilage in low-sodium dairy products.

Acknowledgments: This work was supported by national funds through FCT – Fundação para a Ciência e a Tecnologia I.P., that provide financial support to CESAM (Centre for Environmental and Marine Studies) UID/50006 + LA/P/0094/2020 (doi.org/10.54499/LA/P/0094/2020). The research was also supported by the TID4AGRO Project (0100_TID4AGRO_4_E). FCT also supported this work through funding the PhD grant 2025.05155.BD and through the attribution of a research contract to Carla Pereira within the scope of the project Phage@Kiwifruit—Bacteriophages in the control of kiwifruit canker caused by *Pseudomonas syringae* pv. actinidiae (Psa) (2024.05721.RESTART).

PP41

Anticonvulsant and anxiolytic Effects of a polyphenol-rich extract of white grape juice (WGJe) in rodent models of epilepsy

Martina, Farina[1], Alessandro, Maugeri[2], Francesca, Femia[1], Claudia, Bonasera[1], Michele, Navarra[1]

[1]Department of Chemical, Biological, Pharmaceutical and Environmental Sciences, University of Messina (Italy)
[2]Department of Veterinary Sciences, University of Messina (Italy)
martina.farina@studenti.unime.it; ORCID: 0009-0000-2886-2559

Epilepsy affects approximately 70 million individuals worldwide, thus representing more than 0.5% of the total worldwide illness burden. Given the complexity of this pathology, novel pharmacological agents are constantly sought to find better treatment options. Natural products represent great allies in the management of neurological disorders, such as epilepsy. This is because they are endowed with multitarget capacity, which allow a simultaneous targeting of defective pathways. On this line, the aim of this study was to investigate the effects of a polyphenol-rich extract of white grape juice (WGJe) in different rodent models of epilepsy, exploring its putative mechanism of action. Our results showed that the intraperitoneal injection of WGJe exerted anticonvulsant effects in pentylenetetrazole (PTZ)-induced seizures in ICR-CD1 mice, in which only tonic seizures were significantly hindered ($p < 0.01$). In WAG/Rij rats, a genetic model of absence epilepsy, WGJe did not significantly alter the number and/or duration of the spike-wave discharges in comparison to untreated rats. In genetically audiogenic seizures (AGS)-susceptible DBA/2 mice, WGJe was able to significantly hamper both clonic and tonic seizures ($p<0.01$). Moreover, WGJe showed to possess anxiolytic effects, as assessed through the open field test. Interestingly, the co-administration of WGJe with flumazenil, a GABAA antagonist, restored both clonic and tonic seizures in DBA/2 mice, along with did not protect mice against wild running in comparison to WGJe administered alone, thus suggesting that GABAA receptor mediates the observed results. Indeed, docking simulations confirmed that the main polyphenols of WGJe are able to interact with the benzodiazepine sites located in both extracellular and transmembrane domains in the GABAA receptor. This study suggests the antiepileptic and anxiolytic activity of WGJe and supports its utilization in the management of epilepsy as a novel complementary therapy in the frame of a multitarget pharmacological strategy.

Acknowledgments: *A PhD fellowship from the "Programma Regionale Fondo Sociale Europeo Plus (PR FSE+) Sicilia 2021/2027" to M.F. (CUP: J44D25002160002) is gratefully acknowledged.*

PP42

Recovery of Bioactive Compounds from Blackcurrant Pomace: Extraction, Chemical Profiling, Biological Activity, and Potential for Novel Product Development

Milda Pukalskienė[1] Laura Augustinaitytė[1], Audrius Pukalskas[2], Joanna Oracz[3], Gabriela Kowalska[3]

[1] *Department of Food Science and Technology, Kaunas University of Technology, Lithuania.*

[2] *Lithuanian Research Centre for Agriculture and Forestry, Lithuania*

[3]*Institute of Food Technology and Analysis, Faculty of Biotechnology and Food Sciences, Lodz University of Technology, Poland.*

milda.skemaite@ktu.lt; ORCID 000-0002-8475-1770

This study aimed to recover valuable constituents from blackcurrant pomace using a combination of conventional and innovative multi-step extraction techniques, as well as to evaluate the in vitro biological activity of the obtained extracts. The assessed parameters included total phenolic content (TPC), total procyanidin content, antioxidant capacity (measured using DPPH, ABTS, FRAP, and ORAC assays), and anti-inflammatory potential determined through the inhibition of key pro-inflammatory enzymes such as lipoxygenase (LOX) and hyaluronidase (HYAL).

In addition, Response Surface Methodology (RSM) was applied to optimize pectin extraction conditions in order to maximize yield using enzyme-assisted and acid hydrolysis methods.

The results showed that multi-step extraction significantly improved yields, particularly when ethanol was used as the extraction solvent. Conventional and innovative approaches achieved extraction yields of 30.5% and 39.8 g/100 g, respectively. The extracts demonstrated strong antioxidant properties, with ABTS values ranging from 101.9 to 511.3 mg TE/g extract, and TPC values between 57.2 and 494.9 mg GAE/g extract.

The LOX assay indicated that significant anti-inflammatory activity was observed exclusively in the ethanol extract obtained via pressurized liquid extraction. The antioxidant and anti-inflammatory results were further comprehensively supported by UPLC-MS chromatographic analysis, which enabled a detailed characterization of the chemical profiles of the obtained extracts.

RSM optimization results indicated that enzyme-assisted extraction was effective in improving pectin yield, with a maximum value of 6.5% achieved under conditions of a 1:20 pomace-to-liquid ratio, 3-hour extraction time, and enzyme activity of 106 U. FTIR analysis confirmed that the obtained pectin was characterized by a high degree of esterification.

Overall, the findings underscore blackcurrant pomace as a valuable and promising raw material for the development of innovative natural cosmetic and functional ingredients; however, further research is required to fully substantiate its potential.

Acknowledgments: This work was financially supported by the ECIU (European Consortium of Innovative Universities) SEED program, project No. SP2-KTU-03; From Waste to Opportunity: Sustainable Approaches to Food Waste (WOSAF)

PP43

Pulchinenoside Ic mitigates paraquat-induced oxidative stress in *Caenorhabditis elegans* through the SKN-1/GST-4 pathway

Boris, Krastev[1], Camilla, Todeschini[2], Biser, Binev[1,3], Liliya, Mihaylova[1,3], Milen, Georgiev[1,3*]

[1] *Laboratory of Metabolomics, Department of Biotechnology, Institute of Microbiology, Bulgarian Academy of Sciences, 4000 Plovdiv, Bulgaria*
[2] *ITS Academy Giulio Natta, 24125 Bergamo, Italy*
[3] *Department of Plant Cell Biotechnology, Center of Plant Systems Biology and Biotechnology, 4000 Plovdiv, Bulgaria*
milengeorgiev@gbg.bg; ORCID 0000-0001-5248-6135

Identifying natural compounds capable of modulating inflammation and extending healthspan is a major focus of biological research. Pulchinenoside Ic, a triterpene glycoside, exhibits diverse pharmacological benefits, but its *in vivo* impact on inflammation and cellular homeostasis remains to be fully elucidated [1]. This study investigated the antioxidant, and anti-inflammatory potential of Pulchinenoside Ic under both physiological conditions, high-glucose-induced metabolic stress and paraquat-induced oxidative stress using the model organism *Caenorhabditis elegans.*
Basal viability and the maximum safe concentration were determined. Synchronized wild-type nematodes were treated with Pulchinenoside Ic (25, 50, and 100 μM). Morphological development and locomotion were captured using the WormLab automated system. Transgenic GFP reporter strains were utilized to evaluate the expression of the master antioxidant regulator SKN-1, its downstream detoxification target GST-4 (following paraquat-induced oxidative stress), and intestinal mitochondrial mass.
Pulchinenoside Ic significantly enhanced basal nematode viability across a 10–500 μM concentration range. In the glucose-induced stress model, the compound did not alter body size parameters. Automated tracking revealed a temporary decrease in locomotion speed with dose-dependent partial recovery at higher concentrations. Mechanistically, a higher concentration (100 μM) triggered a significant upregulation of the transcription factor SKN-1, boosted intestinal mitochondrial mass, and mitigated paraquat-induced oxidative stress by stabilizing GST-4 reporter expression.
Collectively, our findings suggest that Pulchinenoside Ic exerts distinct, concentration-dependent bi-directional effect. It directly suppresses fat accumulation at low doses and orchestrates mitochondrial-mediated cytoprotective defence program at higher doses *via* the SKN-1/GST-4 pathway. These findings validate Pulchinenoside Ic as a promising nutraceutical candidate for managing oxidative and metabolic stress, hence, promoting healthspan improvement.

References

[1] Fang, Y. et al. *International Immunopharmacology*, 2026, 171, 116108.

Acknowledgments: This research received funding from the Bulgarian National Science Fund project contract number КП-6-КОСТ/6.

PP44

Biochemical and oxidative alterations of red blood cells in the presence of Pterocarpans: the case of Trifolirhizin

Stefano Putaggio[1], Giuseppe T. Patanè[1,2], Davide Barreca[1], Antonella Calderaro[1], Silvana Ficarra[1], Annamaria Russo[1], Ester Tellone[1]

[1] *Department of Chemical, Biological, Pharmaceutical and Environmental Sciences, University of Messina, Viale Ferdinando Stagno d'Alcontres 31, 98166 Messina, Italy.*
[2] *"Prof. Antonio Imbesi" Foundation, University of Messina, 98100 Messina, Italy.*
stefano.putaggio@studenti.unime.it

Trifolirhizin (TFL) is a pterocarpan flavonoid that possesses several biological properties, but its impact on red blood cells (RBCs) still represents an unexplored field of research. The present study aims to fill this gap by evaluating the impact of TFL on RBCs homeostasis through a detailed experimental analysis that includes membrane integrity (hemolysis, morphology, and acetylcholinesterase (AChE) activity), anion flux kinetics (band 3 protein activity), metabolic status (intracellular and extracellular ATP levels and protein tyrosine phosphatase (PTP-1B) activity), and oxidative profile (met-hemoglobin, lipid peroxidation, thiols oxidation, superoxide dismutase (SOD) and catalase (CAT) activity, and glutathione GSH levels). Finally, cell viability and potential triggering of apoptotic pathways were characterized by flow cytometry and caspase-3 assay. The results indicate that treatment of erythrocytes with TFL (25.0-50.0-100.0 µM) for 24 hours induced a concentration-dependent increase in the percentage of hemolysis, associated with changes in the RBCs morphology even at the lowest dose. Furthermore, TFL inhibited the kinetics of anion exchange (both in intact RBCs and ghosts) and stimulated an increase in PTP-1B activity. This metabolic imbalance is consistent with decreased ATP levels, worsening of oxidative state (increased oxidation of -SH groups, lipid peroxidation, SOD/CAT activity, and decreased GSH levels), and activation of caspase-3. In conclusion, TFL emerges as a multisite disruptor of erythrocyte homeostasis. While its marked pro-oxidant action poses significant concerns regarding hematological toxicity, this same biochemical mechanism suggests a strategic potential as a cytotoxic agent against tumor cell lines resistant to conventional antioxidants.

PP45

Azorean Endemic Species as Sources of Bioactive Phytochemicals with Applications in Medicine

Ana M. L., Seca[1,2,3], Mariana M., Viveiros[1], Francisca F. F. S. A., Lucas[1], Vera L. M., Gouveia[1], Maria do Carmo, Barreto[1,2]

[1] *University of the Azores, Faculty of Sciences and Technology, Portugal*
[2] *CE3C - Centre for Ecology, Evolution and Environmental Changes, Azorean Biodiversity Group & CHANGE - Global Change and Sustainability Institute, Portugal*
[3] *LAQV-REQUIMTE, Universidade de Aveiro, Portugal.*
ana.ml.seca@uac.pt; ORCID 0000-0002-7709-2375

The endemic and native biodiversity of the Azores represents a promising yet largely unexplored source of structurally unique natural products with relevant biomedical potential [1,2]. This work focuses on the isolation, structural characterization and biological evaluation of secondary metabolites from selected Azorean species, namely *Juniperus brevifolia*, *Cystoseira abies-marina* and *Laurus azorica*. Phytochemical studies using chromatographic techniques coupled with spectroscopic analysis (1D/2D NMR and MS) enabled the identification of several structurally diverse compounds.

From *J. brevifolia*, several new natural compounds, such as the spiro heterocyclic 3,4-dehydrotheaspirone, and bioactive diterpenes such as 18-hydroxydehydroabietane were isolated, showing significant cytotoxic and antibacterial activities, even better than the positive control. The brown macroalga *C. abies-marina* yielded new structurally unprecedented meroterpenoids, including cystoazorones A–B and cystoazorols A–B. Among them, cystoazorol A demonstrated significant antiproliferative and antioxidant activity, with promising selectivity towards tumour cells.

In *L. azorica*, phytochemical investigation of the lipophilic fraction led to the first report of several sesquiterpene lactones in this species namely costunolide, 11,13-dehydrosantonin and reynosin. These compounds, together with a terpenoid-rich chemical profile, contribute to the observed antioxidant activity and enzyme inhibition potential, reinforcing their relevance for cosmetic applications.

Overall, these findings highlight Azorean endemic and native terrestrial and marine organisms as valuable and largely untapped sources of structurally unique bioactive phytochemicals with promising biomedical and cosmeceutical applications.

References

[1] Seca, A.M.L. et al., *Phytochemistry*, 2008, 69, 498–505.
[2] Rosa. G.P. et al., *Marine Drugs*, 2023, 21, 35.

Acknowledgments: Thanks are due to FCT – Fundação para a Ciência e a Tecnologia, I.P., under the multiannual funding of the R&D Units [UID/00329/2025] (https://doi.org/10.54499/UID/00329/2025) | Centre for Ecology, Evolution and Environmental Changes (CE3C) and [UID/50006/2025] (https://doi.org/10.54499/UID/50006/2025) | Laboratório Associado para a Química Verde - Tecnologias e Processos Limpos (LAQV). Additional support was provided by Regional Directorate for Science, Innovation and Development [Regional Government of the Azores] through the PROSCIENTIA Incentive System (M1.1.A/FUNC.UI&D/021/2025 [UI&D/GBA/2025].

PP46

Antihypertensive and Cardioprotective effect of Geranyl Acetate and its complex in animal models

Márcio Roberto Viana dos Santos[1]; Ivinne Andressa Nascimento da Silva[1]; Izabel Rodrigues de Santana[1,2]; Aimée Obolari Durço[1,3]; André Sales Barreto[4]; Diego Santos Souza[1]; Danilo Roman-Campos[3]; Elaine Carvalho Santana[5]; Adriano Antunes de Souza Araújo[6].

[1]*Department of Physiology, Federal University of Sergipe, Brazil.*
[2]*Graduate Program in Health Sciences, Federal University of Sergipe, Brazil.*
[3]*Department of Biophysics, Federal University of São Paulo, Brazil.*
[4]*Department of Health Education, Federal University of Sergipe, Brazil.*
[5]*Graduate Program in Biotechnology – RENORBIO, Federal University of Sergipe, Brazil.*
[6]*Department of Pharmacy, Federal University of Sergipe, Brazil.*
marciorvsantos@academjco.ufs.br; ORCID: 0000-0002-9458-0370

Geranyl acetate (GA), a naturally occurring acyclic monoterpene ester present in the essential oils of several aromatic species, has emerged as a bioactive secondary metabolite with putative anti-inflammatory and cardioprotective activities. Despite these beneficial effects, its low solubility and high volatility limit its clinical applicability. Evidence suggests that complexation with β-cyclodextrin (β-CD) may enhance its bioavailability and improve its volatility. Thus, the aim of this study was to evaluate and compare the antihypertensive and cardioprotective effects of free and β-CD-complexed GA (GA+β-CD) in animal models. For antihypertensive study, blood pressure and heart rate were measured in male Wistar rats before and 48h after oral administration of free or complexed GA (50, 100, or 200 mg/kg). The cardioprotective effect was assessed in a murine model of doxorubicin-induced cardiotoxicity. After treatment, electrocardiographic parameters were analyzed. All experimental protocol was previously approved by the Animal Care Committee from UFS (#3618130423). Administration of free GA (50, 100, and 200 mg/kg) reduced blood pressure (8.5 ± 2.5%; 13.4 ± 1.1%, and 18.2 ± 0.3%, respectively) but induced reflex tachycardia. In contrast, GA+β-CD (200 mg/kg) significantly increased both the magnitude and duration of hypotension (24.1 ± 0.9 %) and induced bradycardia. In the murine model cardiotoxicity, doxorubicin prolonged the QTc interval (from 178 ± 3 to 262 ± 32 ms, $n = 5$, $p < 0.05$) and increased QRS duration (from 26 ± 3 to 37 ± 2 ms, $n = 5$, $p < 0.05$). These alterations were significantly ($p < 0.01$) attenuated by both free and complexed GA. In conclusion, GA, particularly when complexed with β-CD, demonstrates promising antihypertensive and cardioprotective effects, warranting further investigation.

Acknowledgments: CNPq, CAPES and FAPITEC

PP47

Recovery of exhausted biomasses from the essential oil distillation chain as a feed resource: Nutritional value and volatile phytochemical profile

Maria Francesca, Bozzini[1], Marco, Ferrara[2], Roberta, Ascrizzi[1,3], Ylenia, Pieracci[1], Massimo, Montanari[4], Guido, Flamini[1,3], Iolanda, Altomonte[2]

[1] *Department of Pharmacy, University of Pisa, Via Bonanno 6, 56126, Pisa, Italy;*
[2] *Department of Veterinary Science, University of Pisa, Viale delle Piagge 2, Pisa, Italy;*
[3] *Nutrafood Research Center, University of Pisa, Via del Borghetto 80, 56124, Pisa, Italy;*
[4] *Council for Agricultural Research and Economics (CREA), Research Centre for Cereal and Industrial Crops, Via Di Corticella 133, 40128, Bologna, Italy.*

mariafrancesca.bozzini@phd.unipi.it; ORCID: 0009-0003-9022-2861

Essential oil (EO) production generates large amounts of solid residues due to the low extraction yields of aromatic plants. These exhausted biomasses (EB), often treated as waste, may still retain bioactive secondary metabolites and nutrients, representing an underutilized resource with potential applications in the food, cosmetic, and livestock sectors. The reintroduction of agro-industrial by-products into production chains can reduce environmental impact and improve resource efficiency [1,2]. In this context, the present study evaluated the nutritional composition and residual volatile profile of EB obtained after steam distillation of bay laurel (*Laurus nobilis* L.), lavender (*Lavandula angustifolia* Mill.), lavandin (*Lavandula* × *intermedia* Emeric ex Loisel.), and industrial hemp (*Cannabis sativa* L.), the latter deriving from the seed-processing chain (double waste recovery). Proximate composition was determined according to AOAC methods, and volatile organic compounds (VOCs) were analysed by HS-SPME/GC–MS. All EB were rich in structural carbohydrates (NDF, ADF). Lavender and lavandin exhibited elevated ADL levels, indicating high lignification and potentially low digestibility. Bay laurel combined high fiber with lower lignification, suggesting potential suitability for ruminant feeding. In addition, industrial hemp residues exhibited higher crude protein and ash contents. Ether extract ranged from 2% to 6% DM. VOCs analysis revealed species-specific terpene patterns. Bay laurel remained rich in monoterpene hydrocarbons (α- and β-pinene, γ-terpinene), with the shortest optimal sampling times, indicating good retention of VOCs in the residual matrix. Lavender and lavandin, besides their typical oxygenated monoterpenes (linalool in lavender; linalool, borneol, and camphor in lavandin), exhibited high relative abundances of β-caryophyllene, and similarly high levels of this sesquiterpene were observed in hemp samples. These findings indicate that EB retained nutritionally relevant fractions together with residual bioactive terpenes, supporting further evaluation as functional feed ingredients. Future research should address antioxidant activity, *in vivo* digestibility, optimal inclusion rates, and sensory acceptability in livestock systems.

References

[1] Miljanović, A. et al. *Plants*, 2023, 12 (13), 2394.
[2] Khiri, S. et al., *Biomass and Bioenergy*, 2025, 201(2), 108109.

PP48

Lactic acid fermentation enhances the health benefits of osmotically dehydrated onion preparations

Katarzyna, Grzelak-Błaszczyk[1], Bartosz, Fotschki[2], Katarzyna, Jaworska[2], Sylwia, Ścieszka[3], Lidia, Piekarska-Radzik[3], Elżbieta, Klewicka[3], Dorota, Napiórkowska[2], Michał, Sójka[1], Robert, Klewicki[1], Joanna, Fotschki[2], Jerzy, Juśkiewicz[2]

[1]*Institute of Food Technology and Analysis, Lodz University of Technology, Stefanowskiego 2/22, 90-537 Łódź, Poland*
[2]*InLife Institute of Animal Reproduction and Food Research, Polish Academy of Sciences, Trylińskiego 18, 10-683 Olsztyn, Poland*
[3]*Institute of Fermentation Technology and Microbiology, Lodz University of Technology, Wólczańska 171/173, 90-530 Łódź, Poland*
katarzyna.grzelak-blaszczyk@p.lodz.pl; ORCID: 0000-0002-2399-4138

Osmoconcentration and lactic fermentation not only extend the shelf life of food, but also provide health benefits and improve the quality of the final product. However, the mechanism of their mutual relationship is unknown. Research on the health-promoting properties of red onions is increasingly focusing on bioactive compounds such as polyphenols and fructans, which can modulate the gut microbiota. New onion varieties subjected to innovative osmoconcentration and fermentation processes represent a particularly interesting area of research, as technological processing can increase the bioavailability of ingredients and modify their biological activity. Understanding the relationships between technological processes, the chemical composition of preparations, and their effects on the body can contribute to the development of innovative functional food products and nutraceuticals with targeted health-promoting effects.

This study aimed to evaluate the effectiveness of osmotic dehydration with a lactose solution, alone or combined with lactic acid fermentation, in producing novel red onion variety preparations with functional properties, and to assess their physiological effects on gastrointestinal function, metabolism and immune status in rats. The main attention was paid to caecal fermentation parameters, microbial enzymatic activity, short-chain fatty acid caecal production, bile acid composition, hepatic lipid metabolism, plasma biochemical markers, gene expression in liver tissue and haematological indices. Dietary onion supplementation exerted moderate to large size effects on caecal digesta mass, pH, SCFA composition, and microbial enzyme activities, indicating enhanced gut fermentation and microbial functional capacity. Onion treatments modulated bile acid metabolism. The osmotically dehydrated/fermented onion preparation produced the most pronounced systemic effects, including reduced hepatic fat and triglyceride accumulation, lower plasma triglycerides and atherogenic index, and favourable modulation of genes involved in lipid metabolism, bile acid synthesis, inflammation, and immune signalling.

The combination of osmotic dehydration with lactose and lactic acid fermentation seems to be most favourable strategy, supporting the potential of fermented onion preparations as functional dietary ingredients.

Acknowledgments: *The research was funded in whole by National Science Centre, Poland (OPUS, 2022/45/B/NZ9/00550).*

PP49

Bronchial epithelial IB3-1 cells exposed to the anti-SARS-CoV2 BNT162b2 vaccine: induction of apoptosis is partially reversed by S-allyl-cysteine and S-1-propenyl-l-cysteine, two bioactive components of Aged Garlic Extract

Federica di Padua[1], Giovanni Marzaro[2], Enzo Agostinelli[3], Roberto Gambari[1], Alessia Finotti[1]

[1]Department of Life Sciences and Biotechnology, Ferrara University, I-44121 Ferrara, Italy; [2]Department of Diagnostics and Public Health, University of Verona, I-37134 Verona, Italy; [3]Department of Sensory Organs, Sapienza University of Rome, Policlinico Umberto I, I-00161 Rome, Italy.

gam@unife.it

The SARS-CoV2 Spike protein (S-protein) exhibits important effects on human cells, including induction of apoptosis. Accordingly, the adverse effects of COVID-19 mRNA vaccines could be at least in part due to the presence of circulating spike [1]. The main purpose of the present study was to determine (a) whether treatment of the IB3-1 bronchial epithelia cells with the BNT162b2 COVID-19 vaccine is associated with activation of the apoptotic pathway and (b) whether SAC (S-allyl-cysteine) and S1PC (S-1-propenyl-l-cysteine), two natural products present in Aged Garlic Extract, have any effect of therapeutic relevance on this experimental model system. We have previously reported inhibitory activities of AGE, SAC and S1PC on the expression of proinflammatory genes in IB3-1 cells [2]. In the present study, we have exposed IB3-1 cells to BNT162b2 (0.7, 1.25, 2.5 and 3,5 □g/mL) and after 3 days of culture apoptosis was assessed using the Annex V and Caspase 3/7 apoptosis kits. The results demonstrated highly significant increase of apoptotic cells after treatment of IB3-1 cells with the BNT162b2 vaccine. In order to verify whether treatment of IB3-1 cells with SAC and S1PC alters the BNT162b2-induced apoptosis, cells have been treated with the BNT162b2 vaccine in the absence or in the presence of 50 and 100 □M SAC and 50 and 100 □M S1PC. The results, obtained employing both Annex V and Caspase 3/7 kits, demonstrated that the proportion of apoptotic cells was significantly reduced in cells treated with the BNT162b2 vaccine in the presence of the AGE constituents SAC and S1PC, suggesting that these natural products are able to mitigate the pro-apoptotic effects induced by the BNT162b2 vaccine on IB3-1 cells. The efficacy of the reversion of BNT162b2 induced apoptosis suggests that SAC and S1PC should be considered for the development of protocols for counteracting apoptosis induced by the Spike mRNA-based COVID-19 vaccines. This might be of potential clinical relevance, since one of the biological adverse effects of Spike protein (and, indirectly, of the Spike-producing vaccines) is high induction of apoptosis in different cellular systems [1].

References

[1] Trougakos, IP et al. *Trends Mol Med*, 2022, 28(7):542-554.
[2] Agostinelli E et al. *Exp Ther Med*. 2025, 30(1):134.

Acknowledgments: This work was funded by Wakunaga Pharmaceutical Co. Ltd. (Hiroshima, Japan).

PP50

Deciphering the mechanism of *Cynomorium songaricum* polysaccharides in alleviating insulin resistance through multi-omics integration

Dongwei, Wang[1,2], Yong, Zhu[1,2], Yishan, Tong[1,2], Jun, Yi[1], Jihang, Chen[1,2]

[1] *Shenzhen Key Laboratory of Steroid Drug Discovery and Development, Department of Pharmaceutical Science, Division of Biomedical Health Sciences, School of Medicine, The Chinese University of Hong Kong, Shenzhen, China*
[2] *The Chinese University of Hong Kong, Shenzhen Futian Biomedical Innovation R&D Center, Shenzhen, Guangdong, China*
chenjihang@cuhk.edu.cn; ORCID: 0009-0000-5692-8949

Insulin resistance (IR) is a key driver of metabolic syndrome [1]. *Cynomorium songaricum* polysaccharides (CSPs) possess diverse bioactivities, but their role in IR remains unclear [2]. In this study, we extracted, purified, and structurally characterized CSPs, and then evaluated their protective effects against high-fat diet (HFD)-induced insulin resistance in mice following an 8-week intervention, combined with multi-omics to uncover the underlying mechanisms. Structural analysis showed that CDPs were mainly composed of glucose. Compared to HFD-fed controls, CSP-treated mice exhibited significantly improved glucose tolerance and insulin sensitivity, as evidenced by oral glucose tolerance test (OGTT), insulin tolerance test (ITT), and reduced HOMA-IR index and inflammatory infiltration in liver histopathology. Multi-omics integration revealed that CSPs reshaped the gut microbiota by enriching beneficial bacteria; altered cecal metabolites, including increased short-chain fatty acids. Correlation analyses linked these microbial and metabolic changes to enhanced host insulin sensitivity and hepatic gene expression. Collectively, our findings demonstrate that CSPs alleviate HFD-induced insulin resistance through coordinated regulation of gut microbiota, microbial metabolites, systemic metabolism, and hepatic transcriptional networks, providing a multi-omics basis for developing CSPs as a prebiotic-like candidate against metabolic disorders.

References

[1] Accili, D. et al. *Nature Reviews Endocrinology*, 2025, 21, 413-426.
[2] Gao, S. et al., *Trends in Food Science & Technology*, 2026, 172, 105661.

Acknowledgments: This work was supported by the research grants from Guangdong Natural Science Foundation (2023A1515011492), Shenzhen Science and Technology Program (GJHZ20240218114200001).

PP51

Valorization of essential oil distillation byproducts of six *Lamiaceae* herbs

Zsuzsanna Pluhár[1], Beáta Gosztola[1], Péter Radácsi[1], Karim Etri[1], Szilvia Tavaszi-Sárosi[1]

[1] *Department of Medicinal and Aromatic Plants, Institute of Horticultural Science, Hungarian University of Agriculture and Life Sciences, Budapest, HUNGARY*

zsuzsanna.pluhar@uni-mate.hu; ORCID 0000-0002-1845-3222

The essential oil industry is experiencing a significant global growth, while producing huge amounts of distillation byproducts. The main aim of our studies was to assess the factors influencing the quality of distillation wastes belonging to six *Lamiaceae* herbs (peppermint, true lavender, lavandin, rosemary, thyme and oregano), in order to ground their sustainable reuse. Samples supplied by industrial partners, operating with steam distillation stills of different size (1 m^3, 3 m^3 and 30 m^3) were tested in our experiments. Content and composition of the essential oils (EO) as well as total polyphenol content (TPC), antioxidant capacity (AC) and phenolic acid amounts (by HPLC) of distillation by-products were determined.

We have found that solid residues still contain considerable amounts of biologically active compounds, however, differences among species were significant in TPC, AC and phenolic acid contents, respectively. Essential oil and byproduct composition were highly determined by species, variety, growing site as well as by the size of distillation equipment. If compared the total polyphenols of distillation byproducts (205-250 mg GAE/g DW) with those measurable prior to distillation (240-334 mg GAE/g DW), only a slight decrease could be shown. Outstanding TPC levels were obtained in distillation wastes of rosemary, lavandin, peppermint and oregano. In the latter, small scale distillation was superior (200 mg GAE/g DW) to the large one (92,88±3,00 mg GAE/g DW). Direction of changes in antioxidant capacity was similar to the TPCs, when comparing the original data (219-246 mg AAE/g DW) with distillation wastes (166-199 mg AAE/g DW). Species with high AC levels were lavandin>rosemary>oregano and >peppermint. Concerning phenolic acids, rosmarinic acid (RA) contents declined in byproducts (6,1-9,7 mg/g), if compared with the original samples (13.9-14,1 mg/g). Higher RA values were found in oregano, thyme and peppermint, while chlorogenic acid (2,034±0,254 mg/g) and caffeic acid (1,072±0,311 mg/g) peaked in lavandin.

PP52

Exploring Neuroprotective Lignan Glucosides from *Osmanthus fragrans* var. *aurantiacus* Using Molecular Networking

Yoo Kyong, Han[1], Kyeong Seon, Lee[1,2], Mi Kyeong, Lee[3], Ki Yong, Lee[1,2]

[1] *College of Pharmacy, Korea University, Sejong 30019, Republic of Korea*
[2] *Interdisciplinary Major Program in Innovative Pharmaceutical Sciences, Korea University, Sejong 30019, Republic of Korea*
[3] *College of Pharmacy, Chungbuk National University, Cheongju 28160, Republic of Korea*
kylee11@korea.ac.kr; ORCID: 0000-0002- 6191-4485

Osmanthus fragrans var. *aurantiacus* is traditionally used in East Asia as a medicinal herb and functional tea. In this study, an LC–QTOF–MS/MS-based molecular networking strategy was applied to identify previously uncharacterized neuroprotective constituents from its extract. This approach led to the isolation of four new furofuran-type lignan glucosides, whose stereochemical features were elucidated using ECD calculations and chemical derivatization [1]. The compounds were evaluated in an L-glutamate–induced oxidative stress model using HT22 neuronal cells, where two lignan glucosides showed notable neuroprotective effects. To explore their potential mechanism of action, molecular docking and molecular dynamics simulations were performed focusing on the Keap1–Nrf2 signaling pathway. These findings were further supported by protein-level analysis indicating modulation of Keap1 expression under oxidative stress conditions. Overall, this work highlights MS/MS-based molecular networking as an effective strategy for discovering neuroprotective lignan glucosides from natural sources.

References

[1] Han, Y.K. et al. *ACS Omega*, 2025, 10(36), 41233-41246.

Acknowledgments: This research was supported by the National Research Foundation of Korea grants funded by the Korean Government (RS-2019-NR040070 and RS-2021-NR058871) and the MSIT (Ministry of Science and ICT), Korea under the ITRC (Information Technology Research Center) support program (IITP-2026-RS-2023-00258971) supervised by the IITP.

PP53

Phytochemical investigation of the aerial parts of *Lycopus lucidus* for functional food applications: isolation of three new abietane-type diterpenes

Woo Jin, Kim[1], Jae Sang, Han[1], Joon Su, Jang[1], Mi Kyeong, Lee[1] and Bang Yeon, Hwang[1]

[1]*College of Pharmacy, Chungbuk National University, Cheongju 28160, Korea*
byhwang@chungbuk.ac.kr; ORCID: 0000-0002-4148-6751

Lycopus lucidus Turcz. (Lamiaceae), widely distributed across East Asia, is a perennial medicinal plant traditionally used to treat dysmenorrhea, carbuncles, and sores [1]. The aerial parts of *L. lucidus* produce diverse secondary metabolites that have been reported to exhibit various biological activities, including anticancer, anti-inflammatory, and antioxidant effects [1, 2]. This study was conducted to isolate and purify bioactive compounds particularly involved in the anti-inflammatory and anticancer effects of the plant. The dried aerial parts of *L. lucidus* were extracted with MeOH and partitioned into *n*-hexane, CH_2Cl_2, EtOAc and *n*-BuOH. All soluble fractions were evaluated for their nitric oxide (NO) inhibitory effects in RAW 264.7 macrophages. Among them, the CH_2Cl_2-soluble fraction exhibited NO inhibitory activity (IC_{50} = 56.8 μg/mL). Subsequent purification of this active fraction using various column chromatography techniques led to the isolation of three new abietane-type diterpenes (**1**-**3**), together with a known abietane-type diterpene (**4**) and a known flavonoid (**5**). Their chemical structures were elucidated based on 1D and 2D NMR and HRESIMS data. Herein, we report the isolation and structural determination of three new abietane-type diterpenes as well as their inhibitory effects on NO production in LPS-induced RAW 264.7 macrophage cells.

References

[1] Min, G.-Y. et al. *Molecular Medicine Reports*, 2021, 24, 827.
[2] Yang, X. et al. *Chemistry & Biodiversity*, 2025, 22, e202500332.

PP54

Phytochemical and biological activity analysis of different mint species

Szilvia, Tavaszi-Sárosi[1], Ameni, Sfaxi[1], Ákos, Juhász[2], Kamirán Áron, Hamow[3]

[1] *Hungarian University of Agriculture and Life Sciences, Department of Medicinal and Aromatic Plants, Villányi St. 29-35, 1118 Budapest, Hungary*
[2] *Hungarian University of Agriculture and Life Sciences, Institute of Genetics and Biotechnology, Department of Microbiology and Applied Biotechnology, Szentgyörgyi A. St. 4, 2100, Gödöllő, Hungary*
[3]*HUN-REN Centre for Agricultural Research, Agricultural Institute, Department of Plant Physiology and Metabolomics, Brunszvik St. 2, 2462, Martonvásár, Hungary*
tavaszi-sarosi.szilvia@uni-mate.hu; ORCID: 0000-0002-4646-6178

The chemical composition (volatile and phenolic compounds) and in vitro biological activity (antioxidant and antibacterial) were evaluated in six mint species - apple mint (*Mentha suaveolens*), bergamot mint (*Mentha aquatica* subsp. *citrata*), horsemint *(Mentha longifolia*), mojito mint (*Mentha* × *villosa*), peppermint (*Mentha* × *piperita*) and spearmint (*Mentha spicata*) - cultivated in the experimental field of the Hungarian University of Agriculture and Life Sciences.
A total of 34 volatile compounds have been identified by GC-MS method in the hydrodistilled essential oil of the dried leaves, main compounds were the following: cis-piperitone-epoxide, linalool and linalyl acetate, p-cymene and thymol, L-carvone, menthone and menthol. Referring to the phenolic compounds 65 constituents have been described by using UPLC-US-MS/MS technique, among them caffeic acid, rosmarinic acid and several flavonoids. Besides the phytochemical parameters *in vitro* biological activity was also analysed. Antioxidant activity was characterised by the total phenolic content (TPC) and total antioxidant capacity (TAC), while antibacterial effects (inhibition zones, MIC, IC_{50} and MBC) were evaluated against *Escherichia coli, Salmonella enterica*, *Bacillus cereus* and *Staphylococcus aureus*.
Significant differences were observed in all analysed parameters. Among the mint species, bergamot mint showed the highest antioxidant activity (TPC: 285.6 mg gallic acid equivalent/100 g dry material; TAC: 234.5 mg ascorbic acid equivalent/100 g dry material) possibly due to the elevated caffeic acid (100.5 µg/g), rosmarinic acid (5050 µg/g) and its unique flavonoid composition (eriocitrin: 36800 µg/g). Antibacterial effect was connected to the main essential oil compounds; therefore horsemint oil showed the best results containing higher ratio of thymol, which is known for its strong antibacterial effect (inhibition zones: 15-18 mm, MIC v/v %: 0.06-0.125, IC50 v/v%: 0.02-0.07, MBC v/v%: 0.125-0.25). None of the essential oils could kill *B. cereus* in the applied concentrations.
Our results confirm that mint species are rich sources of biologically active compounds giving the possibility of diverse pharmaceutical usage.

Acknowledgments: This work has been supported by JÁNOS BOLYAI RESEARCH SCHOLARSHIP OF THE HUNGARIAN ACADEMY OF SCIENCES (BO/00585/22/4) and by the Research Excellence Programme of the Hungarian University of Agriculture and Life Sciences.

PP55

Extraction Method Matters: Phenolic Composition and Bioactivity of Digestive-Support Herbs

Katarzyna, Szafrańska[1], Małgorzata M, Posmyk[1], Agnieszka, Kobylińska[1]

[1] *Department of Plant Ecophysiology, Faculty of Biology and Environmental Protection, University of Lodz, Banacha 12/16, 90-237 Lodz, POLAND*

katarzyna.szafranska@biol.uni.lodz.pl; ORCID 0000-0003-2082-8879

Medicinal plants used in the prevention and supportive treatment of digestive system disorders are an important source of bioactive phytochemicals, particularly polyphenols with antioxidant and metal-chelating properties. This study evaluated the effect of extraction temperature and duration on the polyphenolic profile and bioactivity of selected digestive-support herbs.

Hot (infusion/decoction) and cold (maceration) aqueous extracts were prepared from *Alchemilla vulgaris, Lavandula angustifolia, Potentilla erecta, Rosmarinus officinalis*, and *Senna* sp. The extracts were analyzed for low molecular weight polyphenols (fraction A), high molecular weight polyphenols (fraction B), and dominant compounds. Functional properties were assessed using ABTS, FRAP, and FeMICA assays.

The effect of extraction temperature on fraction A was strongly species-dependent. Hot extraction enhanced the recovery of low molecular weight phenolic acids in *Senna* sp. and *Rosmarinus officinalis*, whereas *Potentilla erecta* showed higher levels under cold conditions. In *Alchemilla vulgaris*, similarly high fraction A levels were maintained irrespective of extraction method. In all five analysed herbs, however, cold extraction favoured the recovery of high molecular weight flavonoids, catechins, and stilbenes, including baicalin, catechin, piceatannol, hesperidin, and resveratrol, associated with enhanced metal-chelating capacity.

Species-specific differences were observed in *Lavandula angustifolia, Potentilla erecta*, and *Rosmarinus officinalis*, where cold macerates showed improved FeMICA activity despite lower ABTS and FRAP values, suggesting that phytochemical diversity contributes more strongly to metal-binding properties than radical scavenging.

These findings support the rational selection of extraction protocols tailored to the therapeutic mechanism in digestive-support phytotherapeutic formulations.

Acknowledgments: The research project is funded by the Minister of Education and Science under the program Science for Society II (NdS-II/SP/0390/2023/01), as well as by the University of Lodz, including the Faculty of Biology and Environmental Protection.

PP56

Hot vs Cold Extraction: Phenolic Profiles and Antioxidant Capacity of Herbs Supporting the Respiratory System

Katarzyna, Szafrańska[1], Agnieszka, Kobylińska[1], Małgorzata M, Posmyk[1]

[1] *Department of Plant Ecophysiology, Faculty of Biology and Environmental Protection, University of Lodz, Banacha 12/16, 90-237 Lodz, POLAND*

katarzyna.szafranska@biol.uni.lodz.pl; ORCID 0000-0003-2082-8879

Respiratory-support medicinal plants are an important source of phytochemicals with antioxidant and metal-chelating activity. This study investigated how aqueous extraction conditions modify the phenolic profile and predominant antioxidant mode of action of selected herbs traditionally used for respiratory support.

Hot (decoction) and cold (maceration) extracts were prepared from *Plantago lanceolata*, *Thymus serpyllum*, *Thymus vulgaris*, *Tussilago farfara*, and *Veronica officinalis*. Extracts were characterized in terms of low molecular weight polyphenols (fraction A) and high molecular weight polyphenols (fraction B), and their functional properties were evaluated using ABTS, FRAP, and FeMICA assays.

A clear species-dependent response to extraction conditions was observed. Cold extraction strongly promoted the accumulation of high molecular weight polyphenols in *Thymus serpyllum*, with fraction B exceeding 7.1 mg ml^{-1}, mainly due to baicalin enrichment. A similar enhancement of phenolic recovery was found in *Veronica officinalis.*

By contrast, hot extracts were characterized by stronger direct antioxidant activity, reflected in higher ABTS and FRAP values, particularly in *Thymus vulgaris*, which showed exceptionally high levels of low molecular weight phenolics (>2.1 mg ml^{-1}). Cold extracts, however, consistently demonstrated improved FeMICA activity, indicating a shift toward metal-chelation as the predominant antioxidant mode of action.

These results indicate that the preparation method may directly determine the dominant antioxidant mechanism of respiratory-support herbal formulations and should therefore be considered in evidence-based phytotherapeutic design.

Acknowledgments: The research project is funded by the Minister of Education and Science under the program Science for Society II (NdS-II/SP/0390/2023/01), as well as by the University of Lodz, including the Faculty of Biology and Environmental Protection.

PP57

Extraction Temperature Shapes Phenolic Diversity and Antioxidant Potential in Herbs Supporting the Nervous System

Katarzyna, Szafrańska[1], Małgorzata M, Posmyk[1], Agnieszka, Kobylińska[1]

[1] *Department of Plant Ecophysiology, Faculty of Biology and Environmental Protection, University of Lodz, Banacha 12/16, 90-237 Lodz, POLAND*

katarzyna.szafranska@biol.uni.lodz.pl; ORCID 0000-0003-2082-8879

Medicinal plants used to support the nervous system are a rich source of polyphenols with antioxidant and potential neuroprotective properties. This study examined how aqueous extraction conditions influence the phenolic composition and functional antioxidant profile of selected herbs traditionally used in nervous system support.

Hot (decoction) and cold (maceration) extracts were prepared from *Bacopa monnieri*, *Melissa officinalis*, *Ocimum tenuiflorum*, *Scutellaria baicalensis*, and *Valeriana officinalis*. Extracts were analyzed for low molecular weight (fraction A) and high molecular weight polyphenols (fraction B), and their activity was assessed using ABTS, FRAP, and FeMICA assays.

Distinct extraction-dependent differences were observed among species. Hot extraction enhanced the recovery of high molecular weight polyphenols in *Bacopa monnieri* and *Melissa officinalis*, largely due to baicalin accumulation, and was associated with stronger radical-scavenging and reducing activity.

In contrast, cold extraction markedly improved the recovery of fraction B in *Scutellaria baicalensis* and *Valeriana officinalis*, where phloretin became the dominant compound. *Ocimum tenuiflorum* also showed pronounced enrichment in fraction B under cold conditions, mainly due to baicalein accumulation.

Cold extracts frequently exhibited higher FeMICA values, indicating superior metal-chelating capacity, whereas hot extracts generally provided stronger direct antioxidant responses.

These findings suggest that extraction conditions substantially influence the profile of putatively neuroprotective phytochemicals and may be critical for optimizing phytotherapeutic strategies aimed at nervous system support and neuroprotection.

Acknowledgments: The research project is funded by the Minister of Education and Science under the program Science for Society II (NdS-II/SP/0390/2023/01), as well as by the University of Lodz, including the Faculty of Biology and Environmental Protection.

PP58

Sargassum fusiforme–Derived Exosome-Like Nanovesicles Enhance Osteogenesis and Suppress Osteoclastogenesis in Ovariectomized Mice

Bum-Joon Koo[1], Jae-Hee Kwon[1], Dong-ha Kim[1], Young-Eun Cho[1],

[1] *Gyeongkuk National University, Andong 36729, Republic of Korea*
yecho@gknu.ac.kr; ORCID: 0000-0001-9864-0265

Osteoporosis is characterized by an imbalance in bone remodeling, leading to bone loss and increased fracture risk following estrogen deficiency although antiresorptive therapies are widely used, long-term safety concerns necessitate alternative strategies. This study evaluated exosome-like nanovesicles derived from Sargassum fusiforme (S.F-NVs) as a natural, orally deliverable nanotherapeutic for restoring bone homeostasis. S.F-NVs were isolated and characterized based on vesicle morphology and size distribution, and osteogenic activity was assessed in MC3T3-E1 cells and primary mouse bone marrow–derived osteoblasts by measuring alkaline phosphatase activity and mineralization. Osteoclastogenesis was evaluated using primary bone marrow–derived precursors, while mechanistic analyses focused on osteogenic and osteoclastogenic signaling pathways. In vivo efficacy was investigated in ovariectomized (OVX) mice following oral administration of S.F-NVs, with trabecular bone microarchitecture analyzed by micro-computed tomography. S.F-NVs exhibited no cytotoxicity and significantly enhanced osteoblast differentiation and mineralization, as indicated by increased alkaline phosphatase activity, mineralized nodule formation, and upregulation of osteogenic markers, including RUNX2, osteopontin, and type I procollagen; these effects were associated with activation of BMP-2/4–mediated Smad1/5/8 and mitogen-activated protein kinase signaling pathways. Conversely, S.F-NVs suppressed osteoclast differentiation from bone marrow precursors. In OVX mice, oral administration of S.F-NVs improved trabecular bone parameters, including increased bone volume and trabecular number, and reduced trabecular separation. Collectively, these findings demonstrate that S.F-NVs promote osteogenesis while inhibiting osteoclastogenesis, thereby restoring bone remodeling balance and supporting their potential as a promising marine-derived nanovesicle candidate for osteoporosis management.

References

[1] Koo, B.J. et al. Preventive Nutrition and Food Science, 2025, 30, 657.
[2] Hwang, J.H. et al. Journal of Controlled Release, 2023, 354, 184–198.

Acknowledgments: This work was supported by National Research Foundation of Korea (NRF) grant funded by Korea government (MSIT) (No. 2024-00340542).

PP59

Anti-Anaphylactic Effects of Decursin from *Angelica gigas*

Ji-Young Yoon[1], Do-Kyun Kim[1*]

[1] *Korea Zoonosis Research Institute, Jeonbuk National University, Iksan 54531, Korea*
dkkim714@jbnu.ac.kr; ORCID: 0000-0002-3457-4868

Allergy is a prevalent, chronic inflammatory condition in which otherwise innocuous antigens elicit maladaptive immune responses, causing significant morbidity and ongoing healthcare utilization worldwide. Despite advances in diagnosis and management, many patients with allergic disorders continue to suffer from persistent symptoms and exacerbations, underscoring the need for safer and more effective interventions. Decursin is a bioactive compound isolated from the medicinal plant *Angelica gigas* Nakai, known for its diverse biological activities, including anti-inflammatory, antioxidant, and neuroprotective effects [1]. However, its role in mast cell-mediated allergic reactions has not been elucidated until now. Our research aims to evaluate the effects of Decursin on mast cells and provide evidence of its potential therapeutic effects in allergic responses. Our mechanistic studies reveal that Decursin inhibits the activation of key upstream signaling molecules in the FcεRI-mediated degranulation pathway of mast cells. Consistent with these findings, ourin vivostudies demonstrate that Decursin exerts significant inhibitory effects in a murine passive cutaneous anaphylaxis (PCA) model and in a murine passive systemic anaphylaxis (PSA) model. Overall, this study demonstrates that Decursin is a potent inhibitor of mast cell-mediated allergic responses by suppressing the immunoglobulin (Ig)E-mediated FcεRI signaling pathway [2], suggesting its potential as a therapeutic agent for allergic diseases.

References

[1] Muralikrishnan A. et al., *Drug Des Devel Ther*, 2024,18,3741-3763
[2]Nagata, Y. et al., *Cells*, 2022, 11(4), 622

Acknowledgments: This work was supported by National Research Foundation of Korea (NRF) grant funded by Korea government (MSIT) (No. 2022R1C1C1006334).

PP60

Natural eutectic mixtures as sustainable biobased stimulants to increase pine resin production

Inês S.L. Farias[1], N. Seixas[1], C. Vilela[1], S.A.O. Santos[1], C.S.R. Freire[1], A.J.D. Silvestre[1]

[1] *CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, Aveiro, Portugal*

ines.farias@ua.pt; ORCID: 0009-0002-5196-4902

The transparent, viscous secretion known as resin is extracted from coniferous trees belonging to the species Pinus. It consists of a non-volatile fraction called rosin, which is mostly made up of diterpenic acids, and a volatile fraction called turpentine, which is rich in monoterpenes. These substances can be used in a variety of industrial applications, including in the food and pharmaceutical industries, as well as in the production of paints, adhesives, disinfectants, cleaning supplies and scents. [1,2]

The process of extracting resin from pine trees comprises a number of steps, including the application of stimulant agents, commonly based on sulphuric acid, to promote high resin production. However, their use raises significant concerns, regarding environmental impact, worker safety, and regulatory compliance, particularly in food and pharmaceutical applications. [1,2]

The goal of the current study is to increase pine resin productivity and safety by developing innovative stimulants based on natural substances formulated as eutectic mixtures (EM).

The results of this study show that several EM-based formulations can increase resin yields about 3.0 times than those obtained with sulphuric acid. Gas chromatography-mass spectrometry analysis showed that the turpentine and rosin composition was unaffected. [1,2]

In conclusion, compared to the traditional systems based on sulphuric acid, the proposed EM-based formulations offer safer, and more sustainable options for pine resin extraction.

References

[1] Farias, et al., Eutectic mixtures of natural origin as new stimulant formulations for pine resin production. Ind. Crops Prod., 2026. Submitted.

[2] [STIMULANT FORMULATION COMPRISING A EUTECTIC MIXTURE FOR USE IN A RESIN TAPPING PROCESS AND METHOD OF OBTAINING THE SAME], Nº120311 [3/06/2025].

Acknowledgments: This work was developed within the scope of the project CICECO – Aveiro Institute of Materials, UID/50011/2025 & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), financed by national funds through the FCT/MCTES (PIDDAC). The RN21 Integrated Project - Innovation in the Natural Resin Sector for the Reinforcement of the National Bioeconomy, is co-financed by the Environmental Fund through Component 12 - Promotion of Sustainable Bioeconomy (Investment TC-C12-i01 - Sustainable Bioeconomy No. 02 / C12-i01 / 202), European funds allocated to Portugal by the Recovery and Resilience Plan (PRR), under the European Union's (EU) Recovery and Resilience Mechanism (MRR), framed within the Next Generation EU, for the period from 2021 to 2026.

PP61

Snail as a Multifunctional Natural Resource: From Nutritional Applications to Advanced Biomaterial Platforms

Anna, Gościniak[1], Miłosz, Ignacyk[1], Joanna, Kobus-Cisowska[2], Beata, Mikołajczak[2], Szymon, Sip[1], Anna, Stasiłowicz-Krzemień[1], Judyta, Cielecka-Piontek[1]

[1] *Poznan University of Medical Sciences, Department of Pharmacognosy and Biomaterials, Rokietnicka 3, 60-806 Poznan, Poland*
[2] *Faculty of Food Science and Nutrition, Poznan University of Life Sciences, Wojska Polskiego 31, 60-624 Poznań, Poland*
jpiontek@ump.edu.pl; ORCID 0000-0003-0891-5419

Living organisms represent a valuable and diverse source of nutrients and bioactive compounds with applications in food, cosmetics, and pharmaceutical sciences. While alternative resources such as insects are increasingly explored as sustainable protein sources, the snail remains an underappreciated yet highly multifunctional biological material.
The aim of this study is to highlight the snail as a versatile natural resource and to present the wide range of applications of its individual components.
Snail meat is a rich source of high-quality protein, essential microelements (selenium, magnesium, calcium, and zinc), and unsaturated fatty acids, contributing to antioxidant and anti-inflammatory effects. It can be utilized in functional foods and as a source of hydrolyzed proteins for dietary supplementation. Snail mucus is a complex biological matrix containing bioactive compounds such as collagen, elastin, allantoin, enzymes, peptides, and polysaccharides. These components exhibit regenerative, moisturizing, and antimicrobial properties, making snail mucus a valuable ingredient in cosmetic and dermatological applications, particularly in skin repair and anti-aging formulations. Snail eggs are considered a high-value food product and may serve as a sustainable alternative to traditional caviar. In addition, the snail shell, primarily composed of calcium carbonate, represents a promising raw material for the development of functional biomaterials. It can be processed and applied as a matrix for nano- and drug delivery systems, supporting innovative approaches in pharmaceutical and food technologies.
The snail represents a multifunctional and sustainable biological resource with broad application potential. Its diverse components can be utilized across multiple sectors, including food, cosmetics, and pharmaceutical sciences. This holistic approach aligns with the principles of circular economy and highlights the potential of snails as a valuable source of bioactive compounds and functional materials.

Acknowledgements: The authors would like to thank Mokry Dwór Farm (Dariusz Sulej, ul. Ziołowa 51, 62-513 Szczepidło, Poland) for providing the biological material used in the present study.

PP62

Sequentially extracted fractions from *Laminaria digitata* as targeted biostimulants for drought-resilient tomato germination

Ana R., Circuncisão[1], Manuel A., Coimbra[1], Susana M., Cardoso[1], Sónia, Silva[1]

[1] *LAQV-REQUIMTE, Department of Chemistry, University of Aveiro, Campus Universitário de Santiago, 3810-193, Aveiro, Portugal*

soniasilva@ua.pt; ORCID 0000-0003-1291-2667

Climate change threatens global food security, as drought stress significantly impairs seed germination and seedling establishment. While seaweed-based biostimulants offer sustainable solutions to enhance crop resilience, the specific roles of distinct seaweed phytochemicals, particularly in seed priming, remain poorly understood [1]. In this context, this study aimed to evaluate the biostimulant and drought-mitigating effects of chemically distinct extracted fractions from the brown macroalga *Laminaria digitata* on cherry tomato (*Solanum lycopersicum* L.) seeds. To achieve this, a holistic sequential extraction process was employed using food-grade solvents to recover fractions enriched in phlorotannins and mannitol (EtOH_Sn), fucoidans ($CaCl_2$_Sn), alginates ($CaCl_2$_Ppt), and a final residual biomass (Final_Res). Two application strategies, namely seed incubation and seed priming, were tested across five doses (0, 1, 10, 100, and 200 mg L^{-1}) under well-watered and polyethylene glycol (PEG)-induced osmotic stress (12% w/w).

The results showed that the EtOH_Sn fraction, richest in phlorotannins (3.3 g PGE/100 $g_{extract}$) and mannitol (5.4 g/100 $g_{extract}$), was the most potent germination biostimulant. Under drought, EtOH_Sn priming increased the germination percentage and index by up to 200% relative to the control. This was attributed to phlorotannin-mediated antioxidant defense and osmotic adjustment by mannitol. The $CaCl_2$_Sn fraction, composed mainly of sulphated fucoidans (-SO_3^-: 41.1 mol%; fucose: 30.5 mol%), also improved seedling vigor via priming. Conversely, both the alginate-rich fraction and Final_Res composed mainly of uronic acids (76.3 and 44.2 mol%) with specific M/G ratios (3.05 and 2.39), primarily promoted post-germinative growth. Applied via incubation at 10 mg L^{-1}, these fractions enhanced aerial length and fresh weight, leveraging the hydrophilic and water-holding properties of the alginate matrix to maintain seedling turgor. Overall, sequential extraction of *L. digitata* yields chemically distinct fractions with stage-specific functions. Phlorotannin-rich priming revealed to be superior for enhancing germination, while alginate-rich incubation effectively supports early seedling growth under water-limited conditions.

References

[1] Gupta, S. et al. *Plant Growth Regulation*, 2022, 97, 271-313.

Acknowledgments: Thanks are due to the University of Aveiro and FCT/MCTES for the financial support to LAQV-REQUIMTE (UID/50006/2025; DOI: 10.54499/UID/50006/2025) research unit through national funds, and the co-funding by FEDER, within the PT2020 Partnership Agreement and Compete 2020. FCT/MCTES supported the research contracts of Susana M. Cardoso under the Scientific Employment Stimulus Institutional Call, and of Sónia Silva (DL 57/2016/CP1482/CT0093; DOI: 10.54499/DL57/2016/CP1482/CT0093) in the scope of the framework contract foreseen in the numbers 4, 5 and 6 of the article 23, of the Decree-Law 57/2016, of August 29, changed by Law 57/2017, of July 19. Ana R. Circuncisão also thanks FCT/MCTES and ESF (European Social Fund) through NORTE 2020 (Programa Operacional Região Norte) for her PhD grant ref. SFRH/BD/147321/2019.

PP63

Genetic variation in a tandemly duplicated TPS gene cluster drives the diversity of natural aroma compounds in lychee fruit

Huimin Hu[1,2], Zaohai Zeng[2], Yanwei Hao[2], Rui Xia[2], Pan Liao[1]

[1] *Department of Biology, Hong Kong Baptist University, Kowloon Tong, Hong Kong SAR, 999077, China*
[2] *State Key Laboratory for Conservation and Utilization of Subtropical Agro-Bioresources, College of Horticulture, South China Agricultural University, Guangzhou, Guangdong, 510640, China*

huhuimin@hkbu.edu.hk; ORCID: 0009-0005-8983-4566; panliao@hkbu.edu.hk ORCID: 0000-0002-1156-8916

Fruits undergo a similar ripening process, yet they exhibit a range of differences in color, taste, and shape, both across different species and within the same species. How does this diversity arise? Here, we uncovered a conserved fruit ripening process in litchi fruit in which a NAC transcription factor, LcNAC1, acts as a master regulator. LcNAC1 regulates a gene cluster composed of four terpene synthase genes (*LcTPSa1-a4*), which are the most abundantly expressed *TPS* genes during the late ripening stages, indicating their key role in terpene biosynthesis in litchi fruit. LcTPSa1-a3 are responsible for catalyzing the production of farnesol, which in turn dictates the aromatic diversity in fruit of different litchi varieties. These four *TPS* genes exhibited distinct expression levels, due to diverse natural genetic variation, including copy number variations (CNVs), presence/absence variations (PAVs), insertions and deletions (indels), and single nucleotide polymorphisms (SNPs). The accumulated mutations impact the binding affinity of LcNAC1 to *LcTPSa1-a3* promoters. A single nucleotide mutation in *LcTPSa1* caused a premature translational termination, resulting in a truncated version of the TPS protein, which surprisingly remains functional. All these genomic changes in the LcNAC1-regulated *TPS* genes likely contribute to the great aromatic diversity observed in litchi fruit. This diversification of fruit aroma in litchi varieties offers a compelling example of how species- or variety-specific traits evolve --- the phenotypic diversity is primarily derived from natural genetic variation accumulated in downstream structural genes within an evolutionarily conserved regulatory circuit.

Acknowledgments: This work is supported by the Key Area Research and Development Program of Guangdong Province (2022B0202070003). This work is also supported by the National Science Foundation of China (#32072547 and #32372665). The authors are grateful to Dr. Zhenhua Liu's laboratory (Shanghai Jiao Tong University) for sharing with us the pEAQ-HT-DEST-1 vector, and also thank Mrs. Yin Zheng for her assistance with GC-MS analysis.

PP64

Roburic acid alleviates glucose-induced metabolic stress in *Caenorhabditis elegans* obesity model

Iva, Stoykova[1], Ester, Campanella[2], Biser, Binev[1,3], Liliya, Mihaylova[1,3], Milen, Georgiev[1,3]

[1] *Laboratory of Metabolomics, Department of Biotechnology, Institute of Microbiology, Bulgarian Academy of Sciences, 4000 Plovdiv, Bulgaria*
[2] *ITS Academy Giulio Natta, 24125 Bergamo, Italy*
[3] *Department of Plant Cell Biotechnology, Center of Plant Systems Biology and Biotechnology, 4000 Plovdiv, Bulgaria*
milengeorgiev@gbg.bg; ORCID 0000-0001-5248-6135

Obesity-related metabolic disorders are characterized by disrupted lipid profiles. Triterpenoids have emerged as promising natural agents for metabolic regulation, yet the specific anti-obesity potential of the tetracyclic triterpenoid roburic acid remain largely uncharacterized [1]. This study evaluated the safety profile, lipid-reducing potential, and antioxidant defence modulation of roburic acid using the *Caenorhabditis elegans* obesity model under high-glucose-induced metabolic stress.

Synchronized *C. elegans* L4 worms were cultured on a 2% glucose growth media and treated with roburic acid (25, 50, and 100 µM). Intestinal fat droplets were quantified using Nile Red staining and confocal microscopy. Morphological parameters and crawling speed were analysed using automated WormLab tracking system. Specific GFP reporter strains were employed to determine molecular mechanisms: for *de novo* lipogenesis (FAT-7), intestinal mitochondrial mass, and the phase II detoxification enzyme GST-4.

In the glucose-stress model, roburic acid potently inhibited intestinal lipid accumulation in a distinct dose-dependent manner. Notably, the 100 µM treatment group significantly outperformed the clinical lipase inhibitor orlistat. Automated tracking confirmed that 100 µM roburic acid effectively reversed the glucose-induced "obese" phenotype – significantly reducing body width and surface. Mechanistically, dose-dependent expansion of intestinal mitochondrial mass was observed. Furthermore, roburic acid modulated GST-4 expression bi-directionally under glucose stress and significantly attenuated over-reactive GST-4 defence spikes under acute paraquat challenge.

Taken altogether, roburic acid is a potent, non-toxic metabolic modulator that reduces lipid accumulation by expanding mitochondrial biogenesis to maximize metabolic breakdown rather than suppressing *de novo* lipogenesis. These findings position roburic acid as a valuable strategic framework for translational metabolic research.

References

[1] Jia, N. et al. (2023) Metabolic reprogramming of proinflammatory macrophages by target delivered roburic acid effectively ameliorates rheumatoid arthritis symptoms. *Signal Transduction and Targeted Therapy* 8(1), p. 280.

Acknowledgments: This research received funding from the Bulgarian National Science Fund project contract number КП-6-N83/4.

PP65

Plant Extracts as Natural Solutions for Mycotoxin Control: Mechanisms, Efficacy, and Applications

Rui Morais[1], Sara Ascenção[1], Inês Amaro[1], Ana Rita Mateus[1,2,3], Fernando Ramos[1,2,3], Nour El houda Mekhadmi[4,5], Ana Sanches Silva[1,2,6]

[1] *University of Coimbra, Faculty of Pharmacy, Polo III, Azinhaga de St, Comba, 3000-548 Coimbra, Portugal*
[2] *Centre for Animal Science Studies (CECA), University of Porto, 4501-401 Porto, Portugal;*
[3] *LAQV, REQUIMTE, Laboratory of Bromatology and Pharmacognosy, Faculty of Pharmacy, University of Coimbra, Polo III, Azinhaga de Sta Comba, 3000-548, Coimbra, Portugal*
[4] *Department of Biology, Faculty of Nature and Life Sciences, University of El Oued, 39000, El Oued, Algeria*
[5] *Laboratory of the Development and Technology of Saharan Resources (VTRS), Echahid Hamma Lakhdar El Oued University, Algeria*
[6] *Associate Laboratory for Animal and Veterinary Sciences (AI4AnimalS), 1300-477 Lisbon, Portugal*
asanchessilva@ff.uc.pt; ORCID: 0000-0002-0226-921

Plant-derived bioactive compounds have emerged as promising natural solutions to mitigate mycotoxins, i.e., toxic secondary metabolites produced by fungi such as Aspergillus and Fusarium, posing serious risks to human and animal health contamination and toxicity [1]. Their occurrence in food and feed is associated with hepatotoxicity, immunosuppression, genotoxicity, and carcinogenicity [1,2].
Compounds such as curcumin and ellagic acid can inhibit aflatoxin B1 (AFB1) metabolism and enhance detoxification by increasing glutathione-S-transferase activity. Curcumin also exhibits strong antimutagenic and DNA-protective effects. Similarly, resveratrol activates detoxification pathways, while 6-gingerol reduces genotoxicity induced by patulin. Other compounds, including lycopene, cyanidin, and rutin, have shown potent antioxidant activity, protecting against oxidative stress, apoptosis, and cellular damage caused by mycotoxins [2].
In addition to isolated compounds, plant extracts and essential oils demonstrate significant anti-mycogenic and detoxifying properties. Extracts from soybean, onion, garlic, and calabash have demonstrated the ability to inhibit toxigenic fungi and decrease mycotoxin accumulation. These protective effects are often associated with mechanisms such as activation of antioxidant pathways, modulation of detoxification enzymes, and interference with mycotoxin metabolism [1]. Essential oils from *Carum carvi* have been reported to completely inhibit aflatoxin production, while phenolic-rich extracts from ginger, rosemary, and green tea reduce oxidative stress and cytotoxicity caused by aflatoxins [1]. For example, rosemary extracts achieved up to 60% AFB1 degradation, while ginger essential oil inhibited *Aspergillus flavus* and reduced aflatoxin production [2].
These bioactive compounds can be incorporated into foods directly or indirectly through innovative systems such as active packaging, where controlled release helps prevent fungal growth and mycotoxin formation during storage.

Overall, plant bioactives represent a sustainable and multifunctional approach to control mycotoxins and reduce their health impacts. This presentation will also address the challenges related to standardization, stability, and regulatory approval must be addressed to enable their broader application.

References

[1] Zhang X, et a. *Metabolites*, 2025; *15*(4): 219.
[2] Makhuvele R, et al. Heliyon, 2020.

Acknowledgments: This work was supported by the project PRIMA/0011/2024 (Bio-Team, DOI https://doi.org/10.54499/PRIMA/0011/2024), funded by the PRIMA Programme (Section 2) and with national funding provided by the Foundation for Science and Technology (FCT), Portugal. This work was supported by UIDB/00211/2025 and UIDB/50006/2025 (https://doi.org/10.54499/UID/50006/2025) with funding from FCT/MCTES through national funds.

PP66

Multifunctional cosmetic potential of *Limonium flexuosum* extract with telomere-lengthening, hydrating, and whitening activities

Min Gyu Park[1], Yun Na Kim[2], Jae sun Lee[2], Yu Jung Kim[2], Won Jin Jung[1], and Eun Ju Jeong[1,2]

[1]*Department of Green Bio Science (BK21), Gyeongsang National University, Jinju 52825, Republic of Korea*
[2]*Agri-Food Bio Convergence Institute, Gyeongsang National University, Jinju 52825, Republic of Korea*
jeong.ej@gnu.ac.kr

The genus Limonium, comprising over 600 species, has been reported to exhibit various skin-beneficial effects, including whitening, moisturizing, and anti-inflammatory activities. Several species, such as *L. gerberi*, *L. narbonense*, *L. tetragonum*, and *L. vulgare*, are registered as cosmetic ingredients in the International Cosmetic Ingredient Dictionary (ICID). In this study, among eleven industrially applicable Limonium species, *L. flexuosum* with the most prominent activity were evaluated for whitening and moisturizing activities, and for telomerase activation and telomere lengthening effects. This study aimed to elucidate the underlying anti-aging mechanisms of *L. flexuosum* in skin cells and to identify marker compounds through LC–MS and LC–UV analyses. Telomerase activity was assessed by measuring the mRNA expression levels of key biomarkers, including hTERT and c-MYC, in HaCaT cells. Telomere length was determined using a quantitative PCR-based Telomere Length Quantification Assay Kit. Skin hydration activity was evaluated by analyzing the expression of HAS1, HAS2, HAS3, and AQP3, while whitening activity was examined by measuring the mRNA levels of MITF, TYR, TYRP1, and TYRP2 in α-MSH-stimulated B16F10 cells. For chemical profiling of *L. flexuosum*, LC-QTOF-MS was employed to predict constituent compounds, and major compounds previously reported in the Limonium genus were selected and comparatively analyzed using LC-UV to identify marker compounds. The extract of *L. flexuosum* exhibited superior telomere-lengthening activity compared to the positive controls, curcumin and quercetin. Also, it significantly upregulated hydration-related genes and showed stronger activity than D-panthenol, the positive control for moisturizing effects. These findings suggest that *L. flexuosum* extract has strong potential as a multifunctional cosmetic ingredient with telomere-protective, whitening, and moisturizing properties. Furthermore, the standardized extract based on the identified marker compounds may serve as an industrially viable functional cosmetic material.

Acknowledgments: This work was supported by the Commercialization Promotion Agency for R&D Outcomes (COMPA) grant funded by the Korea government (Ministry of Science and ICT) (RS-2025-02311143)

PP67

Optimization of Hydrothermal Processing to Enhance Protein Retention and Nutritional Quality in *Lupinus albus* 'Rumbo' Pastes

Matilde Maia[1], Patrícia Matos[1,2,3], Cátia Esteves[4], Margarida Esteves[4], Dina Bastos[5], Ana Sanches Silva[1,6,7], Fernando Ramos[1,2]

[1] *University of Coimbra, Faculty of Pharmacy, Polo III, Azinhaga de St, Comba, 3000-548 Coimbra, Portugal*
[2] *LAQV, REQUIMTE, Laboratory of Bromatology and Pharmacognosy, Faculty of Pharmacy, University of Coimbra, Polo III, Azinhaga de Sta Comba, 3000-548, Coimbra, Portugal*
[3] *Chemical Process Engineering and Forest Products Research Centre (CIEPQPF), University of Coimbra, Rua Sílvio Lima, 3030-790 Coimbra, Portugal*
[4] *TRIBO - Advanced Coatings Technologies, Quinta Vale do Espinhal, EM558 1, 3230-343 Penela, Coimbra, Portugal*
[5] *A Tremoceira Estrela da Piedade Lda, Rua Pedro Costa, Lote 1316, 2820-188 Charneca de Caparica, Portugal*
[6] *Centre for Animal Science Studies (CECA), University of Porto, 4501-401 Porto, Portugal;*
[7] *Associate Laboratory for Animal and Veterinary Sciences (AI4AnimalS), 1300-477 Lisbon, Portugal*
asanchessilva@ff.uc.pt; ORCID: 0000-0002-0226-921

Lupinus albus is a valuable source of plant-based proteins and minerals, with growing interest as a functional food ingredient. However, conventional hydrothermal processing involving prolonged soaking and water exchange may lead to significant losses of soluble nutrients [1,2]. Optimizing these processes is essential to improve nutritional retention and functionality [1].

This study evaluated the impact of different hydrothermal processing strategies and formulation variables (presence or absence of hull) on the nutritional composition of *Lupinus albus* 'Rumbo', comparing whole lupin flour (with hull), pastes, and their corresponding freeze-dried products.

Whole lupin flour was compared with pastes produced by two methods: Method A (27/01), involving soaking, cooking, and 5-day water immersion with periodic changes; and Method B (27/02), involving only soaking and cooking with reuse of cooking water. Pastes were freeze-dried before analysis. Proximate composition (protein, fat, fiber, ash, and phosphorus) and particle size distribution were evaluated.

Whole flour (with hull) exhibited fine particle size (<450 µm) and high protein (43.03%). Method A freeze-dried pastes showed reduced protein (~15.27–15.73%), indicating significant nutrient loss from leaching. Method B improved protein retention in specific formulations, reaching 16.54% in hull-free pastes, while hull-containing samples decreased (10.67%) due to matrix effects. Lipid content ranged from 8.25% to 12.59%. Fiber reached 16.63% in hull-containing formulations, dropping to 2.78% in hull-free pastes. Phosphorus was significantly higher in Method B (up to 1913 mg/100 g dry weight) than in flour (1306 mg/100 g) and Method A pastes (536–655 mg/100 g).

Prolonged soaking and water exchange are critical for nutrient loss in lupin processing. The optimized hydrothermal approach, combined with cooking water reuse, improves protein retention and enhances mineral density in selected formulations. Results

highlight the potential of processing optimization to tailor the nutritional quality of Lupinus albus, supporting its development as a high-value functional food ingredient.

References

[1] Perera D, et al., Foods 2023;12:709.
[2] Malekipoor R, et al., Nutrients 2022;14:2845.

Acknowledgments: This study was carried out in the frame of the "Lupinegg: Study of Lupin Beans as an Egg Substitute and Countertyping in Industrial Confectionery", with the reference CENTRO2030-FEDER-02236100 supported by the Partnership Agreement CENTRO2030 and Portugal2030, co-financed by the European Union. This work was supported by UIDB/00211/2025 and UIDB/50006/2025 (https://doi.org/10.54499/UID/50006/2025) with funding from FCT/MCTES through national funds..