II INTERNATIONAL MEETING

MOLECULES 4LIFE

BOOK OF ABSTRACTS

10-12 September 2025 • UTAD • Vila Real • Portugal

Sociedade Portuguesa de Química
utad Universidade de Trás-os-Montes e Alto Douro
CQ VR Centro de Química Vila Real

Title: *II International Meeting Molecules4Life - Book of Abstracts*

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Editor: *UTAD - Universidade de Trás-os-Montes e Alto Douro*

1st Edition

September 2025, Portugal

Support: *Electronics (pdf)*

ISBN: *978-989-704-600-1*

Editor Prefix: *978-989-704*

E-mail: *molecules4life@chemistry.pt*

INSTITUTIONAL SUPPORT & SPONSORSHIP

Institutional Support

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WELCOME MESSAGE

Dear Participants,

Welcome to **II International Meeting Molecules4Life**.

Welcome to Vila Real and UTAD.

The Chemistry Research Centre-Vila Real (CQ-VR) of the University of Trás-os-Montes and Alto Douro (UTAD) is pleased to host the II International Meeting Molecules4Life. This biennial conference aims to consolidate CQ-VR as a centre that promotes interdisciplinary collaboration. A forum where synergy between experts in chemistry, biochemistry, environment, materials, and researchers from other fields with shared interests can expand and contribute to innovative solutions.

In this second edition, Molecules4Life's theme is "Molecules4...Sustainable Development" and will focus on strategies to understand, improve, and create sustainable solutions that support environmental protection and global well-being.

The meeting is organized around five main topics: Molecular Flows with Environmental Impacts (soil, water, and atmosphere); Environmental Remediation and Pollution Control; Sustainable Materials; Materials for Energy; and Food Security and Clean Label Technologies.

Over the three days of this Meeting, you will have the opportunity to attend a total of 80 scientific communications, divided as follows: 6 inspiring plenary lectures, 4 keynote talks, 40 oral presentations and 30 poster presentations. It will also be a networking opportunity that will stimulate fruitful discussions and foster new scientific collaborations.

We are grateful for the sponsorship of the Portuguese Chemical Society (SPQ), the Vila Real City Council, and the international peer-reviewed open-access journal Sustainability. We also thank local, national and international companies that sponsor this meeting. Their contributions were essential.

We are excited to embark on this interdisciplinary journey and hope you truly enjoy the Meeting and take the opportunity to visit the incredible Douro region, homeland of the world-famous Port Wine. Finally, social activities were planned to encourage networking and create memorable experiences.

The Chairs of the Organizing Committee of the II International Meeting Molecules4Life,

José Alcides Peres, Cristina Oliveira

COMMITTEES

Organization

Centro de Química-Vila Real

- José Alcides Peres - Centro de Química de Vila Real, UTAD - Chairperson
- Cristina Oliveira - Centro de Química de Vila Real, UTAD - Co-Chairperson

Local Scientific Committee

- Alexandra Costa - Centro de Química de Vila Real, ISEL
- Fernando Nunes - Centro de Química de Vila Real, UTAD
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- Marco Lucas - Centro de Química de Vila Real, UTAD
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- Patrícia Barata - Centro de Química de Vila Real, ISEL
- Verónica Bermudez - Centro de Química de Vila Real, UTAD

External Scientific Committee

- Ana Fernández-Jiménez - Instituto de Ciencias de la Construcción Eduardo Torroja, Madrid, Spain
- Antonio Morata - Universidad Politécnica de Madrid, Madrid, Spain
- Beatriz Oliveira - Faculdade de Farmácia da Universidade do Porto, Porto, Portugal
- Bruno Medronho - Universidade do Algarve, Faro, Portugal
- David Fangueiro - Instituto Superior de Agronomia, Universidade de Lisboa, Lisboa, Portugal
- Helena Braga - Faculdade de Engenharia do Porto, Universidade do Porto, Portugal

- Eduardo Silva - Universidade de Aveiro, Departamento de Geociências, Aveiro, Portugal
- Joaquim Faria - Faculdade de Engenharia do Porto, Universidade do Porto, Portugal
- José Sánchez Pérez - Universidad de Almería, Almería, Spain
- Juan García - Universidad Complutense de Madrid, Madrid, Spain
- Katarzyna Styszko - AGH Univ. of Science and Technology, Kraków, Poland
- Maria Victoria Arribas Moreno - Instituto de Investigación en Ciencias de la Alimentación, Madrid, Spain
- Pierre Teissedre - University of Bordeaux, Bordeaux, France
- Rui Martins - Universidade de Coimbra, Coimbra, Portugal

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- Tiago Duarte

Secretariat

- Leonardo Mendes (Sociedade Portuguesa de Química - SPQ)
- Cristina Campos (Sociedade Portuguesa de Química - SPQ)

GENERAL INFORMATIONS

Location

The Meeting will take place at the University of Trás-os-Montes e Alto Douro, *Escola das Ciências da Vida e do Ambiente* (also known as Geosciences Building).

Registration Desk

The Registration Desk will be located at the main entrance of Geosciences Auditorium (*Escola de Ciências da Vida e do Ambiente*, level -1). It will be staffed throughout the Meeting for queries and late registrations according to the following schedule:

- Wednesday, 10th September 2025 (from 11:00 to 18:00h)
- Thursday, 11st September 2025 (from 8:30 to 17:30h)
- Friday, 12nd September 2025 (from 8:30 to 18:00h)

Sessions Location

The **Opening Ceremony**, **Closing Ceremony** and **Plenary Lectures** will be held at the Geosciences Auditorium.

Parallel Sessions will be held in Auditorium 1 and Auditorium 2 (level -1 of Geosciences Building)

Coffee Breaks

Coffee breaks will be held at Geosciences Building, close to Auditorium 1 and 2.

Lunches

- Conference lunches will be served at the Panoramic Restaurant at the University of Trás-os-Montes and Alto Douro. **Lunches are included only for senior researchers and PhD students.**
- **Undergraduate & Master student participants** can have lunch at the UTAD student canteen or at the several coffee shops available on the university campus (see map). Coffee-shops sell snacks, refreshments, and light meals.

Badges

Please ensure that you wear your badge throughout the Meeting. The color coding of badges is the following:

- Red - Plenary Lecturers
- Blue - Delegates and Organizing Committee
- Green - Local Staff

Certificate of Attendance and Certificate of Presentation

Certificate of Attendance or Certificate of Presentation will become available from 13rd September in your Personal Area (https://conferences.chemistry.pt) in a new menu called "Certificates". The certificates will be only accessible to those who have paid status or are exempt.

Conference Language

English is the official language of the conference.

Internet Access

UTAD provides Wi-Fi access to eduroam network. Alternatively, each participant will have access to a visitor voucher for the "guest-utad" wireless network. Vouchers can be requested at the Registration Desk.

Parking

Nearby the conference building there are several parking lots (see map). These parks are shared with the community, so the parking spaces are subject to availability.

SOCIAL PROGRAM

Welcome Drink (10th September, 18:30h)

The Welcome Drink (including all registration types) will take place at the conference venue on the first day of the congress (September 10th) at 18:30h, close to the poster session Hall. This get-together event will feature a selection of snacks, soft drinks, Douro wines, and Port Wine cocktails.

Winery Tour & Congress Dinner (11th September)

The Winery Tour (by bus) and Congress Dinner will take place on the 11st of September at Favaios. The bus will depart at 16:30h from the south entrance of UTAD *campus*. After dinner the bus will return to this entrance, but it will park outside UTAD´s gate because the gate will be closed. On this day, delegates are strongly recommended to park their car outside the UTAD´s south entrance.

AWARDS

These prizes are awarded by the Scientific Committee and seek to recognize the best oral and poster communication in each meeting's topic.

Eligible candidates for the oral and poster awards must be MSc or PhD students.

Best Oral Communication Award

- The prizes for the best oral presentations in all topics are sponsored by WonderStatus, with the possibility of also awarding Honorable Mentions to outstanding contributions.

Best Poster Communication Award

- The prizes for the best poster presentations in all topics are sponsored by WonderStatus, with the possibility of also awarding Honorable Mentions to outstanding contributions.

WonderStatus
Soluções de Laboratório

SCIENTIFIC INFORMATION

Oral Communications

- The oral communications are divided into:
  - ✓ **PL** | Plenary Sessions (40 minutes for presentation, plus 10 minutes for Q&A).
  - ✓ **OC** | Oral Communications (12 minutes for presentation, plus 3 minutes for Q&A).
- To guarantee that sessions run on time, speakers are kindly asked to provide the oral communication presentation files in advance, preferably during registration at the registration desk.

Posters Communications

- The poster exhibition will be in the Geosciences Building close to Auditorium 1 and 2 (level -1).
- Posters Dimension: 90 cm (width) x 120 cm (height).
- Authors are requested to display their posters on the post panels during the first day (September 10th) and removed at the end of the conference (September 12nd).
- Material to attach posters will be made available by the organizing committee.
- Authors are requested to stay near their posters during the poster sessions and be available to answer any questions from the participants and by the evaluation panel, who will select the posters for the Best Poster Communication Award.
  - ✓ **Poster Session 1 & Welcome Drink:** Wednesday 10th September, 18:30h
  - ✓ **Poster Session 2 & Coffee Break:** Thursday 11st September, 15:30-16:30h

SCIENTIFIC PROGRAM

Conference Time-Plan

Time	10th September 2025	Time	11st September 2025	Time	12nd September 2025
		9.15-10.15	PL3- *Environmental Pollution Remediation* Prof. Sixto Malato	9.15-10.15	PL5 - *Sustainable Materials* Prof. Pedro Fardim
		10.15-10.45	KN1 - *Materials for Energy* Prof. Stefania Specchia	10.15-10.45	KN3 - *Sustainable Materials* Prof. Ana Fernández-Jiménez
		10.45-11.15	*Coffee Break*	10.45-11.15	*Coffee Break*
		11.15-11.30	**OC3-EP / OC1-ME**	11.15-11.30	**OC8-EP / OC10-EP**
		11.30-11.45	**OC4-EP / OC2-ME**	11.30-11.45	**OC9-EP / OC5-SM**
		11.45-12.00	**OC5-EP / OC4-FS**	11.45-12.00	**OC3-ME / OC6-SM**
		12.00-12.15	**OC6-EP / OC5-FS**	12.00-12.15	**OC3-SM / OC7-SM**
		12.15.12.30	**OC7-EP /OC6-FS**	12.15.12.30	**OC4-SM / OC8-SM**
12.00-14.00	**Registration**	12.30-14.00	*Lunch*	12.30-14.00	*Lunch*
14.00-14.30	Opening Ceremony	14.00-15.00	PL4 - *Environmental Pollution Remediation* Prof. Raf Dewil	14.00-15.00	PL6- *Materials for Energy* Prof. Adélio Mendes
14.30-15.30	PL1 - *Food Security & Clean Label Technologies* Prof. Martin Wagner	15.00-15.30	KN2 - *Food Security & Clean Label Technologies* Prof. Antonio Morata	15.00-15.30	KN4 - *Molecular Flows with Environmental Impacts* Prof. Eduardo Silva
15.30-16.30	PL2 - *Molecular Flows with Environmental Impacts* Prof. Dave Chadwick	15.30-16.30	Poster Session 2 & *Coffee Break*	15.30-16.00	*Coffee Break*
16.30-17.00	*Coffee Break*	16.30	Winery Tour & Congress Dinner	16.00-16.15	**OC4-MF / OC11-EP**
17.00-17.15	**OC1-MF / OC1-FS**			16.15-16.30	**OC5-MF / OC12-EP**
17.15-17.30	**OC2-MF / OC2- FS**			16.30-16.45	**OC6-MF / OC13-EP**
17.30-17.45	**OC3-MF / OC3-FS**			16.45-17.00	**OC4-ME / OC14-EP**
17.45-18.00	**OC1-EP / OC1-SM**			17.00-17.15	**OC5-ME / OC15-EP**
18.00-18.15	**OC2-EP / OC2-SM**			17.15	Closing Ceremony
18.30	Poster Session 1 & *Welcome drink*				

PL – Plenary lecture; **KN** – Keynote; **OC** – Oral Communication (parallel sessions); **MF** – Molecular Flows with Environmental Impacts (soil, water and atmosphere); **FS** – Food Security and Clean Label Technologies; **ME** – Materials for Energy; **ER** - Environmental Remediation and Pollution Control; **SM** – Sustainable Materials.

SCIENTIFIC PROGRAM

Detailed Program

Time	***10th September***
12.00-14.00	**Registration**
14.00-14.30	**Opening Ceremony** ***Geosciences Auditorium*** Interventions: Prof. Dr. Emídio Gomes (UTAD Rector) Dr. Alexandre Favaios (CMVR President) Prof. Dra. Raquel Chaves (UTAD, ECVA President) Prof. Dr. Fernando Nunes (CQ-VR Director) Chaired by José Peres (UTAD)
14.30-15.30	**Plenary Lecture 1 - Food Security & Clean Label Technologies** ***Geosciences Auditorium*** **Prof. Martin Wagner** (University of Veterinary Medicine, Vienna) *A glimpse on emerging hazards: the FoodSafer Project* Chaired by António Inês (UTAD)
15.30-16.30	**Plenary Lecture 2 - Molecular Flows with Environmental Impacts** ***Geosciences Auditorium*** **Prof. Dave Chadwick** (School of Natural Sciences, Bangor University, Wales) *Effects of extreme weather events on soil health and greenhouse gas emissions from agricultural land* Chaired by João Coutinho (UTAD)
16.30-17.00	**Coffee Break**

	Oral Communications	
17.00-17.15	***Auditorium 1*** Chaired by João Claro (UTAD) & David Fangueiro (ULisboa) **OC1-*MF*** - Nelson Machado (INESC TEC) *Real-time monitoring of leaves' gaseous exchange in C3 green plants: the thermodynamical role of water*	***Auditorium 2*** Chaired by Alice Vilela (UTAD) & Ana Jimenez (Instituto de Ciencias de la Construcción Eduardo Torroja) **OC1-*FS*** - Elisa Costa (UTAD) *Microalgae proteins as sustainable and allergen-free alternatives for fining white wines*
17.15-17.30	**OC2-*MF*** – Justyna Pyssa (AGH University of Krakow) *Identification of population exposure to environmental contamination with selected antibiotics adsorbed on microplastics*	**OC2-*FS*** - Joana Ferreira (IPS) *Enhancing the nutritional quality of edible insects: DHA-rich microalgae supplementation in Acheta domesticus diets*
17.30-17.45	**OC3-*MF*** - Katarzyna Styszko (University of Krakow) *Polycyclic aromatic hydrocarbon biomarker profiles in raw wastewater as indicators of exposure levels in urban environments*	**OC3-*FS*** - Mónica Silva (UTAD) *Combined effects of western diet and micro-nanoplastics on hepatic mitochondrial bioenergetics in C57BL/6J mice*
17.45-18.00	**OC1-*EP*** - Fernando Braga (UTAD) *Sustainable vineyard mulching: optimizing winery by-product co-composting with vine shoots for soil and weed management*	**OC1-*SM*** - Attaullah Khan (UTAD) *Mechanical and thermal performance of waste polypropylene reinforced with glass fiber: a systematic review in the context of sustainability*
18.00-18.15	**OC2-*EP*** - António Pirra (UTAD) *Co-composting conditions and its impact on the quality of substrates from grape stalks and winery waste activated sludge: Lab and pilot-scale studies*	**OC2-*SM*** - José Silva (UTAD) *Utilization of olive stone waste as a sustainable fine aggregate replacement in cementitious mortars*
18.30	**Poster Session 1 & Welcome Drink**	

Time	*11st September*	
9.15-10.15	**Plenary Lecture 3 - Environmental Pollution Remediation** ***Geosciences Auditorium*** **Prof. Sixto Malato** (Plataforma Solar de Almería, Spain) *Solar photochemical processes: applications and photoreactors* Chaired by Marco S. Lucas (UTAD)	
10.15-10.45	**KN1 – Materials for Energy** ***Geosciences Auditorium*** Prof. Stefania Specchia *Sustainable electrocatalysts for low-temperature fuel cells* (Dept. of Applied Science and Technology, Gre.En2 Group Politecnico di Torino, Italy) Chaired by Katarzyna Styszko (AGH University of Krakow)	
10.45-11.15	**Coffee Break**	
11.15-12.30	**Oral Communications**	
11.15-11.30	***Auditorium 1*** Chaired by Marco S. Lucas (UTAD) & Fernando Braga (UTAD) **OC3-*EP*** - Sandra Nunes (UCoimbra) *Molecular dynamics simulations as a tool for advancing environmental remediation and impact mitigation strategies*	***Auditorium 2*** Chaired by Katarzyna Styszko (AGH University of Krakow) & Maria Oliveira (UTAD) **OC1-*ME*** - Bruno Medronho (UAlgarve) *Regenerated cellulose: a versatile platform for sustainable laminates and green energy harvesting*
11.30-11.45	**OC4-*EP*** - Maria Roque (UCoimbra) *Adsorption and advanced oxidation processes: viable paths to remove disinfection byproducts?*	**OC2-*ME*** - Mauro Magalhães (UTAD) *3D printing using photochromic naphthopyrans as photoinitiators*
11.45-12.00	**OC5-*EP*** - Maria Costa (UAlgarve) *Assessing the capacity of Caulerpa prolifera for copper adsorption and neutralization*	**OC4-*FS*** - Tânia Cova (UCoimbra) *Learning from molecules: predicting mycotoxin toxicity through structure-based machine learning*

12.00-12.15	**OC6-*EP*** - Daniela Morais (UTAD) *Valorization of winery effluents in the Douro region: advanced treatment via ceramic membranes and photo-Fenton processes for water reuse*	**OC5-*FS*** - Solange Magalhães (MidSweden University) *Innovative functional bread: integrating acorn flour and regionally sourced essential oils for enhanced nutrition and shelf life*
12.15-12.30	**OC7-*EP*** - Najmeh Askari (KU Leuven) *MOF-on-MOF structures for enhanced degradation of emerging contaminants from water*	**OC6-*FS*** - Manuel Pinto (UTAD) *Sensory evaluation of PDO/PGI wines in the context of accreditation in Portugal and the european framework: current practices and challenges*
12.30-14.00	**Lunch**	
14.00-15.00	**Plenary Lecture 4 – Environmental Pollution Remediation** ***Geosciences Auditorium*** **Prof. Raf Dewil** (KU Leuven, Faculty of Engineering Technology, Belgium) *Exploring novel advanced catalytic techniques for the degradation of emerging pollutants in water* Chaired by Pedro Tavares (UTAD)	
15.00-15.30	**KN2 – Food Security & Clean Label Technologies** ***Geosciences Auditorium*** Prof. Antonio Morata (Universidad Politécnica de Madrid, Spain) *Emerging non-thermal technologies for the extraction and preservation of wine molecules with sensory impact* Chaired by Fernanda Cosme (UTAD)	
15.30-16.30	**Poster Session 2 & Coffee Break**	
16.30	**Winery Tour & Congress Dinner**	

Time	*12st September*	
9.15-10.15	**Plenary Lecture 5 – Sustainable Materials** ***Geosciences Auditorium*** **Prof. Pedro Fardim** (KU Leuven, Faculty of Engineering Science, Belgium) *Polysaccharides as future sustainable materials* Chaired by Bruno Medronho (UAlgarve)	
10.15-10.45	**KN3 – Sustainable Materials** ***Geosciences Auditorium*** **Prof. Ana Fernández-Jiménez** (Instituto de Ciencias de la Construcción Eduardo Torroja, Madrid, Spain) *Development of low-carbon cements (LCCM) by alkaline activation technology* Chaired by Nuno Cristelo (UTAD)	
10.45-11.15	**Coffee Break**	
11.15-11.30	***Auditorium 1*** Chaired by Alexandra Costa (ISEL) & Rosa Rego (UTAD) **OC8-*EP*** - Siaw Lee (Eduardo Torroja Institute for Construction Sciences) *Circular solutions: zeolites from waste for ammonia mitigation in real effluents*	***Auditorium 2*** Chaired by Cristina Matos (UTAD) & Patrícia Barata (ISEL) **OC10-*EP*** - Muhammad Khubaib (UTAD) *From e-waste to resource: evaluating european approaches for a cleaner electronics lifecycle*
11.30-11.45	**OC9-*EP*** - Solange Magalhães (MidSweden University) *Tailored cellulose bioflocculants: enhancing wastewater treatment with low ecotoxicity*	**OC5-*SM*** - Ana Vieira (UTAD) *Green synthesis of silver nanoparticle-silk fibroin scaffolds for biomedical applications*
11.45-12.00	**OC3-*SM*** - Cristina Gonçalves (UTAD) *Replication of the physical-chemical properties of the leaf surface of Myrtus communis L.*	**OC6-*SM*** – Mariana Fernandes (UTAD) *Synthesis of carbon dots from Cinnamomum camphora leaves*

12.00-12.15	**OC4-*SM*** - Rafaela Cabral (ISEL) *Bioactive coordination compounds in biopolymer matrices: an antimicrobial coating strategy*	**OC7-*SM*** - Teresa Pinto (UTAD) *Co-composting of sewage sludge with biowaste from mechanical treatment: a proposal for sustainable biowaste valorization in northern Portugal*
12.15-12.30	**OC3-*ME*** - Amala Joy (UPorto) *Towards visible-light-assisted photocatalytic nitrogen fixation via physical integration of MOF and GCN photocatalyst*	**OC8-*SM*** - Rafael Rebelo (UCoimbra) *Industrial cellulose pulp-based hydrogels for agriculture: a simple and scalable process*
12.30-14.00	**Lunch**	
14.00-15.00	**Plenary Lecture 6 – Materials for Energy** ***Geosciences Auditorium*** **Prof. Adélio Mendes** (Faculdade de Engenharia do Porto, Universidade do Porto) *Green Energy from methanol to produce H_2 and CO_2* Chaired by Amadeu Borges (UTAD)	
	KN4 – Molecular Flows with Environmental Impacts ***Geosciences Auditorium*** **Prof. Eduardo Silva** (Universidade de Aveiro, Departamento de Geociências, Aveiro, Portugal) *Geological Resources and Human Activities: Environmental impacts versus Geohealth* Chaired by Fernando Pacheco (UTAD)	
15.30-16.30	**Coffee Break**	

Oral Communications

	Auditorium 1	**Auditorium 2**
16.00-16.15	Chaired by Eduardo Silva (UAveiro) & M. Fernandes (UTAD) **OC4-*MF*** - David Fangueiro (ISA ULisboa) *Sanitization of pig slurry by modifying pH with agro-industrial by-products: effects on emissions and potential leaching*	Chaired by José Peres (UTAD) & José Sousa (UTAD) **OC11-*EP*** - Carlos Andrade (UTAD) *From CO_2 to methane: a thermodynamic study of the Sabatier reaction for clean energy applications*
16.15-16.30	**OC5-*MF*** – Fernando Pacheco (UTAD) *Assessment of environmental risks in the Barranco do Banho aquifer (Serra de Monchique): disclosure of results*	**OC12-*EP*** - Andreia Farinha (KAUST-King Abdullah University of Science and Technology) *PFAS remediation in water by natural deep eutectic solvents and $scCO_2$*
16.30-16.45	**OC6-*MF*** - Charles Twagiramungu (Haramaya University) *Application of biochar produced from different feedstocks and organic fertilizers: effects on soil properties and maize (Zea mays L.) production in the northern part of Rwanda*	**OC13-*EP*** - Vitor Valente (UCoimbra) *Simulation of new renewable gases mixtures for injection into natural gas networks*
16.45-17.00	**OC4-*ME*** - Paulo Nunes (UTAD) *Passive thermotropic devices with radiative cooling functionality*	**OC14-*EP*** - Marisa Martins (UTAD) *Numerical analysis of PEMFCS as a clean energy solution for mobility*
17.00-17.15	**OC5-*ME*** - Tiago Duarte (UTAD) *Chondroitin-based Ionanofluid for sun-actuated devices*	**OC15-*EP*** - Luís Oliveira (CQVR) *Pyrolysis of sewage sludge: unlocking the hidden potential for valorization and carbon sequestration*
17.15	**Closing Ceremony** ***Geosciences Auditorium***	

LIST OF COMMUNICATIONS

Plenary Lectures & Keynotes

- **Food Security & Clean Label Technologies**

  PL1 | Prof. Martin Wagner

  A glimpse on emerging hazards: the FoodSafer Project.

  KN2 | Prof. Antonio Morata

  Emerging non-thermal technologies for the extraction and preservation of wine molecules with sensory impact.

- **Molecular Flows with Environmental Impacts**

  PL2 | Prof. Dave Chadwick

  Effects of extreme weather events on soil health and greenhouse gas emissions from agricultural land

  KN4 | Prof. Eduardo Silva

  Geological Resources and Human Activities: Environmental impacts versus Geohealth.

- **Environmental Pollution Remediation**

  PL3 | Prof. Sixto Malato

  Solar photochemical processes: applications and photoreactors.

  PL4 | Prof. Raf Dewil

  Exploring novel advanced catalytic techniques for the degradation of emerging pollutants in water.

- **Sustainable Materials**

  PL5 | Prof. Pedro Fardim

  Polysaccharides as future sustainable materials.

  KN3 | Dr. Ana Fernández-Jiménez

  Development of low-carbon cements (LCCM) by alkaline activation technology.

- **Materials for Energy**

  PL6 | Prof. Adélio Mendes

  Green Energy from methanol to produce H_2 and CO_2.

  KN1 | Prof. Stefania Specchia

  Sustainable electrocatalysts for low temperature fuel cells.

Oral Communications

▪ Molecular Flows with Environmental Impacts

OC1-*MF* | Nelson Machado

Real-time monitoring of leaves' gaseous exchange in C3 green plants: the thermodynamical role of water.

OC2-*MF* | Justyna Pyssa

Identification of population exposure to environmental contamination with selected antibiotics adsorbed on microplastics.

OC3-*MF* | Katarzyna Styszko

Polycyclic Aromatic Hydrocarbon Biomarker Profiles in Raw Wastewater as Indicators of Exposure Levels in Urban Environments.

OC4-*MF* | David Fangueiro

Sanitization of Pig Slurry by Modifying pH with Agro-Industrial By-Products: Effects on Emissions and Potential Leaching.

OC5-*MF* | Fernando Pacheco

Assessment of environmental risks in the Barranco do Banho aquifer (Serra de Monchique): disclosure of results.

OC6-*MF* | Charles Twagiramungu

Application of Biochar Produced from Different Feedstocks and Organic Fertilizers: effects on Soil Properties and Maize (Zea mays L.) Production in the Northern Part of Rwanda.

▪ Environmental Pollution Remediation

OC1-*EP* | Fernando Braga

Sustainable vineyard mulching: optimizing winery by-product co-composting with vine shoots for soil and weed management.

OC2-*EP* | António Pirra

Co-composting conditions and its impact on the quality of substrates from grape stalks and winery waste activated sludge: Lab and pilot-scale studies

OC3-*EP* | Sandra Nunes

Molecular dynamics simulations as a tool for advancing environmental remediation and impact mitigation strategies.

OC4-*EP* | Maria Roque

Adsorption and advanced oxidation processes: viable paths to remove disinfection byproducts?

OC5-*EP* | Maria Costa

Assessing the capacity of Caulerpa prolifera for copper adsorption and neutralization.

OC6-*EP* | Daniela Morais

Valorization of winery effluents in the Douro region: advanced treatment via ceramic membranes and photo-Fenton processes for water reuse.

OC7-*EP* | Najmeh Askari

MOF-on-MOF structures for enhanced degradation of emerging contaminants from water.

OC8-*EP* | Siaw Lee

Circular solutions: zeolites from waste for ammonia mitigation in real effluents.

OC9-*EP* | Solange Magalhães

Tailored cellulose bioflocculants: enhancing wastewater treatment with low ecotoxicity.

OC10-*EP* | Muhammad Khubaib

From e-waste to resource: evaluating european approaches for a cleaner electronics lifecycle.

OC11-*EP* | Carlos Andrade

From CO_2 to methane: a thermodynamic study of the Sabatier reaction for clean energy applications.

OC12-*EP* | Andreia Farinha

PFAS remediation in water by natural deep eutectic solvents and $scCO_2$.

OC13-*EP* | Vitor Valente

Simulation of new renewable gases mixtures for injection into natural gas networks.

OC14-*EP* | Marisa Martins

Numerical analysis of PEMFCS as a clean energy solution for mobility.

OC15-*EP* | Luís Oliveira

Pyrolysis of sewage sludge: unlocking the hidden potential for valorization and carbon sequestration.

- **Sustainable Materials**

OC1-*SM* | Attaullah Khan

Mechanical and thermal performance of waste polypropylene reinforced with glass fiber: a systematic review in the context of sustainability.

OC2-*SM* | José Silva

Utilization of olive stone waste as a sustainable fine aggregate replacement in cementitious mortars.

OC3-*SM* | Cristina Gonçalves

Replication of the physical-chemical properties of the leaf surface of Myrtus communis L..

OC4-*SM* | Rafaela Cabral

Bioactive coordination compounds in biopolymer matrices: an antimicrobial coating strategy.

OC5-*SM* | Ana Vieira

Green synthesis of silver nanoparticle-silk fibroin scaffolds for biomedical applications.

OC6-*SM* | Mariana Fernandes

Synthesis of carbon dots from Cinnamomum camphora leaves.

OC7-*SM* | Teresa Pinto

Co-composting of sewage sludge with biowaste from mechanical treatment: a proposal for sustainable biowaste valorization in northern Portugal.

OC8-*SM* | Rafael Rebelo

Industrial cellulose pulp-based hydrogels for agriculture: a simple and scalable process.

- **Food Security & Clean Label Technologies**

OC1-*FS* | Elisa Costa

Microalgae proteins as sustainable and allergen-free alternatives for fining white wines.

OC2-*FS* | Joana Ferreira

Enhancing the nutritional quality of edible insects: DHA-rich microalgae supplementation in Acheta domesticus diets.

OC3-*FS* | Mónica Silva

Combined effects of western diet and micro-nanoplastics on hepatic mitochondrial bioenergetics in C57BL/6J mice.

OC4-*FS* | Tânia Cova

Learning from molecules: predicting mycotoxin toxicity through structure-based machine learning.

OC5-*FS* | Solange Magalhães

Innovative functional bread: integrating acorn flour and regionally sourced essential oils for enhanced nutrition and shelf life.

OC6-*FS* | Manuel Pinto

Sensory evaluation of PDO/PGI wines in the context of accreditation in Portugal and the european framework: current practices and challenges.

- **Materials for Energy**

OC1-*ME* | Bruno Medronho

Regenerated cellulose: a versatile platform for sustainable laminates and green energy harvesting.

OC2-*ME* | Mauro Magalhães

3D printing using photochromic naphthopyrans as photoinitiators.

OC3-*ME* | Amala Joy

Towards visible-light-assisted photocatalytic nitrogen fixation via physical integration of MOF and GCN photocatalyst.

OC4-*ME* | Paulo Nunes

Passive thermotropic devices with radiative cooling functionality.

OC5-*ME* | Tiago Duarte

Chondroitin-based Ionanofluid for sun-actuated devices.

Poster Communications

- **Molecular Flows with Environmental Impacts**

PC1-*MF* | Rui Lopes

A segmented regression across P indicators and bootstrap approach to assess critical soil P saturation thresholds.

PC2-*MF* | Justyna Pyssa

The influence of seasons on the variability of physicochemical characteristics of wastewater from the Płaszow wastewater treatment plant in the context of reducing the eutrophication potential.

PC3-*MF* | Vanessa Almeida

Comparison of EDTA and DTPA-TEA for the extraction of micronutrients in a limed very acidic soil.

- **Environmental Pollution Remediation**

PC4-*EP* | Ana Teixeira

Application of grape waste from wine industry as iron complexing agents at circumneutral pH values. Comparison between solid and liquid residue.

PC5-*EP* | Ana Teixeira

Innovative 3D photocatalysts for agro-industrial recalcitrant pollutants removal.

PC6-*EP* | João Sousa

Effect of biochar, nanobiochar, and chitosan addition on the lability of heavy metals in soil: preliminary studies.

PC7-*EP* | Dominika Uchmanowicz

Characterization of tire and road wear particles (TRWP) in urban air using cascade impactor and SEM-EDS.

PC8-*EP* | Ana Figueiredo

3D printed modular ultrafiltration systems for small-scale and custom applications.

PC9-*EP* | Sara Bortolotti

Can PET and PE be used as remediation agents for metal pollutants?

PC10-*EP* | Wiktoria Sobczyk

Identification of toxic metals in dust pollution in a large urban agglomeration.

PC11-*EP* | Volodymyr Tkach

The theoretical description for sucralose and bisphenol A electrochemical detection in packed dietetic beverages.

- **Sustainable Materials**

PC12-*SM* | Ivo Oliveira

Almond skin as a sustainable resource for the green synthesis of zinc oxide nanoparticles.

PC13-*SM* | Nuno Cristelo

Lightweight concrete from alkali activated municipal solid waste incineration slag for thermal insulating panels.

PC14-*SM* | Patrícia Barata

Synthesis of fluorescent carbon nanomaterials from grape pomace for biomolecule detection.

PC15-*SM* | Ana Figueiredo

Carbon dots derived from agroindustrial wastes: enhancing cellulose acetate membranes for water treatment applications.

PC16-*SM* | Alexandra Costa

Design of experiments in the optimization of sustainable synthesis of carbon nanomaterials from chestnut waste.

PC17-*SM* | Ricardo Mata

Potential for nitrogen mineralization in hydrochar and process water from Nannochloropsis sp..

PC18-*SM* | Rafael Muñoz

Assessing the recycling of a petrochemical catalyst waste into ceramics to enable sustainable environmental remediation.

PC19-*SM* | Ângelo Luís

Innovative food packaging materials with pullulan and essential oils.

PC20-*SM* | Joana Ribeiro

Antifungal behaviour of bio-based plasterboard composites: Integrating natural silkworm cocoon fibers to enhance indoor hygiene in healthcare buildings.

PC21-*SM* | Moises Pedro

Evaluation of the antimicrobial activity of glycerol salicylate against different pathogens and study of its hemolytic activity.

- **Food Security & Clean Label Technologies**

PC22-*FS* | Silvia Afonso

Ethanol reduction in wine using Saccharomyces and non-Saccharomyces yeasts: a strategy to address climate change and consumer demand.

PC23-*FS* | Juan Otero

Comparative study of volatile flavour profiles and physicochemical traits in organic vs. conventional pork.

PC24-*FS* | Magda Semedo

Microalga as raw material for food ingredients: a study on protein extraction and functionality.

PC25-*FS* | Daniel Pereira

How micro(nano)plastics and a high-fat diet affect brain energy and oxidative balance in mice.

PC26-*FS* | Bruno Medronho

Aromatic allies: bioactivity of essential oils from Alentejo and Algarve in functional bread development.

- **Materials for Energy**

PC27-*ME* | Ilias Ouanzi

Electrochemical characterization of nanocomposites for the oxygen reduction reaction.

PC28-*ME* | Tomas Cordero

Lignocellulosic Biorefinery, production of chemicals, bioenergy, and carbon materials.

PC29-*ME* | Sílvia Nunes

Innovative integration of luminescent carbon dots into di-urea crosslinked siloxane hybrids.

PC30-*ME* | Mariana Fernandes

Sodium electrolytes - can they be viable alternatives for electrochemical devices?

PC31-*ME* | Paulo Nunes

Structure and ionic conductivity of POP-based di-ureasil ormolytes doped with [BMIm]PF_6.

II INTERNATIONAL MEETING MOLECULES 4LIFE

PLENARY LECTURES & KEYNOTES

A glimpse into emerging food safety hazards: the FoodSafeR Project

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EFSA defines an emerging food safety risk as "a risk resulting from a newly identified hazard to which a significant exposure may occur, or from an unexpected new or increased significant exposure and/or susceptibility to a known hazard." The latter increased exposure can be the result of the increased presence of the known hazard and/or the increased exposure to this hazard. Food safety "hazards" or "issues" are the (biological, physical or chemical) agents present in our food system (existing or emerging) which may cause a harmful impact on the public health of our European citizens. The risk of a particular food safety hazard or issue will depend on the occurrence (prevalence, concentration) of the hazard in our food, the applied food preparation method by the consumers, the consumption of the food (dose), and its potential impact on human health (acute or chronic effect, short- or long-term effect). All this happens in a changing physical and political environment and the resilience of the European food system has been critically hallmarked. The EU-funded project, FoodSafeR, is testing future impacts on food safety and developing indicators for the trends that project forward into the future. The consortium has selected eight microbiological and chemical hazard scenarios that include food system structures, foodborne pathogens and chemicals. It critically calls for improvements to current food safety management practices and explores how these may be achieved via modern communication tools.

Acknowledgments: This project has been funded by Horizon Europe grant number 101060698

Impacts of extreme weather events on soil health and greenhouse gas emissions from agricultural land

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The frequency and severity of extreme weather (flooding, drought and extreme heat) events have increased globally in recent decades [1], all of which impact on soil substrate availability (C and N) and the abiotic (e.g., pH, aeration status) and biotic (e.g., microbial activity) factors responsible for greenhouse gas (GHG) emissions. In particular, these extreme conditions effect the resistance and resilience of soil microbial communities and their enzymatic 'readiness' responsible for reduction reactions, e.g., via nitrate reductase and nitrous oxide reductase. ***Flooding*** not only increases the risk of CH_4 generation, but also results in the accumulation of NH_4^+ within the soil profile (as mineralization of organic matter continues, but nitrification is inhibited) [2,3] with factors such as temperature and the presence of organic amendments influencing this. As flood waters recede and O_2 diffuses into the anaerobic soil, nitrification of this large pool of accumulated NH_4^+ results in a prolonged period of enhanced N_2O emission [2,3], which can be greater than fluxes following fertilizer N application under typical soil conditions [3]. Under contrasting conditions, where a period of ***drought*** is followed by intense rainfall, large N_2O fluxes have also been observed, e.g., under typical Mediterranean climates [4]. This 'Birch' effect, and subsequent N_2O pulse, is known to be controlled by mineralization rates and the release of osmolytes [5], with the bioavailability and utilization of substrates by the microbial community primed by the drought and important in overall N_2O production and emission. Rewetting from a drier soil state results in larger N_2O emissions if soil is sufficiently rewetted, where drought duration and subsequent size of N_2O "hot moments" are negatively correlated and non-linear [6]. ***Extreme heat-stress events*** (and fire) also impact soil microbial activity, with a critical thermotolerance threshold identified between 40 and 50 °C, beyond which a sharp decline in microbial carbon use efficiency and nutrient availability is observed and, under laboratory conditions, the microbial community recovers extremely slowly. The frequency of combined extreme events is also increasing in some regions [1], and these combinations could increase GHG emissions further. As such, extreme weather events have significant implications for developing climate-resilient GHG emission inventories and for national environmental targets such as meeting Net Zero. This presentation provides evidence of the impacts of extreme weather events on soil biogeochemistry and GHG emissions.

Acknowledgments: Welsh Government's Sêr Cymru Research Network on Low Carbon, Energy & Environment.

References:

[1] R. Dodd; D.R. Chadwick; I. Harris; I.M. Hines; D. Hollis; T. Economou; D. Gwynn-Jones; J. Scullion; D.A. Robinson; D.L. Jones, Ecology Letters, 24 (2021), 60.
[2] A.R. Sánchez-Rodríguez; C. Nie; P.W. Hill; P.W. Hill; D.R. Chadwick; D.L. Jones, Soil Biology and Biochemistry, 130 (2019), 227.
[3] R. Dodd; D. Chadwick; P.W. Hill; F. Hayes; A.R. Sánchez-Rodríguez; D.Gwynn-Jones; S.M. Smart; D.L. Jones, Science of the Total Environment, 861 (2023), 160660.
[4] E. Vázquez; N. Teutscherova; R. Pastorelli; A. Lagomarsino; L. Giagnoni; G. Renella, Soil Biology and Biochemistry 147 (2020), 107839.
[5] C.R. Warren, Soil Biology and Biochemistry, 150 (2020), 108012.
[6] H.A. Barrat; I.M Clark; J. Evans; D.R. Chadwick; L.M. Cardenas, Soil Biology and Biochemistry, 168 (2022), 108606.

Treatment of wastewaters and municipal effluents by solar advanced oxidation processes: technology and applications

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Advanced Oxidation Processes (AOPs) are efficient technologies for water treatment in terms of degradation of pollutants and inactivation of pathogens. In AOPs, the generation of highly reactive radicals allows attaining the oxidation of a great variety of pollutants. A wide range of advanced treatment methods have been investigated including consolidated and not intensively implemented AOPs. The presentation will evaluate their efficiency in the removal of contaminants, advantages and drawbacks, possible obstacles to the application and technological limitations with mid to long terms perspectives. It will also explore the state of the art and latest progress in photoreactors for solar AOPs for water treatment including decontamination of conventional biorecalcitrant wastewaters and elimination of contaminants of emerging concern. The overview will also show how to focus specific wastewaters and discriminate between different AOPs to avoid inefficient applications.

Pilot-scale test results for the complete removal of a plethora of contaminants and microcontaminants have been quite satisfactory. Results reinforce the idea that treatment of extremely low concentrations of contaminants (as contaminants of emerging concern), requires different operating concepts from the application of photocatalysis to high-organic-load industrial wastewaters. The key matter is the design and operation of photoreactors accordingly to the wastewater to be treated. Despite the limitations of the process, the efficiency of the technology for the treatment of wastewater has prompted its investigation at pilot-scale in combination with other technologies as biotreatment and membrane processes. Also, different solar photoreactors have been proposed for applying photocatalysis, trying to take into account the specific needs of the process. In this sense, Raceway Pond Reactors, have arisen as an interesting and feasible scaling-up option for treating municipal effluents, being well-known solar photoreactors based on compound parabolic collectors, more suitable for the treatment of bio-recalcitrant industrial wastewaters with high organic load.

The interest in renewable H_2 production sources, with H_2 as an energy carrier, is growing. It would be also commented the first approaches to another application of solar photocatalysis, the potential combination of H_2 generation with simultaneous water decontamination, as a proof-of-principle study of the potential application of solar photocatalysis as a single technological solution for the water-energy nexus. With this technology, clean hydrogen fuel is produced at the same time as wastewater is treated in anoxic conditions, eliminating highly recalcitrant contaminants and disinfecting it for reuse.

Reductive pathways in heterogeneous photocatalysis: advancing micropollutant degradation toward real-world applications

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The persistence of micropollutants in aquatic environments represents a major challenge for water treatment technologies. While oxidative degradation has long dominated the field of advanced oxidation processes (AOPs), recent advances in heterogeneous photocatalysis have demonstrated that reductive pathways, driven by photo-induced electrons, offer a powerful, selective, and energy-efficient alternative for the breakdown of recalcitrant compounds such as pharmaceuticals and pesticides.
This keynote will explore the emerging field of photocatalytic reduction as a complementary or stand-alone strategy for micropollutant degradation. Emphasis will be placed on the design of photocatalysts that favor electron-rich surface reactions, including the engineering of defect sites, band structure modulation, and electron sink integration. We will present recent experimental work on metal-free and metal-doped semiconductors that exhibit superior reduction selectivity and stability under visible light irradiation. Additionally, the session will address the mechanistic insights into pollutant-catalyst interactions, including molecular modeling and the role of reactive intermediates, such as hydrated electrons.
By bridging fundamental materials chemistry with environmental engineering needs, this talk aims to highlight the potential of reductive photocatalysis to reshape how we think about pollutant detoxification in next-generation water treatment systems.

Acknowledgments: Funded by the European Union, under the Marie Skłodowska-Curie grant agreement no 101154622 (HYCEM). Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

Polysaccharides as future sustainable materials

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Polysaccharides (PS) are abundant biopolymers that can be produced in large scale and are relevant for food, health, and materials. They are common denominators for combining chemical engineering, chemistry, material science, bioscience, biotechnology, and medicine to create a completely new generation of sustainable products and to enhance human and planet health (Figure 1) [2]. However, PS still face several challenges in sustainable processing, control and design of structure-property relationship and fabrication of functional materials. Their potential to tackle great challenges remain locked and unexploited. In this talk, we will address challenges and opportunities of PS covering functional therapeutics, functional prevention, personal care, and sustainable processes. Functional therapeutics involves the creation of new biomaterials for tissue engineering, targeted drug delivery and encapsulation. Functional prevention involves the holistic of product design and formulation without health threatening additives or components. Personal care focuses on design of sustainable products such as cosmetics and personal hygiene products. Sustainable processes involve the development of new processes combining chemical and biochemical processes using green solvents. Future directions and the importance of interdisciplinary and joint venture initiatives between PS scientists and technologists, policy makers and industry are presented and discussed.

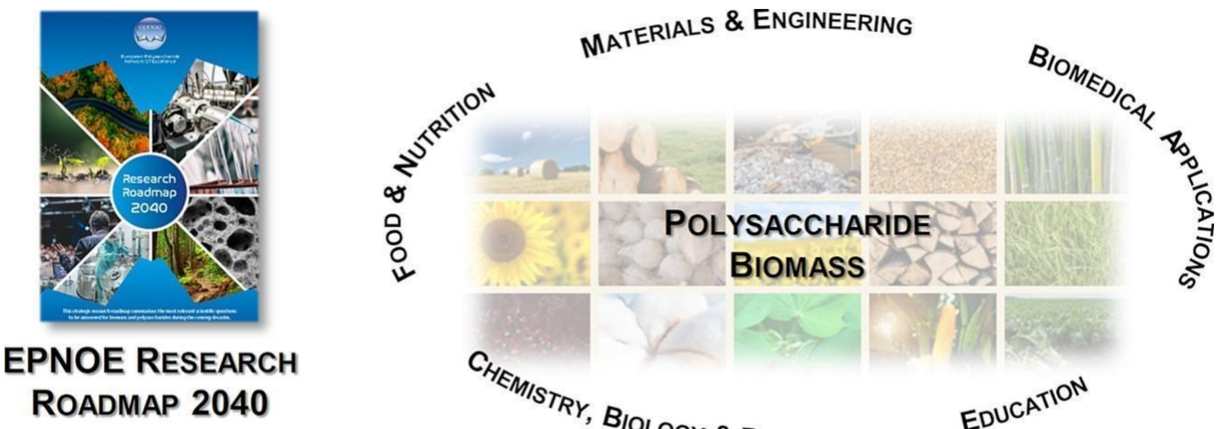

Figure 1. Polysaccharides are safe and will be central to the world of tomorrow as a transition to sustainable technologies is crucial for the future of humanity.

References
[1] L. S. Sobhanadhas; L. Kesavan; P. Fardim, Langmuir, 34 (2018) 9857.
[2] M. Gericke *et al.* & P. Fardim, Carbohydrate Polymers, 326 (2024) 121633.

From biogas to low-cost green methanol

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After 4500 million years running an optimization algorithm, nature chose to produce hydrogen from the water splitting – photosynthesis – but not to store it or use it as such; Nature decided to produce and transform hydrogen into energy-carrying biomolecules and biomolecules used to build biological structures. Hydrogen, under ambient conditions, has a low energy density and must be compressed or liquefied to be used as an energy vector, that is, as a substrate for energy transport and storage. At 700 bar, hydrogen exhibits an energy density of 1.3 kWh/L. The compression process requires the equivalent ca. 13 % of the energy of compressed hydrogen (thermodynamic energy is 6.7 %, assuming isothermal compression, and 10.5 % for adiabatic compression); Liquefied hydrogen has an energy density of 2.3 kWh/L, and the liquefaction process requires the equivalent of 36 % of the energy of liquefied hydrogen. Hydrogen is then a bad energy vector, however, it is a very relevant intermediate reagent. Hydrogen should preferentially be produced and consumed locally, as Nature realized millions of years ago. The methane splitting reaction, $CH_4 \rightleftharpoons C\ (s) + 2H_2$, ΔH^0 = 75.3 kJ/mol, produces decarbonized hydrogen and carbon when green electricity is used to balance the reaction enthalpy. The intermediate temperature catalytic methane splitting (IT-CMS), running between 750 °C and 850 °C, is one of the most efficient and low-cost emerging processes for conducting this reaction; it produces decarbonized hydrogen and high-added-value nanofilament graphite carbon particles. When biomethane is used, this process produces renewable graphitic carbon, CO_2 emission licenses, and hydrogen; the balance cost of this hydrogen is very low due to the high value of the produced graphitic carbon. However, the production of hydrogen at the biogas production sites is not attractive due to the high storage and transport costs of hydrogen. However, it can be made to react with the CO_2 present in the biogas to produce high-value green methanol. Assuming that biomethane cost is 150 €/MWh (very high price) [1], the renewable electricity is 70 €/MWh, the CO_2 permits is 70 €/t, and the graphitic carbon is 0.77 €/kg, the balance cost of hydrogen is *ca*. -2.4 €/kg. When reacted with the biogas CO_2, it can produce green methanol at ca. 211 €/t[1], which compares very favorably with the present cost of methanol, 625 €/t + CO_2 emissions = 721 €/t [2]. The expected EU capacity to produce biogas by 2030 is 35 bcm/year (342 TWh/year) [3], suitable to produce 47 Mt of methanol, preventing the emission of 79.3 Mt/year of CO_2 and originating a net profit of 47 x (721 - 211) ≈ 24 000 M€/year.

Acknowledgments: C.M.C.S. thanks the support of H2Driven Green Agenda, C644923817-00000037, investment project nr. 50, financed by PRR and by EU - NextGeneration EU. LEPABE, DOI:10.54499/UIDB/00511/2020, and ALiCE, DOI:10.54499/LA/P/0045/2020, financed by national funds through the FCT/MCTES (PIDDAC).

References:

[1] https://www.europeanbiogas.eu/benefits/affordable-energy/, assessed in May 2025.
[2] https://www.methanex.com/about-methanol/pricing/, assessed in May 2025.
[3] https://energy.ec.europa.eu/topics/renewable-energy/bioenergy/biomethane_en, assessed in May 2025.

[1] It is assumed that the CO_2 capture and purification from biogas costs ca. 10 €/t.

Sustainable electrocatalysts for low temperature fuel cells

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Fuel cells are devices that efficiently convert the chemical energy of a fuel into electrical energy via electrochemical reactions. Among the wide variety of fuel cell types, low temperature fuel cells (PEMFC and AEMFC) are promising for transportation and portable applications, since they can operate close to ambient conditions. The main drawbacks of low temperature fuel cells are represented by the use of costly Pt-based electrocatalysts at both the anode and the cathode, and in particular the sluggish oxygen reduction reaction (ORR) at the cathode side. Among several types of electrocatalysts for ORR, the most promising alternative to Pt until now are carbonaceous materials doped with N and transition metals (mostly Fe, Co). This lecture will address the main synthesis techniques adopted for the sustainable production of Fe-N-C electrocatalysts, included the use of biomass in a circular economy perspective.

Emerging non-thermal technologies for the extraction and preservation of wine molecules with sensory impact

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The extraction and stabilization of compounds with sensory impact (anthocyanins, tannins, varietal aroma, and others) is a key aspect in wine quality. Emerging non-thermal technologies allow the winemakers to speed the conventional maceration, also preserving the integrity of these molecules in a gentle process. Technologies such as High Hidrostatic Pressure (HHP), Ultra-High Pressure Homogenization (UHPH), Pulsed Electric Fields (PEF), Ultrasound (US), and irradiation technologies are really useful to extract and solubilize phenols and aroma compounds at low temperature and quickly. Moreover, some of these technologies can inactivate oxidative enzymes increasing the stability. Additionally, most of them are able to eliminate wild microorganisms facilitating the use of non-Saccharomyces starters and other emerging fermentation biotechnologies. Most of these technologies have already been approved by OIV and can be used as regular enological practices.

Development of low-carbon cements (LCCM) by alkaline activation technology

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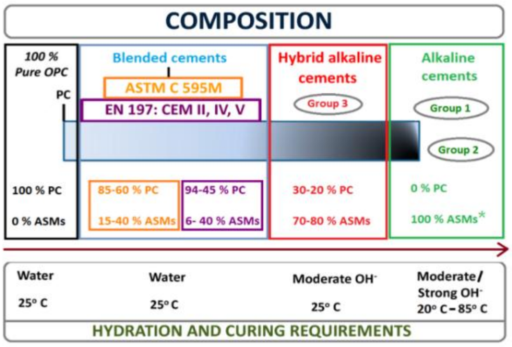
Portland cement (PC) manufacturing contributes significantly to energy consumption, greenhouse gas (GHG) emissions and natural resource depletion. PC production increases by 7-8 % annually and its manufacture accounts for 7-9 % of total GHG production. In order to reduce CO_2 emissions, the cement industry's roadmap includes, among other options: increasing the content of supplementary cementitious materials (SCMs) to replace Portland cement clinker or making clinker-free cements. By applying alkaline activation technology [1-5], both options are possible to produce low-carbon cements -(LCCM). Alkaline cements (AC) are obtained by the physical-chemical interaction of materials (aluminosilicates) from natural origin or industrial waste (with amorphous or vitreous structures) with alkaline activators. Hybrid alkaline cements (HAC) are multi-component systems containing a high percentage of mineral additions (dehydroxylated clays, fly ash, slag, mining waste, etc.), low proportions of Portland clinker (<30 %) and a small proportion of activators (solids or liquids) of moderate alkalinity (Na_2SO_4, $NaCO_3$, NaCl, ...). At this point, it is important to highlight the great versatility in terms of the materials used in these cements, which allow the recovery of waste from other industries. The use of alkaline activation technology therefore allows the development of new sustainable materials with low CO_2 emissions, in addition to the recovery of by-products or industrial waste, avoiding the overexploitation of natural resources and favouring the circular economy.



Acknowledgments: This works has been funded by the Spanish Research Agency (AEI), the Spanish Ministry of Science and Innovation and the ERDF (research Project PID2022-138637OB-C31/AEI/10.13039/501100011033 /FEDER, UE).

References:

[1] I. Garcia-Lodeiro; S. Donatello; A. Fernández-Jiménez; Ángel Palomo, Materials, 9 (2016) 605.
[2] A. Palomo; O. Maltseva; I. Garcia-Lodeiro; A. Fernández-Jiménez, Frontiers in Chemistry, 9 (2021) 705475.
[3] N. Cristelo; J. Coelho; J. Rivera; I. Garcia-Lodeiro; T. Miranda; A. Fernández-Jiménez, Journal of Sustainable Cement-Based Materials, 12 (9) (2023) 1081.
[4] M.R. Ahmad; A. Fernández-Jiménez; B. Chen; Z. Leng; J.G. Dai, Construction and Building Materials 455 (2024) 139087.
[5] P. Martín-Rodríguez; I. García-Lodeiro; L. Fernández-Carrasco; M.T. Blanco-Varela; A. Palomo; A. Fernández-Jiménez, Composites Part B 296 (2025) 112216.

The Role of Geosciences in Sustainable Development: Knowing the Complex Relationships in the Geology-Environment-Health system

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The Sustainable Development Goals (SDGs) provide a comprehensive roadmap for achieving global sustainability by 2030. These 17 goals demand active contributions from scientists, particularly geoscientists, who play a key role either in the exploration and management of geological resources, or in the protection and restoring the natural environment. Research demonstrates that geosciences are involved (in)directly in most of the SDGs, namely in the 7, 11, 12 and 13, highlighting their relevance in addressing today's global challenges, as the obtaining of critical raw materials for green energy transition. Although geological resources are essential to societal development, their exploitation often comes at a significant environmental and health cost. Thus, this keynote explores the intricate relationship between geological activities, environmental impacts, and public health.

Research in many abandoned mining areas reveals metal(loid) contamination of soils, sediments and waters, which poses significant long-term risks for ecosystems. These environmental contamination scenarios are often highly complex, so the implementation of remediation processes requires in-depth knowledge of the specific conditions at each site. This aspect is often overlooked, which explains the lack of success of some of the environmental remediation measures adopted. In addition, these studies highlight the need for spatial risk assessments and environmental monitoring to integrate regional planning and health policies regarding the dangers of urban and industrial expansion into geologically sensitive zones. Although much progress has now been made in terms of legislation and environmental protection measures in many developed countries, the same is not true for many underdeveloped countries. Much of this knowledge has come from studying the environmental liabilities of past mining operations, which continue to work as natural laboratories for studying the processes of availability, mobility and toxicity of potentially toxic elements (EPTs).

However, cases of environmental or human health risks related to EPTs are not only associated with mining scenarios, but there are also several situations of trace element enrichments exclusively associated with natural geological processes. Geohealth studies contribute to identifying health problems related to the geological environment and sustainable resource management strategies tailored to each case.

Recognizing the health dimensions of geological resource use is essential for building a more equitable, resilient, and sustainable future. Integrating geohealth into policy and planning ensures that human development respects the Earth's dynamic systems while safeguarding public health.

Acknowledgments: The authors thank the FCT-Fundação para a Ciência e a Tecnologia (Portugal) the financial support through the GEOBIOTEC (UIDB/GEO/04035/2020) research unit.

II INTERNATIONAL MEETING
MOLECULES 4LIFE

ORAL COMMUNICATIONS

Real-time monitoring of leaves' gaseous exchange in C3 green plants: the thermodynamical role of water

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If life on our planet is considered, photosynthesis represents one of the most important processes, being responsible for the production of biomass. C3 plants are a large group of green plants that use the C3, or Calvin cycle, to promote CO_2 fixation during photosynthesis. This group includes important crops, such as rice, wheat, vine and most trees, being generally found in temperate to cold climates. Therefore, the effects of Climate Change, already visible in many Regions, such as the Mediterranean, which is warming 20% faster than the global average [1], may compromise the feasibility of such crucial crops. In this sense, since plants need to control their temperature, to maintain all their metabolic machinery functioning properly, 98 % of their water requirements result from evapotranspiration to dissipate heat [2], taking advantage of convection phenomena.

Therefore, a custom-made wearable is being developed, within the PhenoBot project, containing distinct low-cost sensors for *in vivo* real-time monitoring of leaves' gaseous exchanges, incident radiation and Photosynthetically Active Radiation (PAR), temperature and relative humidity (RH), which, alongside C3 System Biology models, will allow monitoring, not only photosynthesis, but also plant metabolic status, in real-time. Nonetheless, while the experimental setup gives a fingerprint of the metabolic activity taking place in real time, regarding H_2O, it is also necessary to account with its loss due to heat dissipation, governed by temperature, RH and convection currents.

Therefore, resorting to data registered in real-time, with the developed wearable, during 5 days, two different tests have been performed. In a first estimate, calculated for a temperature of 17 °C, 1 m^2 of canopy can lose 0.3 L of H_2O (0.3 mm) in a day, without wind, and up to 0.7 mm of water if the wind is 36 km/h. In a second estimate, at 35 °C, the temperature of the plant almost equalizes the ambient temperature, losing 1.5 mm of H_2O per day, which turns into 3.5 mm accounting with a wind of 35km/h. Transposing the estimated values to the real conditions of the PhenoBot vineyard trial, at Quinta do Cidrô (Douro Region), these would correspond to H_2O loss values between 221.4 and 516.6 mm (L/m^2 of vineyard area), due to the canopy dissipation, for the vegetative cycle (April-October). These are in good agreement with the intervals between 300-700 mm, pointed by distinct authors [2,3], which consider total water needs during the growth cycle.

Summarizing, the results obtained point to the robustness of the approach developed, resorting to the wearable device, to accurately monitor the gaseous exchanges, which supports the feasibility of such approach to monitor the photosynthetic and metabolic rates, supported by Systems Biology.

Acknowledgments: This work was supported by project PhenoBot: PRR-C05-i03-I-000134, to which NM acknowledges his research contract. FS acknowledges Fundação para a Ciência e Tecnologia (FCT), Portugal, PhD research grant Ref. DFA/BD/9136/2020.

References:
[1] unep.org/unepmap/resources/factsheets/climate-change, Accessed on 15/05/2025
[2] A. Deloire; A. Pellegrino, IVES Technical Reviews, (2021).
[3] H. Medrano; M. Tomás; S. Martorell; J.-M. Escalona; A. Pou; S. Fuentes; J. Flexas; J. Bota, Agronomy for Sustainable Development, 35 (2015) 499.

Identification of population exposure to environmental contamination with selected antibiotics adsorbed on microplastics

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One of the most significant threats of the 21st century, which appeared with the development of modern medicine and the rapid increase in the consumption of pharmaceuticals, is the penetration of pharmaceutical substances into the natural environment. Among them, antibiotics occupy a special place, which, when used on a large scale, enter the environment, and their presence can lead to serious threats. Antibiotic residues present in sewage, soil, surface and ground waters indicate their ability to persist in the environment for a long time and the potential risk of accumulation in the food chain [1].
At the same time, a growing problem is environmental pollution with microplastics, the particles of which, with a diameter of less than 5 mm and a large specific surface area, demonstrate the ability to adsorb other pollutants, including pharmaceuticals. Microplastics, formed both as a result of the degradation of larger plastic waste and produced directly in the form of small particles, are present in all ecosystems - from oceans to soils, and due to their properties and structure, they act as a "carrier" of harmful substances [2]. They can transport hazardous materials over considerable distances, and desorption processes, releasing toxic substances in new places, increase the risk of their spread and penetration into other elements of the environment [3].

The aim of the study was to assess the sorption capacity of selected antibiotics on microplastics depending on the contact time of the solid phase with the contaminated solution. Analyses were carried out using the LC-MS/MS technique, which allows for the identification and quantitative determination of sorption. The interaction of antibiotics and microplastics is a significant threat, requiring a detailed analysis of the mechanisms related to the adsorption and desorption processes.

Understanding the routes of environmental pollution with pharmaceuticals, understanding the mechanisms of the impact of drugs on the environment and identifying the threats these impacts pose will enable the development of solutions that will aim to limit the penetration of pharmaceuticals into the environment and reduce their presence in natural ecosystems in the future.

Acknowledgments: Research supported by AGH University of Krakow within the framework of the “Excellence Initiative - Research University” program and Grant Number: 16.16.210.476 of AGH University of Krakow.

References:

[1] A. Zabłotni; A. Jaworski; Postępy Hig Med Dosw 68 (2014) 1040.

[2] K. Styszko; W. Bolesta; J. Worek; Z. Prus; K. Cwynar; J. Pyssa; D. Uchmanowicz; L. Frydel; A.P. Daso; B. Kasprzyk-Hordern, Energy Reports 13 (2025) 4756.

[3] K. Styszko; W. Bolesta; J. Worek; D. Kaleta; A. Nalepa; J. Pyssa; K. Cwynar; Z. Prus; L. Frydel, EGU24-20853, https://doi.org/10.5194/egusphere-egu24-20853.

Polycyclic Aromatic Hydrocarbon Biomarker Profiles in Raw Wastewater as Indicators of Exposure Levels in Urban Environments

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A novel approach is proposed in this study, utilizing Wastewater-Based Epidemiology (WBE) for the spatial and temporal assessment of exposure to polycyclic aromatic hydrocarbons (PAHs) through the analysis of hydroxylated PAH derivatives (see Fig. 1). The selected biomarkers include 1-hydroxynaphthalene, 2-hydroxynaphthalene, 2-hydroxyfluorene, 9-hydroxyfluorene, 9-hydroxyphenanthrene, 1-hydroxypyrene, and 3-hydroxybenzo(a)pyrene. Most of the target markers were detected in measurable concentrations in both raw and treated wastewater. Back-calculation estimates revealed that, during summer, the total PAH exposure of an average resident of Krakow was approximately 2.1 µg/day, whereas in winter this value increased to 4.1 µg/day. To the best of the authors' knowledge, this is the first study to use OH-PAH profiling in wastewater for the purpose of assessing PAH exposure.

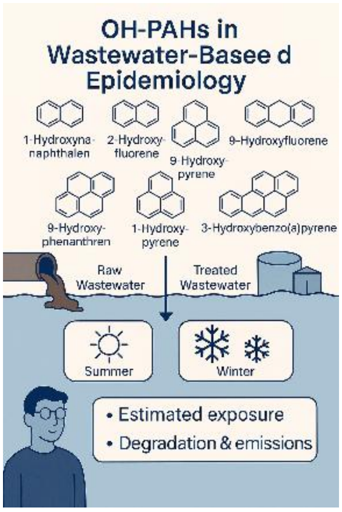

Figure 1. The concept of using wastewater-based epidemiology to assess the level of exposure to pollutants in urban areas.

Acknowledgments: The project was financed by the Polish National Science Centre (grant no. 2022/45/B/ST10/02108). Research supported by AGH UST within the framework of the "Excellence Initiative - Research University" program.

References:

[1] K. Styszko; J. Pamuła; E. Sochacka-Tatara; A. Pac; B. Kasprzyk-Hordern; Ecotoxicology and Environmental Safety, 292 (2025) 11792.

Sanitization of Pig Slurry by Modifying pH with Agro-Industrial By-Products: Effects on Emissions and Potential Leaching

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The surface application of raw pig slurry poses risks to environmental quality and public health due to potential pathogen loads, greenhouse gas emissions (GHG), and nutrient losses [1]. Effective treatment methods are needed to enhance the agronomic value of slurry while minimizing its environmental impact. Slurry pH modification is a promising strategy to reduce emissions and improve nutrient availability [2]. This study explores the use of agro-industrial by-products as alternative additives to replace conventional mineral acids and bases for slurry pH modification.

Three pH-modification strategies were considered: (i) direct acidification (pH 5), (ii) biological acidification (bio-acidification; pH 5) using labile carbon-rich substrates and (iii) alkalinization (pH 9.5). All treatments aimed to reach target pH levels with less than 20% (v/v) additive. Sanitization efficiency was evaluated by enumeration of *E. coli* population, targeting <1000 colony forming units (CFU) per g of slurry. Ammonia and GHG emissions were monitored during 25 days of storage as described by Prado et al. [3], while nutrient and pathogen leaching was assessed following surface application of pig slurry (240 kg N ha-1) to a sandy soil following the methodology described by Fangueiro *et al*. [4].

Target pH values were successfully achieved using by-products, offering cost-effective alternatives to mineral inputs. Although complete sanitization was not consistently reached, direct acidification and bio-acidification significantly reduced *E.coli* population. Ammonia emissions were reduced by >99% through direct acidification and by 85% through bio-acidification. Alkalinization suppressed methane emissions and resulted in the lowest total GHG emissions among treatments. Acidified slurries significantly increased the leaching potential of ammonium and phosphorus compared to raw slurry, whereas nitrate leaching remained minimal. Fecal coliform leaching declined throughout the study, with acidified slurry consistently maintaining levels below the threshold for irrigation water (<100 MPN/100 ml). Modifying the pH of pig slurry with agro-industrial by-products represents a viable strategy to reduce emissions and sanitize the slurry prior to field application. However, its impact on nutrient leaching must be considered, particularly in sandy-textured soils.

Acknowledgments: This work was supported by the Ferticycle project funded by the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie (grant agreement No 860127) and national funds through FCT – Fundação para a Ciência e a Tecnologia, I.P., under the projects UIDB/04129/2020 of LEAF-Linking Landscape, Environment, Agriculture and Food Research Unit and LA/P/0092/2020 of Associate Laboratory TERRA

References:
[1] S. Chrysanthopoulos; J. Coutinho; A.C. Silva; L. Brito; D. Fangueiro; Journal of Cleaner Production, 434 (2024) 140052.
[2] D. Fangueiro; M. Hjorth; F. Gioelli, Journal of Environmental Management, 149 (2015) 45.
[3] J. Prado; J. Chieppe; A. Raymundo; D. Fangueiro, Journal of Cleaner Production, 263 (2020) 121443.
[4] D. Fangueiro; S. Surgy; V. Napier; J. Menaia; E. Vasconcelos; J. Coutinho, Journal of Environmental Management, 146 (2014) 198.

Assessment of environmental risks in the Barranco do Banho aquifer (Serra de Monchique): disclosure of results

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This communication outlines a set of potential risks to surface and groundwater resources in the Barranco do Banho watershed (area: 286 hectares), located in the municipality of Monchique, in the district of Faro (Portugal). We also investigated the possible contribution to these risks brought by the activity of a quarry ("Palmeiras nº 2") operating in this watershed. Considering the biophysical context around the studied area, environmental risks related to land use, urban occupation and forest fires were analyzed, in order to obtain a panoramic view over the risks of anthropic origin that may threaten local water resources, and thus better understand the possible role of the activity in the quarry. The quarry is located in the central part of the Barranco do Banho watershed, occupying 1.7 hectares, and is filled with rainwater and surface run-off up to 351.64 meters of altitude (about 60 cm deep). The environmental risks to which the water resources of the Barranco do Banho watershed are subject are summarized in the form of a flowchart in Figure 1. The risk assessment results are: (a) The risk of contamination associated with forest fires is very high, particularly in the Barranco do Banho valley, in an area of 5.7 hectares; (b) The risk of groundwater contamination associated with farming activities is very high, in the headwaters of the Barranco do Banho, in an area of 9.5 hectares; (c) The risk of groundwater contamination was also considered to be very high in the vicinity of the village of Caldas de Monchique, in an area of 6.9 hectares, associated with the urban presence. The risk analysis carried out did not identify any significant impacts on surface or groundwater resources that could be associated with the quarrying activity. However, it is necessary to remove the water accumulated in the quarry's excavated area so that the water discharged into the public water domain does not carry fine sediments that cause turbidity.

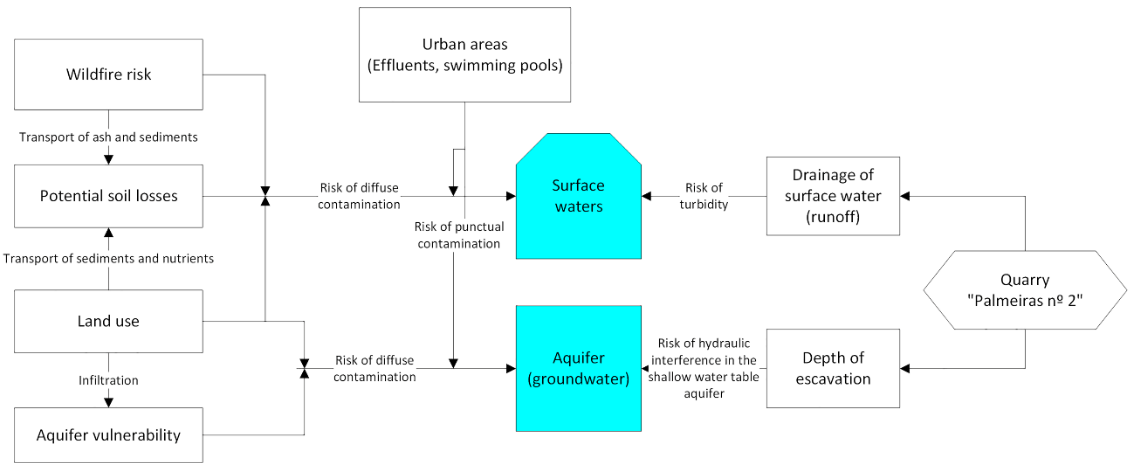

Figure 1. Flowchart of the risk assessment methodology used.

Application of Biochar Produced from Different Feedstocks and Organic Fertilizers: effects on Soil Properties and Maize (*Zea mays L.*) Production in the Northern Part of Rwanda

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Evaluating biochar agricultural potentials requires a wide range of field studies conducted under diverse conditions. In the present study, biochar derived from different feedstocks and organic fertilizers (OF) were applied to two contrasting acidic soils, Andosol and Nitisol, with aim to investigate the effects of biochar and OF on soil properties and maize production. The experiment was carried out in a split plot design, with OF as main plot factor (control without OF (OF0), cow manure (OF1), chicken manure (OF2), and compost (OF3)) and biochar as sub-plot factor (no biochar applied (B0), maize straw biochar (B1), eucalyptus biochar (B2), pinus biochar (B3)). Maize was used as a test crop, two plants being grown per planting pit. For each treatment, three replications were performed. Our results showed an improvement in soil parameters in treated plots compared to the control plots, at both sites: an overall increase was observed in soil pH, soil organic carbon (SOC), total N, available P, exchangeable K and Ca, cation exchange capacity (CEC) and soil porosity, while a decrease was observed in the exchangeable Na, Al^{3+} and H^{+}, and for soil bulk density (BD). The concentration of micronutrients has generally decreased in both soils, except for Cu in the Andosol. At both sites, the combined use of biochar and OF has resulted in better increase of maize growth and yields compared to isolate application of biochar or OF. The highest values of the above ground biomass (AGB) and maize yield were obtained from the plots treated with OF2 and B2 mixed (OF2B2), for both Andosol and Nitisol. Moreover, significant interaction effects between biochar and OF were observed at both sites, for the exchangeable K, stem girth at silking, AGB and grain yield, in addition to that noticed at each site for other parameters, highlighting a potential synergistic effect in the combined use of biochar and OF. Therefore, the use of biochar-OF combination, particularly OF2B2, could be a good strategy to be adopted by farmers to improve the fertility of Andosol and Nitisol and sustain maize production in the northern part of Rwanda.

Acknowledgments: This is a part of ongoing PhD research works funded by the Partnership for Applied Sciences, Engineering, and Technology (PASET) through its Regional Scholarship and Innovation Fund (RSIF). The authors are thankful for the support of the Africa Centre of Excellence for Climate Smart Agriculture and Biodiversity Conservation of Haramaya University, Ethiopia, and the LEAF (Linking Landscape, Environment, Agriculture and Food - UIDB/04129/2020) Research Centre of the Instituto Superior de Agronomia, Universidade de Lisboa, Portugal.

Sustainable Vineyard Mulching: Optimizing Winery By-product Co-Composting with Vine Shoots for Soil and Weed Management

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The destemming of grapes is increasingly adopted in the winemaking process, to avoid the solubilization of compounds with herbaceous or vegetable characters which could have a negative impact on wine aroma and flavor qualities. As a result, up to 12% of the grape volume received at the winery should, almost immediately, be eliminated. However, the correct handling of grape stems proved to constitute an important challenge from the technological point of view. During the last three decades, several scientific studies focused on this subject, proposing several solutions that go from the utilization of the stems as biomass for energy production, to their valorization through advanced industrial processes aiming to extract specialty raw materials for food, cosmetic and pharmaceutical industries. Recently, we were able to elucidate the biological mechanisms involved in the treatment of this material through efficient processes of mesophilic composting (with 20 % of volume reduction, but only a fraction of the traditional CO_2 emission). In this process, another residue known to be hard to eliminate, the waste activated sludge produced by the winery wastewater treatment plants, is co-composted with grape stems, in order to obtain a stable organic substrate in just 2 months, regardless of weather conditions, and with excellent agronomic characteristics such as a germination index of 161%. The present study demonstrates that the application of this mature, non-phytotoxic composted material, when combined with vine shoots as a mulch in the vineyard, most effectively prevented weed growth, increased soil moisture retention, provided slow nutrient release, reduced soil erosion, and attracted beneficial insects (*Pyrrhocoris apterus*) without an increase in pest diseases.

Acknowledgments: The authors would like also to thank Carlos Matos for the elemental analysis performed. The authors thank the Fundação para a Ciência e a Tecnologia (FCT) for financially supporting the research through the projects UIDB/00616/2020 CQ-VR and UIDP/00616/2020.

References:

[1] D. Mundy; R. Agnew, New Zealand Plant Protection, 55 (2020) 135.
[2] A. Pirra, Manual de Boas Práticas Ambientais na Adega. APHVIN-GHEVID, IVDP. ISBN 978-972-98969-5-8. Porto, 2018, 231 pg.
[3] J.G. Zaller; C. Cantelmo; G.D. Santos; S. Muther; E. Gruber; P. Pallua; K. Mandl; B. Friedrich; I. Hofstetter; B. Schmuckenschlager; F.Faber, Environmental Science and Pollution Research, 25 (2018) 23215.
[4] C. Cebrián; R. Sánchez-Gómez; M.R. Salinas; G.L. Alonso; A. Zalacain, Industrial Crops & Products, 109 (2017) 730.
[5] M. Egan, Environmental Science and Pollution Research, 20 (2013) 4299.

Co-composting conditions and its impact on the quality of substrates from grape stalks and winery waste activated sludge: Lab and pilot-scale studies

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The activated sludge process (ASP), a cornerstone of modern wastewater treatment plants (WWTPs) relies on microbial consortia to degrade contaminants in effluents. However, this biological degradation generates excess microbial biomass, known as waste activated sludge (WAS), which must be managed to maintain process efficiency. Composting has emerged as a cost-effective and sustainable solution, converting organic waste into a stable, humus-like product. Despite its benefits—such as up to 80% volume and 50% mass reduction—composting performance is highly sensitive to factors such as aeration, temperature, and carbon-to-nitrogen (C:N) ratio. WAS, with its inherently low C:N ratio (5.2:1 to 8.2:1), often requires carbon-rich amendments to prevent overheating and ammonia emissions. This creates logistical and operational synergies, particularly with as wineries, which produce similar quantities of winery waste activated sludge (WWAS) and grape stalks (GS). The co-composting of GS and WWAS presents a promising strategy for waste valorization in agro-industrial systems.

Optimizing their co-composting is therefore essential to better align winery waste management with sustainability and circular economy principles. In this study, different amounts of a mixture of winery waste activated sludge and grape stalks were co-composted for 8 weeks, at lab-scale under different temperatures and aeration rates, and at pilot-scale. None of the experiments showed the occurrence of a thermophilic stage, even when the composting temperature was kept at 34 ºC, which might suggest biological suppression by the acclimated mesophilic microorganisms ubiquitous to the winery waste activated sludge. The composted substrates were fully characterized by physicochemical analysis, plant growth tests and germination indexes using parsley (*Petroselinum crispum*) seedlings and seeds. Surprisingly, despite the higher volume reduction at lab-scale, it was the initial mixture and the mixture composted outdoors which presented the best horticultural qualities, with seedling survival rates of 88.9% and 87.0% and modified germination indexes of 54% and 161%, respectively. These findings shed some light on previous contradictory results and allow the development of new recycling strategies.

Acknowledgments: The authors would like also to thank Carlos Matos for the elemental analysis performed. The authors thank the Fundação para a Ciência e a Tecnologia (FCT) for financially supporting the research through the projects UIDB/00616/2020 - Centro de Química de Vila Real and UIDP/00616/2020.

References:

[1] M.A. Bustamante; R. Moral; C. Paredes; A. Pérez-Espinosa; J. Moreno-Caselles; M.D. Pérez-Murcia, Waste Management, 28 (2008) 372.
[2] F.C. Marhuenda-Egea; E. Martínez-Sabater; J. Jordá; A. Sánchez-Sánchez; R. Moral; M.A. Ruggieri; C. Paredes; M.D. Pérez-Murcia, Thermochimica Acta, 454(2) (2007) 135.

Molecular Dynamics Simulations as a Tool for Advancing Environmental Remediation and Impact Mitigation Strategies

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In the context of increasing environmental challenges, computational approaches are playing a key role in the development of innovative and sustainable solutions. Molecular dynamics (MD) simulations, in particular, are a powerful tool to investigate and predict the behavior of complex systems at the atomic and molecular levels, providing valuable insights that complement experimental efforts. This work highlights the application of MD simulations to systems relevant to environmental remediation and the mitigation of environmental impacts. We present case studies in which MD simulations have been employed to elucidate pollutant–material interactions, support the rational design of adsorbent materials, and investigate interaction mechanisms in both aqueous and non-aqueous environments, with the aim of reducing environmental impact. These examples underscore the potential of atomistic modeling to reveal mechanistic details that are often inaccessible experimentally, thereby enabling the rational design of more effective materials and processes. The results illustrate how computational chemistry can contribute meaningfully to the development of sustainable technologies aimed at water decontamination, pollutant sequestration, and the reduction of harmful environmental footprints. Overall, this work reinforces the growing importance of MD simulations as a complementary and indispensable tool in the field of environmental chemistry and sustainability science.

Acknowledgments: The authors acknowledge Fundação para a Ciência e a Tecnologia (FCT), the Portuguese Agency for Scientific Research for the financial support through the programs UIDB/00313/2025 and UIDP/00313/2025.

Adsorption and Advanced Oxidation Processes: viable paths to remove Disinfection Byproducts?

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The formation of disinfection byproducts (DBPs) is a known consequence of the free chlorine-based disinfection performed in the drinking water treatment process. Even though this stage has the goal of preventing the formation of waterborne microorganisms by the addition of the disinfectant, its presence may lead to an unwanted formation of the DBPs, in the presence of natural organic matter (NOM) [1]. These DBPs may lead to several health concerns when ingested [2]. To decrease the presence of DBPs in drinking water, these substances may be removed from water after being formed, however, the most effective alternative is to remove their precursors prior to the disinfection stage [3,4].

In this work, brominated and chlorinated phenylalanine (4-bromo-L-phenylalanine and 4-chloro-L-phenylalanine) were established to represent NOM, as amino acids are known to lead to the formation of the most common DBPs found in water, such as trihalomethanes, haloacetic acids and haloacetonitriles [5,6]. Materials such as gravel and sand were used to remove these contaminants as they are typically used in water treatment plants, however, for a pollutant concentration of 10 mg/L, a load of 2 g/L and a contact time of 2 h, these materials only showed removals around 10%. Therefore, this work focuses on the search for alternative adsorbents that can remove these water-present amino acids. Additionally, the removal efficiency obtained by the adsorbents will be compared to the removal achieved by several advanced oxidation processes using layered double hydroxides as catalysts.

Acknowledgments: Funded by the European Union, under the Grant Agreement GA101081963 attributed to the project H2OforAll - Innovative Integrated Tools and Technologies to Protect and Treat Drinking Water from Disinfection Byproducts (DBPs). This research was co-funded by the European Regional Development Fund (ERDF). This work was also supported by national funds from FCT - Fundação para a Ciência e a Tecnologia, I.P., within the projects 10.54499/UIDB/00102/2020 and 10.54499/UIDP/00102/2020. M. I. Roque acknowledges FCT for the Ph.D. Grant 2024.03908.BDANA, funded by national funds.

References:

[1] S.R. Poleneni, in Disinfection by-products in drinking water: detection and treatment methods, M.N.V. Prasad (Ed.), Butterworth-Heinemann, 2020.
[2] S. Hariganesh; S. Vadivel; D. Maruthamani; S. Rangabhashiyam, in Disinfection by-products in drinking water: detection and treatment methods, M.N.V. Prasad (Ed.), Butterworth-Heinemann, 2020.
[3] N.F. Islam; H. Sarma; M.N. Prasad, in Disinfection by-products in drinking water: detection and treatment methods, M.N.V. Prasad (Ed.), Butterworth-Heinemann, 2020.
[4] R. Rienzie; L.R. Sendanayake; N.M. Adassooriya, in Disinfection by-products in drinking water: detection and treatment methods, M.N.V. Prasad (Ed.), Butterworth-Heinemann, 2020.
[5] WHO, Guidelines for drinking-water quality, WHO, 2017.
[6] R. Zhou; Z. Xu; J. Zhu; W. Liu; Y. Meng; P. Zhu; W. Zhou; C. Huang; X. Ding, Journal of Chromatography B-Analytical Technologies in the Biomedical and Life Sciences, (2020) 1150.

Assessing the capacity of *Caulerpa prolifera*for copper adsorption and neutralization

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In recent years, the proliferation of invasive algae, like *Caulerpa prolifera,* observed mainly in the Ria Formosa, has had serious consequences for the local ecosystem, causing a decrease in biodiversity [1], due to its fast reproduction through fragmentation and stolon elongation [2]. The study of this algae for adsorption of metals and neutralization of acid solutions can be a new favorable contribution aiming the management of invasive seaweed and its possible application in controlled bioremediation strategies. In this context, laboratory experiments were carried out using dried seaweed, grinded into different particle sizes. The biomass samples were exposed to a 100 mg/L copper (Cu) solution, a heavy metal commonly found in hazardous effluents such as acid mine drainage, to determine the optimal removal conditions, including pH, solid-to-liquid ratio and contact time. These conditions were obtained using algal particle sizes from 0.020 to 0.125 mm, at an initial pH of 3, a solid-to-liquid ratio of 20-30 g/L, an agitation of 150 rpm, and room temperature. Under these conditions, after a contact time of 120 min, Cu removal was approximately 90% (Figure 1). Also, the Cu solution, initially adjusted to pH 3, experienced a rapid increase in pH to neutral values (~ 7) upon contact with the biomass. This suggests effective buffering capacity and complete neutralization by the algal biomass.

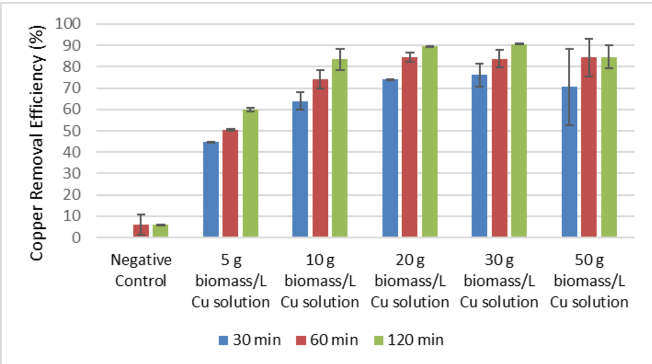

Figure 1. Percentage of copper removal (initial concentration of 100 mg/L and pH of 3.02) when added algae powder with a grain size in between 0.020 and 0.125 mm, for 120 min, at 150 rpm and at room temperature.

Acknowledgments: Foundation for Science and Technology through projects UIDB/04326/2020 (DOI:10.54499/UIDB/04326/2020) and LA/P/0101/2020 (DOI:10.54499/LA/P/0101/2020).

References:
[1] F. Parreira; B. Martínez-Crego; C. Afonso; M. Machado; F. Oliveira; J. Gonçalves; R. Santos, Estuarine, Coastal and Shelf Science, 255 (2021) 107344.
[2] C. Smith; L. Walters, Marine Ecology, 20 (1999) 307.

Valorization of winery effluents in the Douro region: advanced treatment via ceramic membranes and photo-Fenton processes for water reuse

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Addressing climate change and water scarcity in wine regions like Portugal's Douro demands circular, zero-waste strategies for treating and reusing winery wastewater (WWW) at its source. This study evaluated WWW treatment using tubular ceramic membranes in crossflow filtration (micro-, ultra- and nanofiltration – MF, UF, NF) and photo-Fenton oxidation. Samples were collected at the outlet of the primary decanter (WWW_{dec}) and after the aerobic reactor (WWW_{bio}). Compared to WWW_{dec}, WWW_{bio} presented ca. 96% less organic load (measured as chemical and biochemical oxygen demand – COD and BOD_5, respectively), 75% decrease in suspended solids, 91% in total nitrogen (TN) and 61% in total phosphorus (TP), with a pH of 8 (vs. 4 on the WWW_{dec}).
Operating a UF membrane with a 10 nm pore size (WWW_{bio}, t = 1 h, TMP = 6 bar, 20°C, CFV = 4 m s^{-1}) achieved 91% BOD_5 removal at a permeate flux of 138 $L{\cdot}m^{-2}{\cdot}h^{-1}$. Under these conditions, the permeate met Portuguese Decree Law 119/2019 quality B irrigation standards [1], although the performance declined with increasing initial organic loads. When treating WWW_{dec}, the same membrane – weather standalone or as part of $UF_{10nm} \rightarrow NF_{0.9nm} \rightarrow NF_{400\,Da}$ cascade – failed to produce reuse-compliant water due to elevated BOD_5 (> 450 mg $O_2{\cdot}L^{-1}$). Nevertheless, at optimal conditions, the cascade reduced COD by 65%, BOD_5 by 86%, yielded a colorless permeate, and met most physicochemical limits in Table 1 of DL 119/2019, except for TN and BOD_5.
Following these results, we propose implementing a continuous UV-A LED photo-Fenton process as an alternative or complementary strategy for WWW management. To optimize this process, a Box-Behnken design with the response surface methodology framework was employed, focusing on three operational parameters: residence time, hydrogen peroxide $[H_2O_2]/[COD]_{WWW}$ and $[Fe^{2+}]/[H_2O_2]$ ratios. Preliminary findings reveal COD removal efficiencies of ca. 40% when applied to the WWW_{bio} sample.

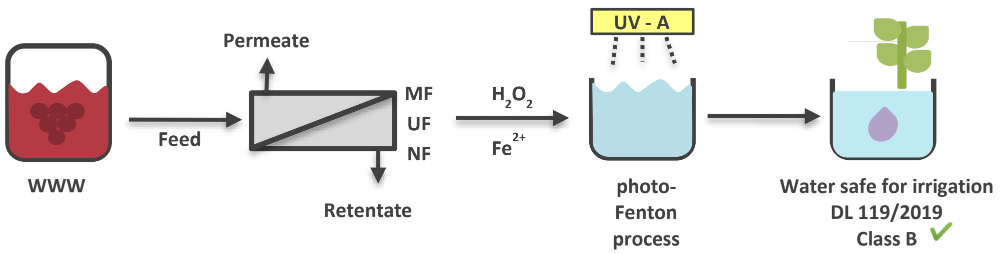

Figure 1. Proposed scheme for the treatment of winery effluents to meet irrigation standards.

Acknowledgments: This work was financially supported by project "Vine and Wine Portugal – Driving Sustainable Growth Through Smart Innovation" (C644866286-00000011), co-financed by the Recovery and Resilience Plan and NextGeneration EU Funds.

References: [1] Portugal. (2019). Decreto-Lei nº 119/2019, de 21 de agosto. Diário da República: 1ª série, nº 160. Retrieved from https://diariodarepublica.pt/dr/detalhe/decreto-lei/119-2019-124097549.

MOF-on-MOF structures for enhanced degradation of emerging contaminants from water

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In recent years, advanced oxidation processes (AOPs), as a group of chemical treatment methods, have emerged as promising methods for wastewater treatment, particularly for removing persistent organic pollutants via conventional treatment methods [1]. AOPs such as Fenton, ozonation, UV irradiation and photocatalysis work by generating highly reactive and powerful oxidizing species, such as hydroxyl radicals, which are capable of breaking down even the most persistent and complex pollutants in wastewater. AOPs have several advantages over conventional wastewater treatment methods, including their ability to treat a wide range of contaminants, their effectiveness at low concentrations, and their ability to operate over a wide range of pH values and temperatures. Metal organic frameworks (MOFs) have emerged as promising materials for water purification due to their tunable porosity, high surface area, and diverse chemical functionality [2].
Among AOPs, photocatalysis under mild conditions and ambient temperature has emerged globally as a sustainable solution for wastewater treatment due to rapid advances in the development of novel nano-photocatalysts. It has been suggested as a potential method for wastewater treatment since it is effective, non-selective, as well as efficient, and the photocatalyst may be reused multiple times [3].
Functional, porous metal-organic frameworks (MOFs) have attracted much attention as a very flexible class of crystalline, porous photocatalysts. At the same time, the favorable elastic properties of MOFs allow for heteroepitaxial growth, even in the case of lattice misfits as large as 20%. Recently, MOF-on-MOF heterostructures composed of distinct MOFs integrated at the nanoscale have gained attention for enhancing performance beyond individual components [4]. This study explores the structural design, and functional application of MOF-on-MOF systems specifically tailored for the removal and degradation of organic pollutants and emerging contaminants such as per- and polyfluoroalkyl substances (PFAS) from aqueous environments under visible-light. By strategically combining MOFs with complementary properties, we demonstrate improved stability in water, selective adsorption capabilities, and synergistic (photo)catalytic activity under mild conditions.

Acknowledgments:
Funded by the European Union (Marie Skłodowska-Curie grant agreement no 101154622 (HYCEM)).

References:
[1] P.K. Pandis; C. Kalogirou; E. Kanellou; C. Vaitsis; M.G. Savvidou; G. Sourkouni; A.A. Zorpas; C. Argirusis, ChemEngineering, 6 (2022) 8.
[2] M.W. Kim; H.K. Kim; H. Lee, K. Kim; Y.C. Hong, Journal of Water Process Engineering, 67 (2024) 106149.
[3] H.X. Li; Y. Wu; Q.Q. He; Q. Gao, Desalination and Water Treatment, 312 (2023) 207.
[4] R. Haldar; C. Wöll, Nano Research, 14(2) (2021) 355.

Circular Solutions: Zeolites from Waste for Ammonia Mitigation in Real Effluents

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The growing global concern for environmental protection and the sustainable management of natural resources is driving the development of efficient, cost-effective, and environmentally sustainable technologies for the treatment of contaminated wastewater. The presence of ammonia in industrial and urban effluents is a significant environmental issue, as it contributes to eutrophication and is toxic to aquatic organisms [1]. In this context, adsorption has emerged as a highly regarded separation technique in environmental chemistry, owing to its low initial cost, simple design, ease of operation, resistance to toxic substances, and its effectiveness in removing contaminants even at low concentrations [2].

This study evaluates the ammonia adsorption capacity of a NaP-type zeolite synthesised via a one-step hydrothermal process using industrial waste rich in aluminium and silica, specifically hazardous salt slag generated during secondary aluminium smelting and a sludge from the glass polishing industry. The use of these waste materials as precursors for zeolite synthesis not only enables the production of an effective adsorbent for ammonia removal, but also represents an environmentally sustainable strategy by valorising difficult-to-manage residues and promoting circular economy practices.

Batch experiments were conducted to investigate the adsorption of ammonium ions (NH_4^+) from a real effluent, specifically a leachate from a non-hazardous waste landfill previously treated by stripping and ultrafiltration. Key parameters such as contact time, adsorbent dosage, and the influence of co-existing anionic species in the solution were analysed. The results showed that ammonia removal was rapid, with significant adsorption occurring within the first 15 minutes. Equilibrium was reached in approximately one hour. Process efficiency was affected by the pH of the solution, as it influences the behaviour of exchangeable ions, necessitating repeated treatment steps to achieve removal rates exceeding 90%. Nevertheless, the synthesised zeolitic material proved effective for ammonia adsorption under real-world conditions.

The NaP zeolite synthesised from industrial waste demonstrated fast kinetics and high efficiency in removing ammonia from wastewater, positioning itself as a competitive alternative to conventional natural and commercial zeolites. Its application not only reduces the environmental impact of contaminated effluents but also contributes to minimising industrial waste volumes, fostering sustainable processes aligned with circular economy principles.

This study highlights the potential of zeolites synthesised from waste as effective adsorbent materials for the purification of ammonia-laden aqueous effluents. This integrated approach supports the sustainable management of industrial resources and residues, offering innovative solutions to current environmental challenges.

Acknowledgements:
The present study is conducted within the framework of the *Aluminium Foundries Circularity via Holistic Zeolite Production for Effluents Depuration (LIFE22-ENV-ES-Z-ONA4LIFE/101114027).*

References:

[1] R. Sánchez-Hernández; I. Padilla; S. López-Andrés; A. López-Delgado, International Journal of Chemical Engineering, (2018) 1256197.
[2] M.Á. Lobo-Recio; C. Rodrigues; T.C. Jeremias; F.R. Lapolli; I. Padilla; A. López-Delgado, Chemosphere 267 (2021) 128919.

Innovative Functional Bread: Integrating Acorn Flour and Regionally Sourced Essential Oils for Enhanced Nutrition and Shelf Life

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Bread remains a staple food worldwide, and recent consumer trends have driven the development of functional products enriched with bioactive ingredients. This study explores the creation of innovative gluten-free bread by incorporating a corn flour and essential oils encapsulated within polymer mixtures comprising bacterial cellulose fibres. The encapsulation process aims to enhance the stability, solubility, and controlled release of essential oils, addressing challenges such as volatility and degradation during baking. Essential oils from *Thymus* mastichina and other medicinal plants, sourced from distinct regions, were characterized for their bioactive profiles using gas chromatography-mass spectrometry (GC-MS). Bacterial cellulose obtained from vinegar production and locust bean gum were employed as a natural carriers to encapsulate these oils, leveraging its biocompatibility and ability to form protective matrices. With the aim of introducing the encapsulated essential oils into bread formulations, several flours were tested on the stability of the emulsion systems. Marked differences were observed depending on the type of flour, from which acorn flour showed higher affinity towards the oil. This approach allowed to increase oil stability in an aqueous system, with the potential for the gradual release of key antimicrobial and antioxidant compounds, contributing to extended bread shelf life and enhanced functional properties. This approach not only augments the health benefits of gluten-free bread but also supports the valorisation and sustainability of the Montado ecosystem by utilizing underexploited resources such as acorns and medicinal plants.

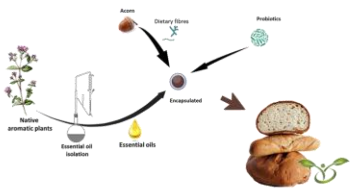

Figure 1. Schematic picture of the work.

Acknowledgments: The authors want to acknowledge Fundação la Caixa and FCT for the financial support through the project "Plantas aromáticas do Alentejo, probióticos e farinha de bolota no desenvolvimento de pão funcional" (PD23-0025). FCT is also acknowledged for its financial support through the Strategic Research Centre Project UIDB/00102/2020 and UIDB/05183/2020.

From E-Waste to Resource: Evaluating European Approaches for a Cleaner Electronics Lifecycle

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The rapidly growing volume of waste from electrical and electronic equipment (e-waste) poses a significant global threat to environmental and human health[1]. In 2022, approximately 62 million tons of e-waste were generated, of which only 23% was properly documented as collected and recycled[2][3]. The remainder is often landfilled or incinerated, releasing hazardous substances such as heavy metals, flame retardants, and persistent organic pollutants, thereby contaminating soil, water and air[4]. In response to the urgent need for sustainable e-waste management strategies, this study conducted a scientometric review to systematically assess and compare e-waste research motivation and trends, generation, treatment methods, and regulatory practices in high-performing Northern European countries (Norway, Sweden, Finland)[5] versus Southern Europe, with Portugal as a focal case study. This analysis categorizes the literature by recycling efficiency, policy implementation, infrastructure maturity, and public awareness. The study emphasizes significant disparities in pollution control measures and environmental remediation outcomes between Scandinavian countries and Portugal, underscoring the environmental consequences of inadequate e-waste management. The review also reveals critical gaps in harmonized legislation, digital monitoring systems, public awareness, and recovery technologies. The findings offer actionable insights for policymakers aiming to reduce pollution and accelerate Europe's transition toward a cleaner and more sustainable electronics lifecycle.

Keywords: E-waste management, scientometric analysis, sustainable recycling, recovery, Legislation framework

Acknowledgments: Acknowledgments: This work was supported by National Funds from FCT – Fundação para a Ciência e Tecnologia through CQ-VR project UIDB/00616/2025 and UIDP/00616/2025.

[1] D.N. Perkins; M.-N.B. Drisse; T. Nxele; P.D. Sly, Annals Global Health, 80 (2014) 286.
[2] United Nations Institute for Training and Research, "The National E-waste Monitor 2025 – Norway." Accessed: Mar. 05, 2025. [Online]. Available: https://ewastemonitor.info/the-national-e-waste-monitor-norway-2025/
[3] "Waste statistics - electrical and electronic equipment - Statistics Explained - Eurostat." Accessed: May 13, 2025. [Online]. Available: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_statistics_-_electrical_and_electronic_equipment
[4] R. Akram *et al*., Global Trends of E-waste Pollution and Its Impact on Environment, (2019) 55.
[5] J. Ylä-Mella; K. Poikela; U. Lehtinen; P. Tanskanen; E. Román; R.L. Keiski; E. PongráczJ, Journal of Waste Manager, 2014 (2014) 457372.

From CO_2 to Methane: A Thermodynamic Study of the Sabatier Reaction for Clean Energy Applications

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The world's heavy reliance on the combustion of fossil fuels to meet energy demands has led to a sharp increase in atmospheric carbon dioxide (CO_2) levels. Fossil fuel consumption is projected to reach 56% by 2040 [1]. As CO_2 is a major contributor to the greenhouse effect, concerns about reducing its emissions have grown significantly. One of the most explored solutions in recent years is carbon capture and storage (CCS), which involves trapping CO_2 emissions from industrial sources, transporting them, and storing them in underground geological formations [2]. However, due to high costs and potential long-term environmental risks, global attention is shifting toward a more promising alternative: carbon capture and utilization (CCU) [1]. Within this context, CO_2 methanation has emerged as an increasingly attractive approach. Using the Sabatier reaction ($CO_2 + 4H_2 \leftrightarrow CH_4 + 2H_2O$), synthetic natural gas (SNG), primarily methane (CH_4), can be produced from CO_2 and hydrogen (H_2). When hydrogen is sourced renewably via electrolysis, this pathway offers a compelling route to combat global warming [3]. SNG stands out for its high energy content and lower CO_2 emissions compared to traditional fossil fuels [4]. Moreover, it benefits from compatibility with the existing extensive natural gas infrastructure, enabling seamless integration into current energy systems [3]. In this work, a steady-state thermodynamic equilibrium analysis of the CO_2 methanation reaction will be carried out. The methodology is based on solving mass balance equations using the equilibrium constants of the reactions involved. The study will focus on the influence of temperature, pressure, and the H_2/CO_2 molar ratio on reaction yield, the formation of by-products such as carbon oxides, and the overall energy balance. The objective is to identify the operating conditions that maximize methane production and minimize the formation of undesired compounds, thereby contributing to the optimization of the methanation process.

References:
[1] W.K. Fan; M. Tahir, Energy Conversion and Management, 254 (2022) 115240.
[2] A. Galadima; O. Muraza, Renewable and Sustainable Energy Reviews, 115 (2019) 109333.
[3] A. Solis-Garcia; T.A. Zepeda; J.C. Fierro-Gonzalez, Catalysis Today, 394-396 (2022) 2.
[4] A.I. Tsiotsias; N.D. Charisiou; I.V. Yentekakis; M.A. Goula, Catalysts, 10(7) (2020) 812.

PFAS Remediation in Water by Natural Deep Eutectic Solvents and $scCO_2$

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Polyfluoroalkyl substances (PFAS) has been quantified in water sources, including drinking water, surface water, wastewater, and groundwater, with concentrations ranging from nanograms per liter (ng/L) to micrograms per liter (µg/L) [1-2].

In this presentation, we discuss two approaches for PFAS remediation in water; one based on hydrophobic natural deep eutectic solvents (NADES) and the other employing supercritical carbon dioxide ($scCO_2$). NADES Menthol:Acetic acid was used in a liquid-liquid extraction, removing more than 90% of the PFAS in water at a ppm level. The extraction efficiency was not influenced by the initial PFAS concentration or the pH (3.8 to 8.0) of the aqueous solution under the tested conditions. In our second approach, the use of $scCO_2$ (323 K, 250 bars) for PFAS extraction at ppb level showed the removal of more than 98.5% in semi-continuous operation (24 L/hr), with more than 90% being removed in the first 20 min. This $scCO_2$ method is likely to be applicable for PFAS removal from porous solid like soil or sludge.

Acknowledgments: The team thanks the King Abdullah University of Science and Technology (KAUST) for all the support in our research.

References:

[1] X.C. Hu; D.Q. Andrews; A.B. Lindstrom; T.A. Bruton; L.A. Schaider; P. Grandjean; R. Lohmann; C.C. Carignan; A. Blum; S.A. Balan; C.P. Higgins; E.M. Sunderland, Environmental Science & Technology Letters, 3 (2016) 344.

[2] B.G. Moneta; M.L. Feo; M. Torre; P. Tratzi; S.E. Aita; C.M. Montone; E. Taglioni; S. Mosca; C. Balducci; M. Cerasa; E. Guerriero; F. Petracchini; C. Cavaliere; A. Lagana; V. Paolini, Science of the Total Environment, 894 (2023) 165089.

Simulation of new renewable gases Mixtures for Injection into Natural Gas Networks

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The growing integration of alternative gases, such as biomethane and hydrogen, into conventional natural-gas networks demands a thorough analysis of the physicochemical properties of the resulting mixtures. This study introduces a computational tool designed to calculate key thermodynamic and combustion-related properties, namely relative density, higher heating value, and the Wobbe index, as functions of gas composition and operating conditions. The tool enables simulation of diverse mixing ratios, flow configurations, and scenarios, including variations in temperature and pressure. These capabilities allow a comprehensive evaluation of technical feasibility, energy efficiency, and compliance with regulatory thresholds under realistic field conditions [1–3]. The application's core is based on the van der Waals equation of state, which models real-gas behavior rather than relying on idealized assumptions. This thermodynamic model provides enhanced accuracy in predicting gas-mixture behavior, especially under varying pressures and temperatures [4]. In addition, the tool incorporates interactive 3D surface plots that visually represent how key properties vary across multidimensional parameter spaces. This graphical component helps users intuitively grasp how changes in gas composition and process parameters affect overall performance and the suitability of mixtures for injection into existing infrastructure. By supporting the design of injection points and distribution networks, the tool enables evaluation of gas mixtures under real operating conditions and ensures compliance with regulatory gas-quality standards. The numerical model can predict the thermodynamic properties of mixtures at 20 atm with an error of less than 0.5%.

References:

[1] Portgás, *Manual de Especificações Técnicas - Projeto e Construção de Redes e Ramais de Distribuição de Gás Natural*, Portgás, Portugal, 2018.

[2] European Committee for Standardization (CEN), *EN 16723-1:2016 - Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network - Part 1: Specifications for biomethane for injection in the natural gas network*, Brussels, 2016.

[3] European Committee for Standardization (CEN), *EN 16726:2015 - Gas infrastructure - Quality of gas - Group H*, Brussels, 2015.

[4] R.H. Perry, D.W. Green (Eds.), *Perry's Chemical Engineers' Handbook*, 7th ed., McGraw-Hill, New York, 1997.

Numerical Analysis of PEMFCs as a Clean Energy Solution for Mobility

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The transport sector accounts for approximately one quarter of greenhouse gas emissions in the European Union (EU) and remains the only sector where emissions continue to rise [1]. In response, the European Green Deal sets ambitious targets to reduce emissions by 55% by 2030 and to achieve climate neutrality by 2050 [2]. One of the proposed measures includes phasing out new internal combustion engine vehicles by 2035, alongside increased investment in electric and hydrogen refuelling infrastructure [3]. Within this framework, fuel cells - particularly proton exchange membrane fuel cells (PEMFCs) - have gained attention as a promising technology for zero-emission mobility, already being deployed across multiple sectors [4]. PEMFCs are characterised by high energy efficiency, low operating temperatures, rapid start-up, silent operation, and low environmental impact [5]. Moreover, they offer longer lifespans and lower costs compared to other fuel cell technologies [6]. This study investigates the potential of PEMFCs in the transport sector through a numerical modelling approach, evaluating their performance and consistency with EU climate objectives. Preliminary results show that the model outputs align well with experimental data, with errors ranging from 4% to 15% across current densities up to 0.55 A/cm^2. The aim is to assess the viability of PEMFCs as a clean alternative to internal combustion engines and to identify the main technical and policy challenges to their broader adoption.

References:

[1] European Parliament, 'CO_2 emissions from cars: facts and figures (infographics)'. Accessed: May 13, 2025.

[2] European Parliament, 'Green Deal: key to climate-neutral and sustainable EU'. Accessed: May 13, 2025.

[3] European Parliament, 'Reducing car emissions: new CO2 targets for cars and vans explained'. Accessed: May 13, 2025.

[4] Fuel Cell & Hydrogen Energy Association, 'Fuel Cell Basics'. Accessed: Apr. 30, 2024.

[5] N. Chatrattanawet; T. Hakhen; S. Kheawhom; A. Arpornwichanop, Journal of Cleaner Production, 148 (2017) 934.

[6] S. A. Ansari; M. Khalid; K. Kamal; T.A.H. Ratlamwala; G. Hussain; M. Alkahtani, Sustainability, 13 (2021) 1218.

Pyrolysis of Sewage Sludge: Unlocking the Hidden Potential for Valorization and Carbon Sequestration

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The growing volumes of sewage sludge generated by wastewater treatment plants (WWTPs) pose a substantial economic and environmental challenge, particularly in light of the considerable expenses associated with landfill disposal and transportation [1]. Local pyrolysis serves as a viable option, facilitating mass reduction and producing biochar with potential benefits for soil enhancement and carbon sequestration [2–4]. The use of biochar derived from sewage sludge has gained attention as a viable strategy to enhance soil fertility and promote long-term carbon sequestration [4,5]. Biochar can improve soil structure, water retention, and nutrient availability, while stabilizing carbon and reducing greenhouse gas emissions [5]. This ongoing study utilizes previously gathered physicochemical data from sewage sludge samples of three Portuguese wastewater treatment plants, including moisture content, ash content, volatile matter, elemental composition, and heating value. Experimental data from drying tests will be utilized to evaluate the energy demands of pre-treatment phases. A theoretical study, based on existing research on sewage sludge pyrolysis, is being created to evaluate possible mass reduction, biochar output, and carbon sequestration capacity [3,4]. In parallel, a simplified life cycle approach will evaluate the environmental benefits of local pyrolysis compared to the conventional practice of sludge transportation and landfill disposal. Preliminary results suggest that local pyrolysis could lead to a substantial decrease in sludge volume, significantly lowering transportation and disposal needs while offering a potential pathway for carbon sequestration [5]. The study is presented as an exploratory framework to support future experimental validation and decision-making on sustainable sewage sludge management.

References:

[1] A. Gianico; C. Braguglia; A. Gallipoli; D. Montecchio; G. Mininni, Water, 13 (2021) 103.
[2] F. Schlederer; E. Martín-Hernández; C. Vaneeckhaute, Journal of Environmental Management, 352 (2024) 119964.
[3] M.K. Hossain; V. Strezov; K.Y. Chan; A. Ziolkowski; P.F. Nelson, Journal of Environmental Management, 92 (2011) 223–228.
[4] L. Zhao; Z.-F. Sun; X.-W. Pan; J.-Y. Tan; S.-S. Yang; J.-T. Wu; C. Chen; Y. Yuan; N.-Q. Ren, Water Research X 18 (2023) 100167.
[5] J. Lehmann; J. Gaunt; M. Rondon, Mitigation and Adaptation Strategies for Global Change 11 (2006) 403.

Mechanical and Thermal Performance of Waste Polypropylene Reinforced with Glass Fiber: A Systematic Review in the Context of Sustainability

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Recycled polypropylene reinforced with glass fiber (rPP-GF) presents a promising option as a sustainable material, particularly aligned with the growing global demand for environmentally friends alternatives [1]. In this systematic literature review, the mechanical, thermal and sustainability performance of rPP-GF composites was examined, with a focus on applications aligned with the circular economy and resource-efficient manufacturing.

The research developed in this field reveals that glass fiber reinforcement significantly enhances mechanical properties [2]. Tensile strength and stiffness increase by 30-70%, and impact resistance improves by 2-5 times, depending on fiber content, matrix composition, and processing methods [3]. These robust composites also exhibit notable thermal improvements, including a higher degradation onset temperature, higher heat deflection temperature capacity and enhanced crystallinity [4], making these composites suitable for applications in automotive components, construction panels, packaging systems, and durable consumer products.

Compared to their virgin counterparts, rPP-GF composites considerably reduce the overall environmental impact in carbon footprint and energy consumption by approximately 60%. Moreover, their recyclability, industrial compatibility, and potential for multiple life cycles are aligned with circular economy strategies. However, technical challenges remain, including fiber attrition during reprocessing, inefficient end-of-life separation, and lack of standardized testing protocols. Future research should prioritize the development of unified testing frameworks, hybrid filler systems (e.g., graphene nanoplatelets, basalt, hemp), advanced recycling and fiber recovery technologies, and the integration of bio-based polymer matrices. Overall, rPP-GF composites represent a high potential, scalable solution for achieving both functional performance and environmental sustainability across different application sectors.

Acknowledgments: This work was developed under the Project and funded by National Funds from FCT - Fundação para a Ciência e Tecnologia through project UIDB/00616/2025 and UIDP/00616/2025 for the Unit Institute CQVR.

References:

[1] L. Lyu; M. Bagchi; N. Markoglou; C. An; H. Peng; H. Bi; X. Yang; H. Sun, Journal of Hazardous Materials, 461 (2024) 132566.

[2] Y. Adamu; T.K. Bello; U. Shehu; A. Bello; S. Adamu; M.T. Isa, Polymer Research, 31(73) (2024).

[3] P. Morampudi; K.K. Namala; Y.K. Gajjela; M. Barath; G. Prudhvi, Materials Today Proceedings, 43 (2021) 314.

[4] T. Stachowiak; D. Kwiatkowski; M. Chmielarz; D. Grzesiczak, Materials, 17(6), (2024) 1433.

Utilization of olive stone waste as a sustainable fine aggregate replacement in cementitious mortars

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The accelerated growth of the global population has significantly increased the demand of natural resources, leading to a substantial rise in waste generation. This intensifying consumption aggravates humanity's ecological footprint, highlighting the urgent need for sustainable strategies, eco-friendly solutions, and alternative materials to mitigate the environmental impact of human activities, particularly within the construction sector, which is the largest contributor to waste production in the European Union.

In response to these challenges, this study explores the valorization of crushed olive stones, one of the most abundant agricultural by-products in the Mediterranean region, as a sustainable material for use in cement-based mortars. Olive stone aggregates were used to fully or partially replace fine aggregates in percentages of 25%, 50%, 75%, and 100%.

The experimental procedure included an evaluation of the mechanical performance through compressive and flexural strength tests, as well as an assessment of the physical and chemical behavior of the mortars, including water absorption tests, surface wettability analysis via static contact angle measurements, and durability assessment against aggressive agents commonly encountered in construction environments, such as acidic water and solutions containing sulfates and chlorides.

Acknowledgments: This work was supported by National Funds from FCT - Fundação para a Ciência e Tecnologia through CQ-VR project UIDB/00616/2025 and UIDP/00616/2025.

References:

[1] A.I. Bessa; A. Jerónimo; V Briga-Sá, Simpósio Argamassas e Soluções Térmicas de Revestimento, Coimbra, Portugal, 2024.
[2] J. Ferreiro-Cabello; E. Fraile-Garcia; A. Pernia-Espinoza; F.J. Martinez-de-Pison, Buildings (2022).
[3] D.F.F.M. Gouveia, Dissertação de Mestrado Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Lisboa, Portugal, 2014.
[4] F.H. Heukamp, Massachusetts Institute of Technology, 2003.
[5] A. Jerónimo; M. Fernandes; A. Briga-Sá, 16(4) (2024) 1355.
[6] A. Jerónimo; M. Fernandes; A. Briga-Sá, Congresso Construção 2022, Guimarães, Portugal, 2022.
[7] A. Jerónimo; D. Gonçalves; I. Silva; M. Fernandes; A. Braga-Sá, Congresso Construção Sustentável, Guimarães, Portugal, 5-7 dezembro, 2023.
[8] R. Lewis; S. Lindon; W. Peter; R. Ray, Advanced concrete technology - Constituent materials, Oxford: Elsevier Ltd, 2003, 288.
[9] G. Moir, Cements. In J. Newman & B. S. Choo (Eds.), Elsevier Ltd., 2003.
[10] A.R. Vieira, Dissertação de Doutoramento, Universidade de Coimbra, Repositório da Universidade de Coimbra, Portugal, 2013.

Replication of the Physical-Chemical Properties of the Leaf Surface of *Myrtus communis* L.

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Innovative and sustainable solutions may be created using design principles from biology and applying them as inspiration for the development of nanomaterials and nanodevices. Plants, which represent the most abundant group of living organisms on our planet, are natural materials that exhibit high degrees of complexity and resistance, hierarchical structuring, and functionalities that allow them to adapt to the challenges of nature. One of the most important properties of plants is the leaves' hydrophobicity. The wettability exhibited by many plant leaves is correlated with the cuticle wax composition and morphology [1].

In the present work, we decided to study in depth the physical-chemical properties of the adaxial and abaxial surfaces of the leaf of *Myrtus communis* L. (Myrtle) collected at the Botanical Garden of UTAD. The composition of the epicuticular and intracuticular waxes was determined. The anatomy and morphology of both leaf surfaces were characterized. The static water contact angle values were calculated. The reflectance, transmission, and absorbance features were also examined. The ultimate goal of this work was to replicate the hydrophobic properties of *M. communis* leaf in a film.

Acknowledgments: This research was funded by Foundation for Science and Technology (FCT) and FEDER through POCI-COMPETE 2020 (UID/QUI/00616/2013 and UID/QUI/00616/2019 for CQ-VR, UIDB/04033/2020 for CITAB, and UID/QUI/50006/2020 for LAQV/Requimte) and from project PORPLANTSURF - Superhydrophobic films inspired in the surface of plant leaves and petals from Northern Portugal (POCI-01-0145-FEDER-029785). A.G., M.F., J.R., A.L.C. and V.D.Z.B acknowledge Erasmus+ Programme UTAD-Vila Real/ITMO-Saint Petersburg. A.P.R and S.A. acknowledge partial support from the Swedish Energy Agency (grant no. 49227-1). M. F. acknowledges FCT-UTAD for the contract in the scope of Decreto-Lei 57/2016 – Lei 57/2017.

References:

[1] W. Barthlott; M. Mail; B. Bhushan; K. Koch, Nano-Micro Letters, 9 (2017) 23.

Bioactive Coordination Compounds in Biopolymer Matrices: An Antimicrobial Coating Strategy

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Antimicrobial resistance (AMR) is a growing global health concern, which is in part associated with an uncontrolled spread of infectious bacteria and biofilm formation on different types of surfaces [1]. Polymer-based antimicrobial coatings have emerged as promising solutions to this issue. Hybrid biopolymers incorporating coordination polymers (CPs) show a significant potential in this field due to their combined structural and functional advantages [2,3].

Biobased polymers, particularly those derived from polysaccharides, offer biodegradability, biocompatibility, and the ability to encapsulate antimicrobial agents with controlled release [4]. Incorporating bioactive CPs into these matrices enhances their antimicrobial performance. CPs composed of biocidal metal ions and bioactive ligands can provide tunable porosity, host-guest interactions, and release of antimicrobial agents while maintaining a low level of cytotoxicity [5,6].

In this work, several bioactive Ag(I), Cu(II), and Zn(II) coordination polymers were synthesized, fully characterized, and evaluated for their antimicrobial activity when incorporated into polymeric films. The bioCPs were assembled from metal salts and different benzoic acid-based building blocks, and used as active antimicrobial dopants to produce hybrid biopolymer films.

The antibacterial properties of bioCPs and hybrid biopolymer films were evaluated against Gram-positive (*S. epidermidis* and *S. aureus*) and Gram-negative (*P. aeruginosa* and *E. Coli*) bacteria and their associated bacterial biofilms. The materials exhibited promising levels of antibacterial and antibiofilm activity, demonstrating their potential as sustainable and effective coatings for applications in healthcare, packaging, and public environments.

Acknowledgments: This work was financially supported by FCT Portugal (PolyBioPrint 2023.14308.PEX, UID/00100/2023, UIDB/00100/2020, UIDP/00100/2020, LA/P/0056/2020, CEECIND/02725/2018, CEECIND/00194/2020, and 2022.09436.BD) and IPL (IPL/IDI&CA2024/Gel2Heal_ISEL)

References:

[1] B. Song; E. Zhang; X. Han; H. Zhu; Y. Shi; Z. Cao, ACS Applied Materials & Interfaces 12 (2020) 21330; [2] L. Yan; A. Gopal; S. Kashif; P. Hazelton; M. Lan; W. Zhang; X. Chen, Chemical Engineering Journal 435 (2022) 134975; [3] T.A. Fernandes; F. Macedo; R.G. Cabral; T. Guiu; C.H.J. Franco; P. Jorge; A.C. Sousa; V. André; N. Cerca; A.M. Kirillov, RSC Applied Interfaces 1 (2024) 98–109; [4] I. Benalaya; G. Alves; J. Lopes; L.R. Silva, International Journal of Molecular Science 25 (2024) 1322; [5] N. Wenqian; J. Wu; R.A. Ghiladi; Y. Guan, Coordination Chemistry Reviews 442 (2021) 214007; [6] R. Li; T. Chen; X. Pan, ACS Nano 15 (2021) 3808-3848.

Green Synthesis of Silver Nanoparticle-Silk Fibroin Scaffolds for Biomedical Applications

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The growing need for sustainable, bio-friendly materials in biomedical applications has led to the emergence of eco-friendly methods for the design of functional nanocomposites. Among these, silver nanoparticles (AgNPs), valued for their antimicrobial properties, are used in wound care and tissue engineering [1]. However, current procedures involve toxic chemicals and high energy use, raising safety and economic concerns. A friendlier alternative is the use of natural, biocompatible materials and green synthesis methods. Silk fibroin (SF), a protein derived from *Bombyx mori* cocoons, presents an attractive solution, by reducing and stabilizing AgNPs while serving as a biodegradable and mechanically strong scaffold [2].

This study describes a green synthesis approach for developing AgNP-loaded SF-based scaffolds compatible with fibroblast cells for tissue regeneration. AgNPs were obtained in situ under visible light in aqueous SF solutions (Figure 1), and integrated on porous SF scaffolds via a salt-leaching method. The resulting scaffolds showed well-defined morphology, confirmed AgNP formation, good mechanical strength (1.5-2.5 MPa), and high-water uptake (~175 %). Fluorescence analysis revealed interactions between SF and AgNPs.

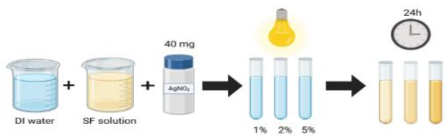

Figure 1. Schematic representation of the in-situ synthesis of SF-AgNPs.

Acknowledgments: This research was funded by National Funds by FCT and, whenever applicable, by FEDER funds through the POCI–COMPETE 2020–Operational Programme Competitiveness and Internationalization in Axis I–Strengthening Research, Technological Development and Innovation (UIDB/00616/2020, UIDP/QUI/00686/2020, PTDC/CTM-REF/4304/2020), CQ-VR (UIDB/0616/2020 and UIDP/0616/2020) and FibEnTech-UBI (UIDB/00195/2020), financed by national funds through the FCT/MCTES (PIDDAC). S.C.N. acknowledges the FCT for the Assistant Research contracts (2020-00805.CEEIND; DOI: 10.54499/2020.00805.CEECIND/CP1625/CT0001-R.F.P.P. acknowledges FCT for the Strategic Funding UID/00686: CQ-UM/UM and FCT-UMinho for the Assistant Research contract (https://doi.org/10.54499/2023.07994.CEECIND/CP2841/CT0013).

References:

[1] S. Ranjbar; A. Bakhtiari; N. Khosravi; S.J. Ashkavandi; *et al.*, Journal of Composites and Compounds, 6 (2024) 1.
[2] X. Fei; M. Jia; X. Du; Y. Yang; *et al.*, Biomacromolecules, 14 (2013) 4483.

Synthesis of Carbon Dots from *Cinnamomum camphora* leaves

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Carbon dots (CDs) have attracted significant attention due to their strong fluorescence stability, excellent resistance to photochemical degradation, and low toxicity [1]. CDs have been distinguished from traditional fluorescent materials as promising benign candidates for various potential applications including biomedical imaging, photocatalysts, sensors, and optoelectronic devices. CDs can be synthesized from a wide range of carbon sources, among which food or plants [2]. The latter offer several advantages: they are inexpensive, environmentally friendly, and readily available. Moreover, various parts of the plant—including fruits, stems, flowers, roots, seeds, and leaves—can be effectively used for CD synthesis [3].

In this work, we prepared CDs from both young and mature leaves of *Cinnamomum camphora*, by means of a carbonization process at different temperatures and different periods of time. *C. camphora*, commonly called camphor, is located in the Botanical Garden of UTAD. This plant is a member of the *Lauraceae* family, and its flowering season is between May and June. It has an extensive history and a big variety of applications in science and has been used, worldwide, to treat a variety of symptoms. The CDs were characterized by Ultraviolet-visible and fluorescence spectroscopy, Zeta (ζ) potential and Transmission Electron Microscopy. The morpho-anatomical and physical-chemical analysis of the same plant parts was performed in order to better understand the chemical composition of the CD surface.

Acknowledgments: This work was funded by CQ-VR (CQVR-UIDB/0616) and developed under the project A-MoVeR - "Mobilizing Agenda for the Development of Products & Systems towards an Intellingent and Green Mobility", operation n.º 02/C05-i01.01/2022.PC646908627-00000069, approved under the terms of the call n.º 02/C05-i01/2022 - Mobilizing Agendas for Business Innovation, financed by European funds provided to Portugal by the Recovery and Resilience Plan (RRP), in the scope of the European Recovery and Resilience Facility (RRF), framed in the Next Generation UE, for the period from 2021 -2026. R.F.P. Pereira acknowledges FCT for the Strategic Funding UID/00686: CQ-UM/UM and FCT-UMinho for the Assistant Research contract (https://doi.org/10.54499/2023.07994.CEECIND/CP2841/CT0013).

References:

[1] Y. Wang; A. Hu, Journal of Materials Chemistry C, 2(34) (2014) 6921.
[2] A.P.J. Nunes; R.F.P. Pereira; S.C. Nunes; S.F.H. Correia; L. Fu; R.A.S. Ferreira; M. Fernandes; V. de Z. Bermudez, Small, (2024).

Co-composting of Sewage Sludge with Biowaste from Mechanical Treatment: A Proposal for Sustainable Biowaste Valorization in Northern Portugal

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The increasing need for sustainable organic waste management has driven attention to innovative strategies such as co-composting. This study presents a pilot-scale project conducted in the Northeast of Portugal, aiming to assess the technical and environmental feasibility of co-composting sewage sludge (from WWTPs) with biowaste from Mechanical and Biological Treatment Units (MBT). The process tested two mixing ratios (1:2 and 1:3, sludge:biowaste), optimizing parameters such as C/N ratio, temperature, moisture, and aeration to produce high-quality compost (Class IIA, according to Portuguese legislation).

The compost exhibited low levels of heavy metals and pathogens, adequate nutrient balance, and high organic matter content, meeting legal and agronomic standards. Life Cycle Assessment (LCA) demonstrated a significant reduction in greenhouse gas (GHG) emissions compared to landfilling, with emission reductions of up to -1.75 kg CO_2eq per tonne of treated sludge. The annual potential production of Class IIA compost is estimated between 66,722 and 77,842 tonnes, sufficient to meet the demand for soil recovery in over 337,000 ha susceptible to desertification in Northern Portugal.

Table 1 - Compost quality and GWP impact by mixing ratio

Parameter	Ratio 1:2	Ratio 1:3
Organic Matter (%)	27.6	36.3
C/N Ratio	14.74	12.45
Compost Class	IIA	IIA
GHG Reduction (kg CO_2eq t^{-1})	-1.49	-1.75

The project validated the viability of integrating urban biowaste and wastewater sectors in a circular economy framework. It also highlighted key implementation challenges, such as infrastructure scaling, regulation alignment, and the competitiveness of organic amendments. The findings support co-composting as a robust tool for climate change mitigation, soil regeneration, and sustainable waste valorization in semi-arid regions.

Acknowledgments: This work was supported by national funds through FCT-Portuguese Foundation for Science and Technology, under the projects UID/04033: Centro de Investigação e de Tecnologias Agro-Ambienteis e Biológicas and LA/P/0126/2020, https://doi.org/10.54499/LA/P/0126/2020, and co-funded by FEDER through GREENValue [POCI-07-62G4-FEDER-181589].

Industrial Cellulose Pulp-based Hydrogels for Agriculture: A Simple and Scalable Process

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Climate change and population growth threaten global food security and water resources. Efficient solutions for sustainable water use in agriculture are essential. Hydrogels, which absorb and release water, show promise as soil conditioners [1]. This work developed biodegradable cellulose hydrogels by repurposing cellulose solvent salts as nitrogen fertilizers, offering an alternative to petroleum-based SAPs. Allylic cellulose derivatives were obtained through modification in the NaOH/urea solvent system. Solutions were neutralized with nitric acid (HNO_3), yielding sodium nitrate ($NaNO_3$) as nitrogen fertilizer, benefiting from urea, the most used nitrogen fertilizer [2]. The use of cellulose industrial pulp and cellulose modification scalability was evaluated. Hydrogels were prepared by UV-FRP, crosslinking cellulose derivatives in the presence of salts. EDS analysis confirmed nitrogen and sodium distribution through cellulose structure (Fig.1-A). Hydrogels showed 2500% swelling capacity, and pH and salt resistance. Fertilizer release tests showed delayed release compared to salts diffusion (Fig.1-B). Biodegradability testing showed 40 wt.% remaining after 30 days (Fig.1-C). This approach aligns with the sustainability goals and reveals the potential of allylic cellulose derivatives for eco-friendly hydrogels [3]. Further tests are being conducted in order to improve the hydrogels properties.

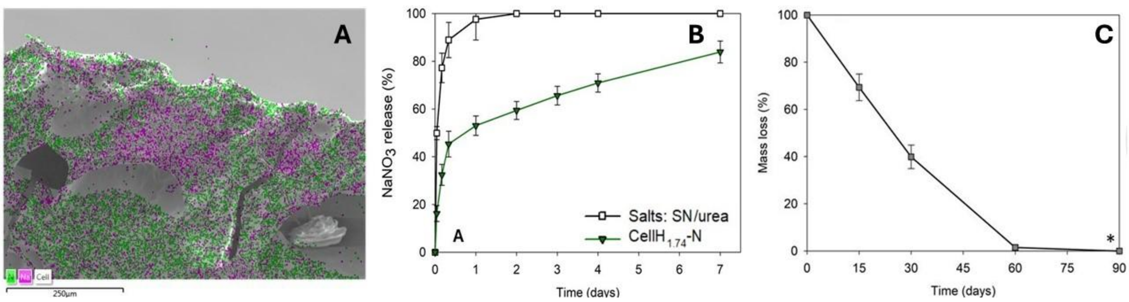

Figure 1. Properties of developed hydrogels: A- EDS images to evaluate fertilizers dispersion into hydrogels matrix; B - Sodium nitrate cumulative release in soil conditions; C - Biodegradability preliminary test.

Acknowledgments: Rafael C. Rebelo acknowledges FCT for the financing of his PhD scholarship 2021.08025.BD.

References:

[1] A. El Idrissi; O. Dardari; F.N.N.N.Metomo; Y. Essamlali; A. Akil; O. Amadine; S. Aboulhrouz; M. Zahouily, International Journal of Biological Macromolecules, 253 (2023) 127229.
[2] H. Kiiski; H. Dittmar; M. Drach; R. Vosskamp; M.E. Trenkel; R. Gutser; G. Steffens, Fertilizers, 2. Types. In Ullmann's Encyclopedia of Industrial Chemistry. John Wiley & Sons, Ltd. 2016, 1-53.
[3] A. Thakur; H. Kaur, Materials Today: Proceedings, 48 (2022) 1431-1438.

Microalgae proteins as sustainable and allergen-free alternatives for fining white wines

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Developing non-animal, allergen-free alternatives to traditional protein-based fining agents is essential for ensuring consumer safety and promoting sustainable winemaking [1, 2]. This study evaluates the effectiveness of microalgae-derived proteins - Spirulina, *Chlorella vulgaris* (CV), and *Tetraselmis chuii* (TC) - as fining agents in white wine, in comparison to conventional animal-based proteins such as casein, gelatin, and egg albumin protein. Two concentrations (25 g/hL and 50 g/hL) were tested, with 50 g/hL corresponding to the maximum dose established by the OIV for plant-based proteins. The effects were assessed in two white wines (A and B), focusing on proanthocyanidin fractions and wine quality (chromatic characteristics, phenolic and volatile profile). The addition of commercial fining agents significantly reduced total polymeric proanthocyanidins. At 50 g/hL, microalgae proteins showed comparable efficacy, especially in white wine B, which had a lower initial concentration of polymeric proanthocyanidins (91.8 ± 4.8 mg/L) than wine A (100.7 ± 1.2 mg/L). The extent of reduction in polymeric prodelphinidins and procyanidins depended on both the type and concentration of the fining agent. In wine B, microalgae-derived proteins, improved limpidity and lightness (L), and reduced yellow hues (b) and chroma (c*), often outperforming traditional fining agents. Colour differences (ΔE) remained below the visual perception threshold in wine A but exceeded 2.0 in wine B, indicating perceptible changes. Browning potential tests confirmed that all fining agents reduced initial colour and improved long-term colour stability. Furthermore, microalgae proteins preserved a higher proportion of phenolic acids than traditional fining agents. Volatile compounds analysis showed a more pronounced aromatic profile in wine A (455.7 ± 60.5 area·10^5) compared to wine B (268.7 ± 14.3 area·10^5). A significant reduction in volatile compounds occurred only in wine A, particularly with *Chlorella vulgaris* protein extract and egg albumin, leading to a reduction of approximately 44%. Microalgae protein extracts represent sustainable, allergen-free alternatives to conventional fining agents, with performance varying according to the wine matrix, highlighting the importance of tailored application strategies.

Acknowledgments: The authors thank the FCT for the grant SFRH/BD/144107/2019, https://doi.org/10.54499/SFRH/BD/144107/2019. The financial support of the CQ-VR Chemical Research Centre-Vila Real (UIDB/00616/2020 and UIDP/00616/ 2020) by FCT-Portugal and COMPETE.

References:

[1] M. Marangon; S. Vincenzi; A. Curioni, Molecules, 24 (2019) 2186.
[2] L.L. Pino-Ramos; E. Gómez-Plaza; V.R. Olate-Olave; V.F. Laurie; A.B. Bautista-Ortín, Food Chemistry, 448 (2024) 139055.

Enhancing the Nutritional Quality of Edible Insects: DHA-Rich Microalgae Supplementation in *Acheta domesticus* Diets

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The rising concern about developing sustainable food systems, combined with the increasing demand for nutritious and environmentally friendly protein sources, has led to a growing interest in edible insects as viable alternatives to conventional livestock [1]. In particular, the house cricket (*Acheta domesticus*) stands out for its notable nutritional value and low impact farming, typically relying on a simple standard diet based on by-products from vegetable processing industries [1,2].

In this work, aiming to enhance even more the nutritional value of *Acheta domesticus*, especially its lipid profile, the impact of incorporating DHA-rich microalgae into the standard diet was evaluated.

Two experimental diets were formulated with 5% and 10% DHA-rich microalgae incorporation, partially replacing the baseline feed. Crickets were reared under controlled conditions, and their biochemical composition was assessed at subadult stage. The results show an increase in the lipidic content, as well as an improved fatty acid profile, with special focus on omega-3 content.

With a simple dietary change and by bridging insects and algal biotechnologies, this approach offers a scalable, cost-effective solution to improve the quality of emerging insect-based protein sources, without compromising their sustainability.

Acknowledgments: The authors thank the Portuguese Foundation for Science and Technology (FCT) for the financial support to the Research Centre for Natural Resources, Environment and Society — CERNAS (UIDB/00681/2025), LEAF (UIDB/04129/2020) and Life Quality Research Centre - LQRC/CIEQV (UID/CED/04748/2020).

References:

[1] R. Moruzzo; S. Mancini; A. Guidi, Insects, 12(6) (2021) 557.

[2] N. Cunha; V. Andrade; A. Macedo; P. Ruivo; G. Lima, Foods, 14(7) (2025) 1164.

Combined effects of western diet and micro-nanoplastics on hepatic mitochondrial bioenergetics in C57BL/6J mice

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The current rise in micro-nanoplastics (MNPs) pollution and diet-related diseases such as obesity and type 2 diabetes, poses a growing public health concern [1,2]. Emerging evidence suggests potential synergistic interactions of these two factors, with unhealthy diets, such as Western dietary regimens, potentially exacerbating MNPs toxicity. Mitochondria, central to obesity and type 2 diabetes pathogenesis and MNPs-induced toxicity, may act as a key target for investigating the combined effects of MNPs and poor diets [3]. This work aimed to understand the impact of Western diets in MNPs toxicity on hepatic mitochondrial bioenergetics. Male C57BL/6J0laHsd mice (3-week-old) were divided into two main groups and fed either a standard diet or a high-fat diet (40% of energy from fats) for 13 weeks. Later on, each group was divided into three. Two groups were fed the corresponding dietary regimen for 4 weeks, with a mix of weathered MNPs at Low (L) and High (H) concentrations. Thus, six experimental groups were evaluated: STD - CTL (animals fed with a standard diet without MNPs); STD - MNPs L (animals fed with a standard diet with MNPs at the lowest concentration); STD - MNPs H (animals fed with a standard diet with MNPs at the highest concentration); HFD - CTL (animals fed with a high-fat diet without MNPs); HFD - MNPs L (animals fed with a high fat diet with MNPs at the lowest concentration); HFD - MNPs H (animals fed with a high fat diet with MNPs at the highest concentration). Results obtained for respirometry evaluation seem to indicate the presence of some degree of mitochondrial dysfunction. Energisation of complex II leads to a decrease in oxidative phosphorylation capacity in the liver of all groups exposed to HFD compared to STD ones, but only with significance for the CTL groups. MNPs administered through STD led to similar outcomes. All sources of variation - diet, MNPs concentration, and interaction - influenced the outcomes, suggesting combined effects that can't be predicted by each factor alone. Similar patterns were observed for LEAK respiration assessment. Nonetheless, those changes were not justified by the alterations observed in the enzymatic activity of electron transport chain components. Mitochondrial complexes were affected differently: complex II showed increased activity, whereas complex II+III and IV were decreased in animals fed an HFD with MNPs. An increase in mitochondrial mass was also noted when citrate synthase activity was evaluated. These findings indicate that different diet regimens can modulate the outcome of MNPs exposure, highlighting the need to include lifestyle factors and pre-existing health conditions in the toxicological testing of MNPs-related risks to human health.

References:
[1] J.C. Prata; J.P. da Costa; I. Lopes; A.L. Andrade; A.C. Duarte; T. Rocha-Santos, Science of Total Environment, 77 (2021) 146094.
[2] P. Bullon; H.N. Newman; M. Battino, Periodontology 2000 (2014) 139.
[3] M.G. Silva; M.M. Olivera; F. Peixoto; The Impact of Micro-Nanoplastics on Mitochondria in the Context of Diet and Diet-Related Diseases. Stresses, 5(12) (2025) 1.

Learning from molecules: Predicting mycotoxin toxicity through structure-based Machine Learning

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Mycotoxins are chemically diverse fungal metabolites that frequently contaminate food and feed, posing significant health risks to humans and animals. While some mycotoxins are well studied, many others remain uncharacterized. In this work, we explore whether molecular structure alone can inform toxicity predictions, using a structure-based machine learning approach [1].
A curated set of 59 mycotoxins, comprising both established and emerging compounds, was analyzed using a wide array of molecular descriptors. These include topological, electronic, and physicochemical properties extracted directly from molecular structures. Unsupervised learning methods revealed clustering patterns consistent with known mycotoxin families. Supervised models, including random forest and neural networks, were then trained to classify compounds according to acute toxicity.
Our results highlight that specific structural features, such as molecular symmetry, polarity, and hydrogen bonding capacity, are informative indicators of toxic potential. The models achieved robust predictive performance and provide insight into which molecular traits most influence acute toxicity. This proposed computational framework offers a valuable complement to experimental toxicology, supporting early hazard identification and improved food safety assessment.

Acknowledgments: The authors acknowledge Fundação para a Ciência e a Tecnologia (FCT), the Portuguese Agency for Scientific Research for the financial support through project UIDP/00313/2020.

References:

[1] T.F. Cova; C. Ferreira; S.C.C. Nunes; A.A.C.C. Pais, Journal of Agricultural and Food Chemistry, 73(10) (2025) 6173-6188.

Innovative Functional Bread: Integrating Acorn Flour and Regionally Sourced Essential Oils for Enhanced Nutrition and Shelf Life

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Bread remains a staple food worldwide, and recent consumer trends have driven the development of functional products enriched with bioactive ingredients. This study explores the creation of innovative gluten-free bread by incorporating a corn flour and essential oils encapsulated within polymer mixtures comprising bacterial cellulose fibres. The encapsulation process aims to enhance the stability, solubility, and controlled release of essential oils, addressing challenges such as volatility and degradation during baking. Essential oils from *Thymus* mastichina and other medicinal plants, sourced from distinct regions, were characterized for their bioactive profiles using gas chromatography-mass spectrometry (GC-MS). Bacterial cellulose obtained from vinegar production and locust bean gum were employed as a natural carriers to encapsulate these oils, leveraging its biocompatibility and ability to form protective matrices. With the aim of introducing the encapsulated essential oils into bread formulations, several flours were tested on the stability of the emulsion systems. Marked differences were observed depending on the type of flour, from which acorn flour showed higher affinity towards the oil. This approach allowed to increase oil stability in an aqueous system, with the potential for the gradual release of key antimicrobial and antioxidant compounds, contributing to extended bread shelf life and enhanced functional properties. This approach not only augments the health benefits of gluten-free bread but also supports the valorisation and sustainability of the Montado ecosystem by utilizing underexploited resources such as acorns and medicinal plants.

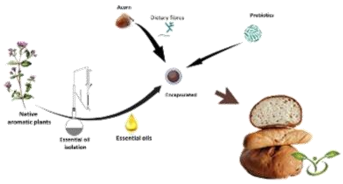

Figure 1. Schematic picture of the work.

Acknowledgments: The authors want to acknowledge Fundação la Caixa and FCT for the financial support through the project "Plantas aromáticas do Alentejo, probióticos e farinha de bolota no desenvolvimento de pão funcional" (PD23-0025). FCT is also acknowledged for its financial support through the Strategic Research Centre Project UIDB/00102/2020 and UIDB/05183/2020.

Sensory evaluation of PDO/PGI wines in the context of accreditation in Portugal and the European Framework: Current practices and challenges

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Wine certification standards and EU regulations ensure food security by guaranteeing product safety, traceability, and compliance with regulations. They also support clean label technologies and innovation in natural processing. In the EU and Portugal, wine certification is crucial for ensuring quality, safety, and competitiveness, with PDO and PGI accounting for 68% of domestic wine sales. EU regulations [1] require the definition of protected product characteristics, including sensory descriptions. In Portugal, all wines undergo sensory evaluation as part of the certification process, reflecting the country's commitment to quality and consistency. However, challenges related to sensory standardization and evaluation methodologies are acknowledged. Initiatives like the E3S PDO Working Group [2] aim to harmonize practices, drawing inspiration from successful collaborations in other sectors, such as olive oil and wine regulation in Galicia.

This work analyses wine certification, focusing on sensory evaluation in Portugal and the EU. It reviews case studies from Spain, Croatia, Greece, France, and Italy, showcasing various approaches to certification that merge traditional methods with modern protocols and statistical analyses. Key European regulations, including PDO requirements and the ISO/IEC 17025 standard [3], are highlighted to ensure quality in sensory laboratories. A unified methodology is necessary to enhance reliability and facilitate international recognition of wine certifications [4]. The work also addresses the challenges in forming and maintaining tasting panels, selecting scales and descriptors for sensory analysis, and discusses the historical evolution of certification systems. It concludes with guidelines for harmonizing methods, emphasizing the importance of continued investment in technology and training for the sustainable development of the wine sector.

Acknowledgments: The authors thank ALABE for facilitating sample logistics and the wine companies for providing samples for the tastings. This study was funded by the CQ-VR [UIDB/00616/2020 and UIDP/00616/2020, https://doi.org/10.54499/UIDB/00616/2020], the CEMAT/IST-ID [UIDB/04621/2020 and UIDP/04621/2020, https://doi.org/10.54499/UIDB/04621/2020], LEAF (UIDB/UIDP/04129/2020), and TERRA (LA/P/0092/2020).

References:

[1] OJEU, Regulation (EU) No 1151/2012 of the European Parliament and of the Council of 21 November 2012 on quality schemes for agricultural products and foodstuffs. Official Journal of the European Union, 2012.
[2] F.J. Pérez-Elortondo; M. Zannoni, Editorial Acribia S.A, 1ª ed. 2021.
[3] ISO 17025, General requirements for the competence of testing and calibration laboratories. 2017, International Organization for Standardization.
[4] A. Gomis-Bellmunt; A. Claret; L. Guerrero; F.J. Pérez-Elortondo, Food Research International, 176 (2024) 113828.

Regenerated Cellulose: A Versatile Platform for Sustainable Laminates and Green Energy Harvesting

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Regenerated cellulose (R-cellulose) is emerging as a multifunctional material bridging sustainability and advanced functionality. In this work, we demonstrate two promising applications of R-cellulose: as high-performance laminates and as active layers in triboelectric nanogenerators (TENGs). Using a simple, solvent-free process, transparent all-cellulose laminates were produced by stacking freshly regenerated cellulose II films, without chemical modifications or resins. These laminates exhibit excellent mechanical properties - E-moduli exceeding 9 GPa for single layers - and tunable flexibility depending on layer number. Their malleability and scalability make them ideal for eco-friendly alternatives in packaging, construction, and design. In parallel, R-cellulose films regenerated from various alcohols showed outstanding triboelectric performance, with open-circuit voltages up to ca. 260 V and significant gains in output power (up to 382 %) as a function of regeneration solvent. This enhancement is attributed to increased hydrophilicity and optimized surface microstructure, which improves effective contact area with soft counter layers. Together, these findings highlight regenerated cellulose as a robust, renewable platform for both structural and energy-harvesting applications.

Acknowledgments: The authors are also grateful for the financial support from the KK Foundation European Regional Development Fund grant (number 20361245). This research has also been supported by Treesearch. MN acknowledges support from the Swedish Research Council Grant Number 2022-04425. AE acknowledges the financial support from FORMAS grant number 2023-0901. BM acknowledges the Portuguese Foundation for Science and Technology, FCT, through the projects UIDB/05183 and the researcher grant CEECIND/01014/2018/CP1540/CT0002 (DOI:10.54499/CEECIND/01014/2018/CP1540/CT0002) L.A. acknowledges FCT for the research grant 2021.00399.CEECIND (DOI: 10.54499/2021.00399.CEECIND/CP1656/CT0025).

3D printing using photochromic naphthopyrans as photoinitiators

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The term "photopolymerization" refers to a series of chain reactions initiated by light with the purpose of solidifying viscous liquid resins [1]. This method requires three components: monomer (polyacrylate), photoinitiator (PI) and radiation. The photoinitiator absorbs light and generates radicals that react with the monomer forming three-dimensional objects. In 2020, an innovative 3D printing technique was developed, which uses a colorless photochromic spiropyran linked to a benzophenone as the photoinitiator which is activated by the successive absorption of UV and visible light [2]. More recently (2023) it was proven that naphthopyrans, in conjugation with a benzophenone, in the presence of a co-initiator, can also be used as photoinitiators of radical polymerization [3]. The UV light transforms these colorless molecules into a colored benzophenone that through the absorption of visible light promotes the formation of radicals that initiate a polymerization reaction (Figure 1). This system ensures that only the areas that receive both light beams polymerize.

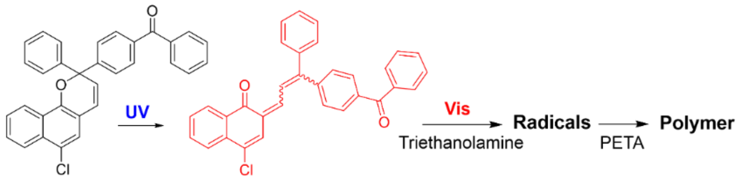

Figure 1. Naphthopyran UV photoswitching and radical formation through UV + visible light irradiation [3].

In this work, we describe a new photochromic PI that integrates an indeno-fused naphthopyran and a benzoylcarbazole core. This colorless molecule is able to promote radical polymerization using only laser visible light, which offers a significant advantage in energetic efficiency: enabling polymerization processes with reduced energy consumption and safer operating conditions. The formulation includes a colorless mixture of PI, triethanolamine (co-initiator) and pentaerythritol tetraacrylate (PETA monomer) that, through irradiation with visible light (410 nm), produces thin and well-defined 3D objects (Figure 2).

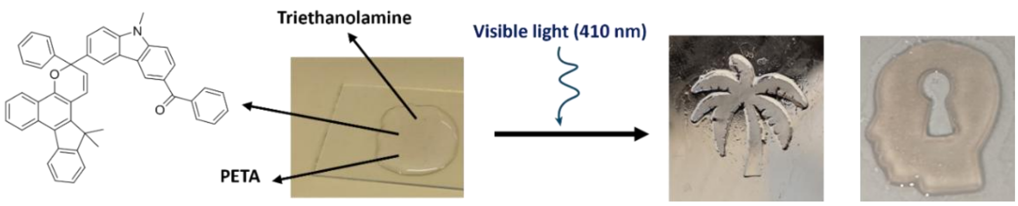

Figura 2. Photopolymerization process of the newly synthesized type II PIs.

References:
[1] M. Kaur; A.K. Srivastava, Journal of Macromolecular Science - Polymer Reviews, 42 (2002) 481.
[2] M. Regehly, Y. Garmshausen, M. Reuter, N.F. König, E. Israel, D.P. Kelly, C.Y. Chou, K. Koch, B. Asfari, S. Hecht, Nature, 588 (2020) 620.
[3] C.M. Sousa, J.R. Fernandes, P.J. Coelho, European Polymer Journal, 196 (2023) 112312.

Acknowledgments: The authors acknowledge the Portuguese Foundation for Science and Technology (FCT) for financial support to the research unit CQVR (UIDB/00616/2020).

Towards visible-light-assisted photocatalytic nitrogen fixation via physical integration of MOF and GCN photocatalyst

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Ammonia (NH_3) is primarily produced for nitrogen fertilizers, and photocatalytic nitrogen fixation (PNF) offers a greener alternative to the energy-intensive Haber-Bosch ammonia production process. However, developing efficient photocatalysts for NH_3 production is challenging due to water being the hydrogen source and the low solubility of nitrogen (N_2) in water. Metal-organic frameworks (MOFs) show promise as photocatalysts for N_2 fixation because of their large surface area and modifiable structures that enhance their functionality. Herein, we report for the first time a series of Ti-MOF based catalysts for visible light-assisted photocatalytic N_2 fixation by introducing different ratios of graphitic carbon nitride (GCN) through both physical and chemical mixing methods (Fig.1). In different ratios, the photocatalytic NH_3 production of the 25% GCN/MOF material (81 $\mu mol.g^{-1}.h^{-1}$) is three times higher than that of its individual catalysts. When exposed to visible light, electrons in GCN are excited and migrate to defect sites in Ti-MOF, while holes accumulate in the valence band of GCN. These electrons reduce N_2 molecules, greatly improving the efficiency of photocatalytic N_2 fixation [1]. Physical mixing methods produce better results than chemical mixing. This synthesis approach can introduce useful defects, like linker vacancies in MOFs or surface irregularities in GCN, which enhance N_2 adsorption and activation. Furthermore, physical mixing avoids harsh chemical processes that could degrade MOF or GCN structures, preserving their intrinsic properties [2]. Our strategy highlights a better synthesis approach for designing a hybrid MOF/GCN-based photocatalyst for green NH_3 production.

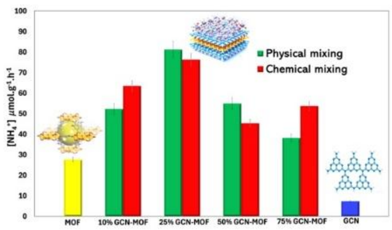

Figure 1. Photocatalytic ammonia generation using different catalysts.

Acknowledgments: This work was supported by national funds through the FCT/MCTES (PIDDAC), under the project 2022.04682.PTDC - SuN2Fuel - (DOI:10.54499/2022.04682.PTDC). This research was also supported by: UID/50020 of LSRE-LCM - Laboratory of Separation and Reaction Engineering - Laboratory of Catalysis and Materials - funded by Fundação para a Ciência e a Tecnologia, I.P. /MCTES through national funds; and ALiCE - LA/P/0045/2020 (DOI: 10.54499/LA/P/0045/2020). MJS acknowledges FCT funding under the Scientific Employment Stimulus - Institutional Call DOI:10.54499/CEECINST/00010/2021/CP1770/CT0011). AJ acknowledges the FCT scholarship with reference 2023.02602.BD.

References

[1] L. Zhang; X. Zhou; S. Liu; H. Liu; S. Zhu; Y. Mao; Q. Yang; S. Zhu; C. Zhang; T. Wang; C. Wang, Journal of Cleaner Production, 425 (2023) 138912.
[2] N. Ojha; K.K. Pant; E. Coy, Industrial & Engineering Chemistry Research, 62 (2023) 21885.

Passive thermotropic devices with radiative cooling functionality

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Passive dynamic thermotropic (TT) radiative cooling (RC) windows aid net-zero energy buildings in smart cities by adjusting sunlight and solar heat in response to temperature variations, as they become opaque when temperatures rise, thereby using thermal radiation to dissipate heat into outer space. They are ideal for controlling solar heat gain and privacy [1].

Here we introduce an innovative eco-friendly TT layer with ultraviolet (UV) shielding and RC ability based on a di-urea cross-linked poly(oxypropylene) (POP)/siloxane hybrid matrix doped with carbon dots (CDs) obtained from *Agapanthus africanus* leaves [2] and variable contents of TT 1-butyl-3-methylimidazolium chloride ([BMIm]Cl) ionic liquid [3]. This hybrid structure, denoted d-U'(Y), where U' stands for urea and Y= 2000 represents the average molecular weight of the POP chains in gmol^{-1} (approximately 33 OP repeat units), seem quite interesting. The [BMIm]Cl was incorporated to impart the desired thermoresponsive effect and CDs were integrated for two purposes: (1) as sustainable UV-blocking agents, and (2) to activate surface plasmon resonance effects (SPRE), amplifying the TT response. The TT layers were characterized prior to device fabrication using thermal analysis, X-ray diffraction, atomic force microscopy, contact angle measurements, and wetting envelope analyses. The thermotropic devices (TTDs) assembled demonstrated, at the highest [BMIm]Cl concentration used, improved thermo-optical performance mediated by the SPRE, broad operational range (30-70 °C), and good cycling stability. Maximum transmittance variation (ΔT) values of 31/27 % at 550/1100 nm were achieved. This new class of TT layer represents a milestone in the development of smart RC materials for autonomous solar modulation windows.

Acknowledgments: This work was funded by the SOLPOWINS project - *Solar-Powered Smart Windows for Sustainable Buildings* (PTDC/CTM-REF/4304/2020), financed by FCT, FEDER, and NORTE2020. Additional support was provided by the Chemistry Research Centre of Vila Real (CQ-VR) under the projects UIDB/0616/2020 and UIDP/0616/2020.The research was also developed within the scope of the A-MoVeR project – *Mobilizing Agenda for the Development of Products and Systems towards an Intelligent and Green Mobility* (operation 02/C05-i01.01/2022, PC646908627-00000069), approved under the call 02/C05-i01/2022 *Mobilizing Agendas for Business Innovation*. This project is financed by European funds provided to Portugal through the Recovery and Resilience Plan (RRP), under the European Recovery and Resilience Facility, as part of the *NextGenerationEU* program (2021–2026).

References:

[1] P.J. Nunes, M. Fernandes, V. de Zea Bermudez, Journal of Science: Advanced Materials and Devices (2025) 100907. https://doi.org/10.1016/j.jsamd.2025.100907.
[2] P.J. Nunes, R.F.P. Pereira, S.C. Nunes, S.F.H. Correia, L. Fu, R.A.S. Ferreira, M. Fernandes, V. de Z. Bermudez, Small (2024). https://doi.org/10.1002/smll.202404717.
[3] P.J. Nunes, W. Zając, K. Styszko, S. Pereira, E. Fortunato, V. de Zea Bermudez, M. Fernandes, Solid State Ionics 424 (2025) 116850. https://doi.org/10.1016/j.ssi.2025.116850.

Chondroitin-based Ionanofluid for Sun-Actuated Devices

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Ionanofluids (INFs)-comprising ionic liquids and dispersed nanoparticles-represent a cutting-edge class of materials with significant potential for energy-related applications. They synergistically combine the distinctive properties of ionic liquids with the enhanced thermal conductivity and tunable optical features imparted by nanoparticles. These characteristics can be further optimized through the integration of carbon-based nanomaterials [1]. Among these, carbon dots (CDs) are particularly notable for their ability to fine-tune the optical properties of INFs.

Recently, some of us developed a thermotropic INF via a one-step synthesis using silk fibroin-derived CDs (SF-CDs) [2]. This material exhibited a high specific heat capacity, superior thermal conductivity, and effective photothermal conversion, achieving efficiencies of up to 28%. However, the SF-INF displayed a photoluminescence emission peak at 410 nm, which is suboptimal for certain applications. For sun-activated thermal devices, a red-shifted emission near 420 nm is preferable, as it aligns with the surface plasmon resonance of silver nanoparticles-commonly used to boost local heating through efficient light absorption at this wavelength.

To overcome this limitation, we synthesized a thermotropic INF analog incorporating CDs derived from glycosaminoglycan chondroitin sulphate. In this work we report the structural, and thermo-optical characterization of this new system. The fact that it emits at approximately 450 nm suggested an enhancement of the performance of the sun-actuated thermotropic device beyond that achieved with SF-CD-based INF [2]. The present INF holds promise for advancing the development of more efficient solar-responsive thermal systems.

Acknowledgments: The research was also developed within the scope of the A-MoVeR project – Mobilizing Agenda for the Development of Products and Systems towards an Intelligent and Green Mobility (operation 02/C05-i01.01/2022, PC646908627-00000069), approved under the call 02/C05-i01/2022 Mobilizing Agendas for Business Innovation. This project is financed by European funds provided to Portugal through the Recovery and Resilience Plan (RRP), under the European Recovery and Resilience Facility, as part of the NextGenerationEU program (2021–2026). Additional support was provided by the Chemistry Research Centre of Vila Real (CQ-VR) (UIDB/0616/2020 and UIDP/0616/2020) and FibEnTech-UBI (UIDB/00195/2020). S.C.N. acknowledge FCT for their Assistant Research contract 2020-00805.CEEIND; DOI: 10.54499/2020.00805.CEECIND/CP1625/CT0001. R.F.P. Pereira acknowledge FCT for the Strategic Funding UID/00686: CQ-UM/UM and FCT-UMinho for the Assistant Research contract (https://doi.org/10.54499/2023.07994.CEECIND/CP2841/CT0013).

References:

[1] J. Cavieres; M.J. Inestrosa-Izurieta; D.A. Vasco; J.I. Urzúa, Journal of Molecular Liquids, 351 (2022) 118677.
[2] T.A.G. Duarte; R.F.P. Pereira; B. Medronho; E.S. Maltseva *et al.*, Chemical Materials, 36(3) (2024) 1136.

II INTERNATIONAL MEETING MOLECULES 4LIFE

POSTER COMMUNICATIONS

A segmented regression across P indicators and bootstrap approach to assess critical soil P saturation thresholds

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Phosphorus (P) losses from agricultural soils poses significant environmental concerns, particularly where high soil degree of P saturation (DPS) is detected. This work aimed to determine and compare critical DPS thresholds using segmented regression across four P indicators: water-soluble P (WSP), P extracted with $CaCl_2$ (P_{CaCl_2}), the equilibrium P concentration (EPC_0), and P-Olsen inorganic fraction (P_{Ols}). Data were collected from 47 soils in the Lisbon Wine Region, displaying contrasting mineralogical characteristics and equivalent $CaCO_3$ contents. The critical DPS thresholds were estimated for each variable using breakpoint analysis with 95% confidence intervals (CI) derived from 1000 bootstrap samples, enabling robust estimation of parameter uncertainty without relying on parametric assumptions. This resampling process approximates the sampling distribution of the breakpoint estimates, enabling a more reliable CI estimation [1].

The following median DPS thresholds were observed: EPC_0 (25.1%), WSP (21.7%), P_{CaCl_2} (23.5%), and P_{Ols} (18.9%). Despite overlapping CI in some cases, the Kruskal-Wallis test revealed significant differences among variables (X^2_{KW}= 2025.6, p-value < 0.001). Pairwise Wilcoxon tests with Holm correction confirmed all pairwise comparisons as highly significant (p-value < 0.001), highlighting distinct DPS sensitivities. Among the evaluated indicators, the DPS threshold estimated using P_{Ols} displayed the widest bootstrapped CI (4.1–28.7%), reflecting considerable uncertainty in the estimation of its critical breakpoint. In contrast, the thresholds derived from EPC_0 and P_{CaCl_2} presented narrower CI, suggesting more stable estimations. The distribution of bootstrapped DPS thresholds, visualized through violin plots, highlighted the divergence between P indicators, with P_{Ols} consistently associated with lower critical DPS values. When applying the estimated DPS thresholds, only 7 out of 47 soils surpassed any of the estimated values, and 4 soils exceeded the conventional 25% DPS limit. These soils were predominantly classified as non-calcareous, indicating a higher environmental P risk in this type of soils. The type of soil (calcareous soils (> 50 g $CaCO_3$ kg^{-1}) alkaline soils (< 50 g $CaCO_3$ kg^{-1}) and neutral to acidic soils (pH ≤ 6.5)) was shown to influence DPS distributions, with $CaCO_3$ potentially buffering or enhancing P mobility depending on the extraction method.

Our findings suggest that the choice of P indicator substantially impacts the estimated DPS critical limit. Indicators such as EPC_0 and P_{CaCl_2} offer tighter confidence bounds and may be more appropriate for defining agronomic or environmental thresholds. However, P_{Ols} appears more sensitive at lower DPS levels and may be better suited for early risk detection. Ultimately, this approach contributes to more robust and sustainable P management by refining DPS threshold identification through multiple indicators and model validation.

Acknowledgments: Rui Lopes was supported by FCT (PhD grant 2021.06338.BDO) and by the projects NORTE-01-0145-FEDER-000038 and WINE/INTERACT/NORTE-01-0145-FEDER-000017.

References:

[1] L. Qian; S. Dang; M. Hong; J. Yang; H. Li, Water Resources Management, 37 (2023) 1055.

The influence of seasons on the variability of physicochemical characteristics of wastewater from the Płaszów Wastewater Treatment Plant in the context of reducing the eutrophication potential

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A significant problem for water management is municipal wastewater rich in biogenic elements. With the increasing development of urbanization, population growth, and intensification of agriculture, the amount of urban wastewater increases, and its composition deteriorates [1]. Currently, urban wastewater is considered one of the main anthropogenic causes of eutrophication. The phenomenon of eutrophication itself leads to a number of negative ecological effects, such as changes in the species diversity of aquatic plants and animals or deterioration of water quality and requires measures to prevent its intensification. In the context of preventing the development of eutrophication, wastewater treatment plants play an important role, reducing the nutrient load in wastewater before it is discharged into water bodies. For this reason, the analysis of the composition of urban wastewater is an important topic of scientific research, necessary to ensure an effective and efficient treatment process [2].

The aim of the study was to determine the eutrophication potential of municipal wastewater from the Płaszów Wastewater Treatment Plant. The scope of the study included a comparison of the physicochemical properties of raw sewage and wastewater after the biological treatment process, calculation of the share of bioavailable forms of nitrogen and phosphorus in wastewater and assessment of the effectiveness of wastewater treatment at the Płaszów Wastewater Treatment Plant. Samples were collected from I 2020 to V 2022. The phenomenon of eutrophication and biogenic elements were discussed. The research part focused on the analysis of bioavailable forms of nitrogen and phosphorus in wastewater. Furthermore, the physicochemical properties of raw and biologically treated wastewater were compared, the change in selected properties depending on the season was investigated and the effectiveness of the wastewater treatment system in Płaszów was evaluated. The parameters analyzed were: pH, total suspended solids, BOD_5, COD, ammonium nitrogen, nitrate(III) nitrogen, nitrate nitrogen(V), total Kjedahl nitrogen, total nitrogen, orthophosphates, total phosphorus.

Acknowledgments: Research supported by AGH University of Krakow within the framework of the Grant Number: 16.16.210.476.

References:

[1] J. Pyssa; M. Piech, Przemysł Chemiczny, 102(10) (2023) 1092.
[2] J. Pyssa; M. Piech; E. Pyssa; K. Styszko, EFE2024 - 41, https://efe2024.agh.edu.pl.

Comparison of EDTA and DTPA-TEA for the extraction of micronutrients in a limed very acidic soil

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Acidic soils affect large areas, more than 30 %, of the world's arable land, pH exerts strong controls on crop production. Soil pH is a fundamental parameter influencing a wide range of soil properties and processes. It affects nutrient cycling and fertility, microbial community activity and function, organic matter decomposition, metal availability and speciation and inorganic carbon equilibria.

In *Douro Valley* region (Portugal) soils are generally derived from schist, which contributes to their acidity. This feature, along with other edaphoclimatic factors – such as high gravel and stones contents and sandy loam texture – plays a key role in shaping the distinctive characteristics of the wines produced in this area. The limited content of the fine earth fraction and texture of these soils also influence their capacity to retain nutrients and water. Although grapevines can tolerate soils with a pH ranging from 4.5 to 8.5, the optimal pH for their development lies between 6.0 and 6.7. For this reason, liming is commonly employed to raise soil pH.

Aiming to study the plant available micronutrients in a very acidic soil after liming, medium-term incubation was performed with a very acidic soil (pH_{water} 4.64) from *Douro Valley* region, a sandy-loam soil with 14.8 g OM kg^{-1}. The laboratory incubation was designed with five pH levels (4.64, 6.07, 7.14, 7.76, 7.90) obtained by soil liming with $CaCO_3$ (reagent grade) and soil moisture equivalent to 40% water-filled porosity (WFP). Samples were incubated during a 28-days period in 3 replications. Previously, a 12-days soil pre-incubation was performed at 25 °C and 20 % of WFP. At the end of the incubation the availability of the micronutrients Cu, Zn, Fe and Mn, was performed using two known extraction methods: EDTA [1] and DTPA-TEA [2].

Regarding EDTA extractions, extracted Fe showed an increase correlated with the increasing of soil pH (R^2=0.876), extracted Cu did not reveal any difference related to the soil pH increase; on the other hand, Mn and Zn extractions revealed a reduction with the increasing of soil pH (R^2=0.955, R^2=0.891, respectively). However, DTPA-TEA extractions showed negative correlations between Fe, Mn, Cu and Zn extracted (R^2=0.942, R^2=0.980, R^2=0.992 and R^2=0.947, respectively) and the increasing of soil pH.

EDTA method showed a greater extraction ability of micronutrients, which can be due the higher complexation capacity of EDTA. DTPA-TEA method seems to reflect better the expected decrease in the phytoavailability of these four micronutrients in soils with neutral and alkaline reaction.

Acknowledgments: This work was supported by the Portuguese Foundation of Science and Technology (FCT) through the PhD grant 2021.06737.BD doi.org/10.54499/2021.06737.BD, CQ-VR UIDB/00616/2020 doi.org/10.54499/UIDB/00616/2020 and the projects VitalityWINE/INTERACT/NORTE-01-0145-FEDER-000017 and innovine&wine/NORTE-01-0145-FEDER-000038.

References:

[1] W.L. Lindsay; W.A. Norvell, Soil Science Society of America Journal, 42 (1978) 421.
[2] E. Lakanen; R. Ervio, Soils Acta Agralia Fennica, 123 (1971) 223.

Application of grape waste from wine industry as iron complexing agents at circumneutral pH values. Comparison between solid and liquid residue

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Water is a scarce resource, and wastewater treatment plants are finding it increasingly difficult to treat it properly. This is partly due to the presence of contaminants of emerging concern, or CECs. This creates the need for an additional step in the treatment process. This is where advanced oxidation processes come into play. Among them, several studies have shown the effectiveness of the photo-Fenton process [1]. This reaction is based on the decomposition of H_2O_2 by the catalytic action of iron species into ·OH radicals, which are highly reactive and responsible for oxidizing pollutants. The main challenge is that the optimal pH for the photo-Fenton process is around 2.8 due to iron activity. At higher pH levels, iron tends to form hydroxyl species, which become inactive and stop the process. Chemical iron-chelating agents such as EDDS are available; however, organic substances, including humic acids and polyphenols, have also proven effective for this purpose, offering a potentially economical and environmentally friendly alternative [2]. Grape waste from the wine industry could be a good source of these compounds. Three scenarios were studied, in which the compounds were extracted from both solid and liquid waste, the liquid being from cleaning and the other from a production effluent. A basic extraction at pH 13 using KOH was performed in all cases, with a 1:4 ratio (1 part sample to 4 parts basic solution), over 24 hours. A series of characterizations was carried out to analyze all the obtained extracts, and the results were compared with each other. Finally, iron chelating capacity at pH 5,6 and 7 was tested, resulting in good results. Further studies will focus on evaluating its real effectiveness in photo-Fenton processes through future experiments.

Table 1. Characterization of the extracts obtained through a basic extraction at pH 13.

Source	**DOC (mg C/L)**	**COD (mg O_2/L)**	**Phenolic content (mg GAE/mg C)**
Solid waste	7 188	28 400	0.035
Red wine cleaning effluent	3 914	11 400	0.207
White wine production effluent	16 218	32 963	0.111

Acknowledgments: AGROALNEXT/2022/041 project, funded by European Union NextGenerationEU (PRTR-C17). Ministry of Science and Innovation - Government of Spain and Generalitat Valenciana. IN2AQUAS project (no. 10111955555) funded by the European Union HORIZON/MSCA. "Vine and Wine Portugal – Driving Sustainable Growth Through Smart Innovation" project with reference number C644866286-011, co-financed by the Recovery and Resilience Plan (RRP) and NextGeneration EU Funds. The authors are also grateful for the financial support of Fundação para a Ciência e a Tecnologia (FCT) to CQVR (UIDB/00616/2025).

References:

[1] F. Rodrigues-Silva; M.C.V.M. Starling; D.A.S. Rodrigues; C.C. Amorim, Journal of Environmental Chemical Engineering, 11 (2023) 110675.
[2] P. García-Negueroles; S. García-Ballesteros; L. Santos-Juanes, Journal of Environmental Chemical Engineering, 9 (2021) 106862.

Innovative 3D Photocatalysts for Agro-Industrial Recalcitrant Pollutants Removal

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Advanced oxidation processes (AOPs) can be efficient methods for treating recalcitrant wastewater, typically characterized by the presence of organic pollutants resistant to conventional degradation treatments. Among the various AOPs, TiO_2 suspension photocatalysis is effective for degrading recalcitrant pollutants but faces limitations in catalyst recovery and reuse. To overcome these challenges, this work explores 3D printing as a strategy to develop structured TiO_2 photocatalysts for removing compounds such as phenol (Ph) and tyrosol (Ty) from agro-industrial wastewater.

The TiO_2 3D structured monoliths were prepared by mixing TiO_2 (P25, Evonik-Degussa), a bentonite suspension (20% w/w), and a sodium carboxymethylcellulose (CMC) solution (3% w/w) in a 1:1:1.5 ratio. A cartesian axis BIQU B1 printer with a syringe extrusion system coupled to a piston was used for 3D monolith printing (D ~30.0 mm, H ~ 1.5 mm, ~10 cells·cm^{-2} and the final structures were calcined in air at 650 °C for 120 minutes. Photocatalytic experiments were conducted in a 28 mL cylindrical Milireactor equipped with an UltraVitalux (Osram) 300 W lamp (UV-A: 13W, 315-400 nm). The system operated in recirculating mode at a flow rate of 6.6 mL·min^{-1}. Pollutant removal and mineralization were monitored using HPLC and TOC analyser means.

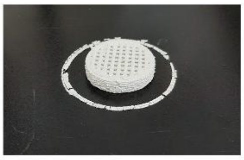

Figure 1. Stages of the monolith: during 3D printing, prior to calcination, and after calcination.

As expected, TiO_2 suspensions exhibited the highest pollutant removal rates. Nonetheless, the TiO_2 monolith also demonstrated efficient performance, achieving significant removal of Ph (50%) and Ty (61%), clearly surpassing the rates observed in the photolysis experiments. In addition, all tests were performed using a single monolith, indicating notable mechanical-chemical stability after the reaction, as well as satisfactory reusability over successive operational cycles.

Acknowledgments: This work has been supported by the MICINN PID2020-116478RBI00 project, REMTAVARES Network (S2018/EMT-4341) and project "Vine and Wine Portugal - Driving Sustainable Growth Through Smart Innovation" with reference number C644866286-011, co-financed by the Recovery and Resilience Plan (RRP) and NextGeneration EU Funds. The authors are also grateful for the financial support of Fundação para a Ciência e a Tecnologia (FCT) to CQVR (UIDB/00616/2025).

Effect of Biochar, Nanobiochar, and Chitosan addition on the Lability of Heavy Metals in Soil: Preliminary Studies

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Increasing accumulation and bioavailability of heavy metals in soil is presenting significant risks to environmental and human health. Nature based soil amendments such as biochar, nanobiochar, and chitosan has gained attention as a promising strategy for immobilizing heavy metals and reducing their lability in contaminated soils. Present study aimed to evaluate the effect of these emergent soil conditioners on the lability of selected metals (e.g., Cu, Fe, Zn and Mn), in a vineyard soil exposed to copper-based fungicide application. Soil conditioners were mixed and incubated for 28 days to evaluate their effect on the lability of trace elements under laboratory conditions. Four treatments were tested: (i) unamended soil (control), and soil amended with 1% (w/w) of (ii) biochar, (iii) nanobiochar, and (iv) chitosan. Bioavailable fractions of Cu, Fe, Zn, and Mn were extracted at the end of incubation period using the DTPA method (1:2 soil-to-solution ratio) and quantified by inductively coupled plasma optical emission spectrometry (ICP-OES). The application of biochar, nanobiochar, and chitosan significantly reduced the availability of Zn, Cu, Mn, and Fe in the soil compared to the control. The most pronounced reduction was observed for Mn, with nanobiochar achieving a 51.1% decrease, followed by biochar (28.9%) and chitosan (15.6%). For Zn and Cu, chitosan treatments produced the most significant reductions, with decreases of 11.3% and 8.2%, followed by nanobiochar treatment with 9.9 and 5.4%, respectively. Chitosan, with a 19.6%, and nanobiochar, with a 6.1% reduction, were the most effective treatments in decreasing Fe availability. These variations likely result from the distinct physicochemical properties of the conditioners materials. The increased surface area and reactivity of nanobiochar significantly increasing metal adsorption, particularly for Mn. In contrast, the amino and hydroxyl functional groups of chitosan facilitate more effective insolubility of Zn, Cu, and Fe by chelation and pH changes, the latter reflecting its alkaline nature. The observation of present study demonstrated the potential of the amendments, particularly chitosan and nanobiochar, to mitigate the availability of metals such as Cu, Zn, Fe, and Mn in the soil, contributing to the reduction of environmental risks associated with the contamination by these elements and to the improvement of soil quality.

Characterization of Tire and Road Wear Particles (TRWP) in urban air using cascade impactor and SEM-EDS

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Tire and road wear particles (TRWP) are an increasingly significant component of airborne particulate matter in urban environments. As they are not linked to combustion processes, their emissions are difficult to control and mitigate [1]. TRWP are formed through the mechanical abrasion of tires and road surfaces during vehicle operation and contain a complex mixture of materials, including synthetic rubber, fillers like carbon black, and trace metals such as zinc [2].

In this study, ambient particulate samples were collected using a cascade impactor, allowing for aerodynamic size-based fractionation. Morphological and elemental characterization of selected particles was carried out using scanning electron microscopy (SEM) combined with energy-dispersive X-ray spectroscopy (EDS), a technique that enables the detection of elements typically associated with tire wear, such as C, Zn, and S. Due to their small size, TRWP can penetrate deep into the human respiratory system, and their health impact increases with decreasing particle diameter [3].

Preliminary observations suggest considerable morphological heterogeneity and chemical complexity among the potential TRWP particles identified in the samples. These features, combined with their ability to adsorb other airborne pollutants, raise concern about their cumulative toxicity [3,4]. In vitro studies have demonstrated that exposure to TRWP may result in oxidative stress, inflammation, disruption of cellular homeostasis, and impaired tissue repair mechanisms [5]. Long-term exposure could therefore contribute to chronic respiratory conditions and increased cancer risk, particularly in urban populations.

Acknowledgments: Research supported by AGH UST within the framework of the "Excellence Initiative - Research University" program.

References:

[1] Z. Luo; X. Zhou; Y. Su; H. Wang; R. Yu; S. Zhou, Science of the Total Environment, 795 (2021) 148902.
[2] H.A. Özen; T. Mutuk, Environmental Pollution, 367 (2025) 125536.
[3] Y. Jiang; L. Lu; C. Du; Y. Li; W. Cheng; H. Bi,G. Li; M. Zhuang; D. Ren; H. Wang; X. Ji, Frontiers in Bioengineering and Biotechnology, 10 (2023) 1105710.
[4] A.P. Abad López; J. Trilleras; V.A. Arana; L.S. Garcia-Alzate; C.D. Grande-Tovar, RSC Advances 13 (2023) 7468.
[5] S. O'Brien; C. Rauert; F. Ribeiro; E.D. Okoffo; S.D. Burrows; J.W. O'Brien, X. Wang; S.L. Wright; K.V. Thomas, Science of the Total Environment, 874 (2023) 162193.

3D printed Modular Ultrafiltration Systems for Small-Scale and Custom Applications

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Membrane separation processes, in particular ultrafiltration, have gained increasing importance in a wide range of areas, including wastewater treatment, drinking water purification, and in the pharmaceutical, biotechnology, food, cosmetic, biofuel, and biomedical industries. One of the main advantages of this technology lies in its low energy consumption, ease of scaling up, and integration into other separation processes [1,2].

Given the wide variety of potential applications, it is necessary to adapt both permeation configurations and membrane characteristics to meet specific needs. In addition, optimization of operating conditions on a small scale is often required. For this reason, the availability of a small-scale, customized permeation unit for each sample is essential, especially in cases involving limited sample volumes (such as in the concentration of bioactive compounds), which may not be compatible with large-scale ultrafiltration systems. In addition, applications involving compound fractionation may require the use of more than one permeation cell equipped with membranes with distinct properties. Using additive manufacturing technology, it is possible to overcome the challenges mentioned before [3,4].

In this work, we developed a modular permeation cell design that enables process scalability and flexible system configuration, accommodating diverse sample types and variable volumes to meet both industrial and research demands.

Acknowledgments: We are grateful to IPL/IDI&CA2024/3DPUFCells _ISEL and FCT/MCTES UIDB/04540/2020, UIDP/04540/2020 (CeFEMA)) for financial support.

References:

[1] A. Janeca; F.S.C. Rodrigues; M.C. Gonçalves; M. Faria, Membranes, 11 (2021) 825.
[2] S. Ramos Cabral; B. Monjardino de Brito de Azevedo; M. Pereira da Silva; A.S. Figueiredo; A.P. Louro Martins; M.N. de Pinho, Journal of Membrane Science and Research, 5 (2019) 172.
[3] R. Tan; M. Franzreb, Biotechnology and Bioengineering, 117 (2020) 654.
[4] L.D. Tijing; J.R.C. Dizon; I. Ibrahim; A.R.N. Nisay; H.K. Shon; R.C. Advincula, Applied Materials Today 18 (2020)

Can PET and PE microplastics be used as remediation agents for metal pollutants?

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Polyethylene (PE) and polyethylene terephthalate (PET) microplastics (MPs) are commonly regarded as pollutants and vectors of environmental contamination due to their capacity to adsorb metals [1,2] and other contaminants [2]. Considering that capacity and that most of those studies were done using artificial or solutions with low metal concentrations, this study aims to explore their potential reuse as remediation agents by assessing their capacity to adsorb metals from industrial metal-bearing effluents. PE and PET were selected because they are among the most demanded plastics worldwide, differing by the presence of an ester functional group in PET, in which the oxygen atom containing non-bonding electrons can theoretically act as a spot for metal adsorption, thus allowing a comparison of the surface functionality in the adsorption process. Two MPs sources were used to reflect theoretical and applied perspectives: pristine pellets and films derived from post-consumer plastic products, namely PET bottles and PE plastic bags. The isoelectric point (pI) of the PE pellets was observed at approximately pH 1.9, while the pI of the PET pellets was determined to be around pH 4.6. Two effluents were tested: acid mine drainage from the São Domingos mine area and industrial wastewater from a zinc electroplating facility. Batch experiments were conducted under controlled conditions. Metal concentrations were measured by atomic absorption spectroscopy, except for aluminium, which was analysed using microwave plasma atomic emission spectroscopy. Fourier-transform infrared spectroscopy (FTIR) was performed on the MPs surface before and after exposure to detect possible chemical alterations and surface interactions. The results did not show significant metal adsorption by either polymer under the tested conditions. FTIR analysis also indicated minimal or no detectable surface modifications. These findings suggest that, although conceptually promising, the use of PE and PET MPs as remediation agents may have limited effectiveness in real effluent contexts. This study contributes to a more critical understanding of possible MPs reuse in environmental applications and highlights the importance of testing them under more complex conditions.

Acknowledgments: This study received Portuguese national funds from FCT - Foundation for Science and Technology through projects UIDB/04326/2020 (DOI:10.54499/UIDB/04326/2020) and LA/P/0101/2020 (DOI:10.54499/LA/P/0101/2020). S. Bortolotti acknowledges the European Commission for her scholarship and support of the *Erasmus Mundus* Master in Chemical Innovation and Regulation (ChIR).

References:

[1] V. Godoy; G. Blázquez; M. Calero; L. Quesada; M. A. Martín-Lara, Environmental Pollution, 255 (2019) 113363.

[2] M.V. Zambrano-Pinto; R. Tinizaray-Castillo; M.A. Riera; N.R. Maddela; R. Luque; J.M. Rodríguez Díaz, Science of The Total Environment, 908 (2024) 168244.

Identification of toxic metals in dust pollution in a large urban agglomeration

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This paper presents the results of measurements of PM2.5 dust emissions from a point source of pollution in a large urban agglomeration of Krakow: the ArcelorMittal Poland plant. Toxic metals were identified in PM2.5 dust samples using a microwave-induced argon plasma atomic emission spectrometer - Agilent 4200 MP-AES. Each sample was analysed three times to ensure reliable results. The dust was shown to contain the elements nickel, arsenic, cadmium and lead. The highest concentrations of dust pollutants were associated with stable atmospheric conditions and low rainfall in the area. It is worth noting that, in the case of the ArcelorMittal Plant, the integrated permit decision of 26 October 2021 does not specify a pollution limit for arsenic and cadmium, despite the fact that their emissions occur in the steel and sheet metal production facilities. The lack of standards may increase uncontrolled emissions of harmful elements, so it is necessary to include arsenic and cadmium in the content of the document. The presence of cadmium in the air is linked to the production of sheet metal at the ArcelorMittal site, where advanced metallurgical processes are used. This poses a serious risk to human, animal and plant health due to its easy accumulation in the environment. Based on the Sustainability Report published by ArcelorMittal Poland, annual emissions of PM2.5 from the Plant were found to be less than 22 tonnes. The identification of toxic metals in particulate matter is of strategic importance in managing air quality and informing the public about episodes of increased health risk.

References:

[1] Integrated permit 2022. Marszałek Województwa Małopolskiego, decision of 4 August 2022, case no: SR-II.7222.2.10.2020.BK, concerning the amendment of the integrated permit for the installation of ArcelorMittal Poland SA Branch in Kraków [in Polish].
[2] Sustainability Report 2022. ArcelorMittal Poland [in Polish].

The theoretical description for sucralose and bisphenol A electrochemical detection in packed dietetic beverages

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The report, published in September 2023 by the European Commission [1], indicates the clear growth in the consumption of hazardous plastics based on polyesters, including bisphenol polyterephthalates and polycarbonates. Bisphenols [1] constitute a group of biphenolic compounds, which are often used as monomers in these plastics, but are dangerous for health and the environment. All bisphenols act in the body as xenoestrogens, causing hormonal alterations. Among them bisphenol A is the most used. On the other hand, sucralose [2], coded under the number E955, is one of the most widely used sweeteners in the world. It is considered one of the sweetest sweeteners in the world, being 2 times sweeter than saccharin, 3 times sweeter than aspartame and up to 1000 times sweeter than baking sugar. Unlike the synthetic sweeteners mentioned, sucralose has an expressly intense sweetness, because its structure is based on that of true carbohydrates (Fig. 1 on the right). This sweetness is also associated with a lower number of hydrogen bonds possible for sucralose compared to natural carbohydrates. Nevertheless, due to highly expressed genotoxicity and ecotoxic effect, the development of a method capable of detecting sucralose rapidly and precisely is really up to date.

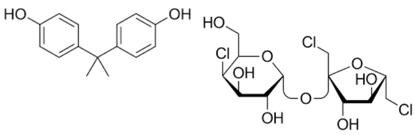

Figure 1. Bisphenol A and sucralose.

In this work, the possibility of electroanalytical detection of sucralose in the presence of bisphenol A is evaluated. The detection is carried out in neutral medium by CoO(OH)-modified anode and in different ways depending on CoO(OH) use as redactor or oxidant. The analysis of the corresponding mathematical model confirms the efficiency of the anodic oxidation of both sucralose and BPA in packed dietetic drinks.

Acknowledgments: Volodymyr V. Tkach acknowledges Faculdade de Engenharia da Universidade do Porto and Universidade de Trás-os-Montes e Alto Douro for their support in difficult times for Ukraine and its science

References:

[1] EFSA CEP Panel *et al.*, EFSA Journal, 21(4) (2023) 6857.
[2] J.F. Aguayo-Guerrero; L.F. Méndez-García; H. Solleiro-Villavicencio; R. Viurcos-Sanabria; G. Escobedo, Life, 14 (2024), 323.

Almond Skin as a Sustainable Resource for the Green Synthesis of Zinc Oxide Nanoparticles

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Green synthesis of nanoparticles has emerged as a sustainable and environmentally friendly alternative to conventional chemical and physical production methods. This approach utilizes biological agents - such as plant extracts, bacteria, or fungi - as natural reducing and stabilizing agents, thereby eliminating the need for hazardous chemicals and energy-intensive processes. Consequently, green synthesis offers notable advantages, including lower toxicity, improved biocompatibility, and reduced environmental impact. These features make it particularly suitable for applications in biomedicine, pharmacology, agriculture, and environmental remediation.

Zinc oxide nanoparticles (ZnO NPs) have attracted significant attention in biological applications due to their antibacterial, antifungal and antidiabetic properties, with various plant species explored for their synthesis. In the present study, almond skin - a by-product of almond processing - was employed as a reducing agent for the green synthesis of ZnO NPs using an aqueous extract, sodium hydroxide, and zinc acetate solution at room temperature. The synthesized nanoparticles were characterized by X-ray diffraction (XRD), ultraviolet-visible (UV-Vis) spectroscopy, and antioxidant activity using the DPPH method. XRD analysis revealed clear differences between the almond skin and the resulting nanoparticles, confirming the successful formation of ZnO NPs, although the data also indicated that the nanoparticles were not fully crystalline. Additionally, the UV-Vis absorbance spectrum (220-700 nm) showed two distinct peaks characteristic of ZnO NPs, further supporting the effectiveness of the green synthesis approach. However, the antioxidant activity of the ZnO NPs was relatively low compared to similar studies.

Overall, this study demonstrates the potential of almond skin as a viable raw material for the green synthesis of ZnO nanoparticles, although further optimization of the synthesis parameters is necessary to enhance their properties and functionality.

Acknowledgments: This work is supported by National Funds by FCT - Portuguese Foundation for Science and Technology, under the projects UID/04033/2023: Centre for the Research and Technology of Agro-Environmental and Biological Sciences and LA/P/0126/2020 (https://doi.org/10.54499/LA/P/0126/2020).

Lightweight Concrete from Alkali Activated Municipal Solid Waste Incineration Slag for Thermal Insulating Panels

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The present study aimed at the development of more sustainable and eco-friendlier lightweight geopolymer concrete (density ≤ 1200 kg/m3), cured at ambient temperature, to produce thermally insulated panels. The precursor selected was a bottom ash (BA) from the incineration of Municipal Solid Waste (MSW), which was alkali activated with Na2SiO3. An expanded clay was used as the coarse aggregate. The final product obtained was a highly porous, lightweight and low thermal conductivity geopolymer concrete. The weight decrease was achieved by including the expanded clay and the bottom ash as substitutes for the denser natural aggregates. Some of the most influential parameters – liquid-to-solid-ratio, cement to fine-aggregate ratio, cement to coarse aggregate ratio – on the mechanical and thermal properties of the concrete were evaluated. Compressive strength between 1.7 and 3.9 MPa and thermal conductivity between 1.062 and 0.15 W/m·K were obtained, with a porosity of 45%. The material developed showed elevated potential for the manufacture of wall bricks, with high thermal insulation and moderate compressive strength, capable of replacing conventional bricks for the construction industry.

Table 1. Compressive strength, density and porosity results.

ID	UCS (MPa) 28d	Density (kg/m^3)	Porosity
AMS0.6	1.66	1211.456	41.28
AMS0.5	2.93	1119.651	42.20
AMC1	3.2	1123.585	46.20
AMC0.5	3.93	1205.153	42.49
AMF1.5	3.53	1167.07	43.39
AMF2	3.43	1148.908	44.88

Figure 1. General view of the slump tests, showing the workability of the AFM2 (a) and control (b) pastes.

Synthesis of Fluorescent Carbon Nanomaterials from Grape Pomace for Biomolecule Detection

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Portugal has a long tradition in wine production, with centuries of history. Vineyards are cultivated across various regions of the country, from north to south, each with their own identity shaped by climate and soil characteristics. The Douro region is internationally recognized, particularly for its Port Wines, while Alentejo stands out for its bold and aromatic reds [1].

With large-scale wine production comes a substantial volume of residues, such as grape pomace (GP), a subproduct produced after pressing the grapes to extract the juice. This material is mainly composed of leftover pulp, skins, seeds, and stems [2-4]. Despite often being considered waste, GP is rich in compounds with significant nutritional and industrial value. Its composition changes, depending on the grape variety, processing method, and fermentation time, but it typically contains high levels of fiber, polyphenols, natural pigments, and minerals. For these reasons, GP has a wide range of potential applications and plays an important role in supporting a circular economy [2-4].

Carbon nanomaterials (CNMs) represent an important group of carbon-based materials with complex structures, *quasi*-spherical morphology, and a diversity of functional groups on their surfaces. Using low-cost raw materials and simple, sustainable methods, it's possible to produce fluorescent CNMs with unique morphological, optical and biological properties, including nanoscale size, strong photostability, water solubility, biocompatibility, and low toxicity. These features make them highly attractive for a range of applications, particularly in bioimaging and biosensing [5,6].

In this work, we present the results on the synthesis of fluorescent CNMs from GP (CDGP) via hydrothermal carbonization using conventional heating. We also explore their potential for detecting biomolecules, specifically, heme proteins. Early findings are promising, suggesting strong potential for clinical diagnostic applications. Ongoing work is focused on investigating their selectivity toward other biomolecules.

Acknowledgments: We are grateful to FCT/MCTES (UIDB/00616/2020 and UIDP/00616/2020).

References:

[1] A.I. de Almeida Costa; C. Marano-Marcolini; M. Malfeito-Ferreira; V. Loureiro; Foods, 10 (2021) 979.
[2] C. Wang; Y. You; W. Huang; J. Zhan; Food Chemistry: X, 24 (2024) 101845.
[3] M. Spinei; M. Oroian; Foods, 10 (2021) 867.
[4] A. Karastergiou; A-L. Gancel; M. Jourdes; P-L. Teissedre; Antioxidants, 13(9) (2024) 1131.
[5] Q. Wang; X. He; Y. Lyu; J. Wang; L. Wang; S. Yang; A. Yan; S. Wang; P. Guo; M. Wang; Y. Li; H. He; F. Huang; G. Chen; Materials Today Communications, 44 (2025) 111824.
[6] A.I. Costa; P.D. Barata; B. Moraes; J.V. Prata; Chemosensors, 10 (2022) 113.

Carbon Dots Derived from Agroindustrial Wastes: Enhancing Cellulose Acetate Membranes for Water Treatment Applications

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Recently, there has been significant interest in the research and development of carbon dots (C-dots) due to their outstanding properties. These include exceptional optical characteristics, photostability, water solubility, low toxicity, biocompatibility, and antimicrobial activity. These features make C-dots highly versatile, with applications across several fields, namely medicine, biotechnology, electronics, environmental science, and renewable energy [1]. Agroindustrial waste, such as fruit peels, olive bagasse, and agricultural residues, can be used as abundant and sustainable carbon sources for synthesizing C-dots, reducing waste, and promoting a circular economy [2].
The integration of C-dots into cellulose acetate (CA) membranes represents a significant advancement in membrane technology, offering enhanced functional properties for various applications, particularly in water treatment and separation processes. By incorporating C-dots into CA membranes, improvements in hydrophilicity and permeability can be achieved, leading to increased water flux and enhanced pollutant rejection rates [3,4].
This study explores the incorporation of C-dots synthesized from agro-industrial waste into CA membranes. The C-dots and the C-dot-modified membranes will be evaluated for their effectiveness in environmental remediation, specifically in removing organic dyes from water effluents.

Acknowledgments: We are grateful to IPL/IDI&CA2024/CN2NDots_ISEL and FCT/MCTES (UIDP/04035/2020: https://doi.org/10.54499/UIDB/04035/2020 (GeoBioTec); UIDB/00616/2020 and UIDP/00616/2020 (UTAD); UIDB/04540/2020, UIDP/04540/2020 (CeFEMA)) for financial support. We acknowledge Agromontenegro for the supply of chestnut waste.

References:

[1] D. Ozyurt; M.R. Kobaisi; K. Hocking; B. Fox, Carbon Trends, 12 (2023) 100276.
[2] I.K. Tetteh; I. Issahaku; A.Y. Tetteh, Carbon Trends, 14 (2024) 100328.
[3] M.L.X. Li; M. Jiang; X. Liu; Z. Chen; S. Wang; T.D. James; L. Wang; H. Xiao, Chemical Engineering Journal, 399 (2020) 125741.
[4] L. Yang; J.C. Jackson; C.H.M. Camargos; M.T. Maia; D.S.T. Martinez; A. Jardim de Paula; C.A. Rezende; A.F. Faria, ACS Applied Nano Materials, 7 (2024) 1477.

Design of Experiments in the Optimization of Sustainable Synthesis of Carbon Nanomaterials from Chestnut Waste

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Portugal is one of Europe's foremost producers of chestnuts, with the chestnut industry playing a crucial role in the country's agricultural sector, particularly in the Trás-os-Montes and Beira Interior regions [1]. The processing of chestnuts generates large quantities of agro-industrial waste, including shells, husks, and various biomass residues. These by-products are often underutilized, despite their rich carbon content and significant potential for valorization [2]. Exploiting these waste materials for value-added products, such as carbon-based nanomaterials, represents a sustainable approach to waste management and circular economy development in the agri-food sector [3].

The application of experimental design (Design of Experiments, DoE) techniques for synthesizing carbon-based nanomaterials through hydrothermal processes has emerged as a highly effective approach to enhance production conditions and optimize material properties [4,5]. This work investigates the integration of statistical experimental design to streamline the synthesis of carbon nanomaterials derived from chestnut industry residues, thereby adding value to agro-industrial waste and fostering advancements in sustainable nanotechnology. By systematically varying parameters such as temperature, reaction time, and precursor concentration, we identified optimal conditions that help the formation of nanostructures with tailored morphological, optical, and biological properties [6]. The synthesized materials were characterized using FTIR, UV-Vis, and steady-state fluorescence spectroscopies, highlighting their promising potential in medical sciences, catalysis, and environmental remediation. These findings underscore the effectiveness of experimental design in maximizing yield and performance while reducing resource consumption in the eco-friendly synthesis of carbon nanomaterials.

Acknowledgments: We are grateful to IPL/IDI&CA2024/CN2NDots_ISEL and FCT/MCTES (UIDP/04035/2020: https://doi.org/10.54499/UIDB/04035/2020 (GeoBioTec); UIDB/00616/2020 and UIDP/00616/2020 (UTAD); UIDB/04540/2020, UIDP/04540/2020 (CeFEMA)) for financial support. We acknowledge Agromontenegro for the supply of chestnut waste.

References:

[1] M. Braga; S.S. Araújo; H. Sales, R. Pontes; J. Nunes, Agriculture, 13 (2023) 1629.
[2] M.Â. Rodrigues; J.C.M. Barreira; I.C.F.R. Ferreira; A. Bento, Revista de Ciências Agrárias 2 (2020) 57.
[3] A.I. Costa; P.D. Barata; B. Moraes; J.V. Prata, Chemosensors, 10 (2022) 113.
[4] A. Rigoulet; T.Rafaïdeen; C. Coutanceau; T.W. Napporn, ChemElectroChem, 11 (2024) e202400189.
[5] D.H.H. Nguyen; A. Muthu; H. El-Ramady; A. Béni; J. Prokisch, Journal of Food Composition and Analysis, 132 (2024) 106347.
[6] F. Arcudi; L. Đorđević; M. Prato, Accounts of Chemical Research, 52 (2019) 2070-2079.

Potential for nitrogen mineralization in hydrochar and process water from *Nannochloropsis* sp.

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The role of organic fertilizers in enhancing nutrient availability for plant growth and promoting environmental health has been widely studied. Thermochemical processes have been explored as a sustainable method of producing added-value products that could improve soil characteristics and mitigate the depletion of available nutrients. Hydrothermal carbonization (HTC) converts biomass into two main products: hydrochar, a carbon-rich solid, and process water, an aqueous phase rich in organic compounds. Hydrochar can effectively improve soil quality while the process water may be used as a soil fertilization complement. Prior to this study, hydrochar and process water were produced from *Nannochloropsis* sp. biomass using a batch reactor. A circumscribed central composite design (based on a 2^3 factorial design previously studied) was performed to optimize the parameters and obtain a solid material with approximately 10 % higher carbon content than the feedstock. An anaerobic soil incubation experiment was then conducted to assess potential mineralization of nitrogen (PMN) [1]. Four different treatments were applied to the soil, each with four replications: a control treatment, with no material application, and individual applications of *Nannochloropsis* sp. biomass, hydrochar, and process water. The ammonium nitrogen concentrations were analyzed on days 0 and day 7 of the incubation period to determine the potential mineralization of nitrogen. Our results showed that, compared to other treatments, microalgal biomass application led to a higher mineralization of nitrogen on day 7. It was also observed that the potential mineralization of nitrogen in the hydrochar application was lower than in the process water. Accordingly, PMN values were 0.56, 2.58 and 15.82 % for hydrochar, process water and microalgal biomass, respectively. These values represent the proportion of organic nitrogen that has been mineralized. In conclusion, *Nannochloropsis* sp. microalgal biomass demonstrated effective short-term nitrogen mineralization. However, both hydrochar and process water show promise as long-term sources of mineral nitrogen. Further studies are necessary to validate this potential and assess nitrogen retention and emissions in other forms.

Acknowledgments: PhD Scholarship (reference: 2022.12319.BD) and LEAF project UIDB/04129/2020 both funded by FCT. Elemental analysis of hydrochar were performed in the Laboratory of Biofuels and Biomass (LBB), an Accredited Laboratory according to NP EN ISO/IEC 17025:2018, at LNEG (Lisbon, Portugal). *Nannochloropsis* sp. biomass was provided by the company A4F, SA – Algae For Future.

References:

[1] D. Fangueiro; R. Bol; D. Chadwick, Journal of Plant Nutrition and Soil Science, 171 (2008) 313.

Assessing the recycling of a petrochemical catalyst waste into ceramics to enable sustainable environmental remediation

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The desulphurization of petroleum fractions is mainly performed by the catalytic reaction of hydrogen with sulphur compounds in a process known as hydrodesulphurization (HDS), which allows to remove up to 99% of the sulphur from oil. Reducing the sulphur content to the maximum permissible level (10 ppm) can only be achieved by using catalysts specifically designed for the HDS process. Metal-based catalysts, such as Co-Mo, Ni-Mo and Ni-W, supported on alumina/silica have proven to be highly efficient due to their high selectivity and high capacity for hydrogenation of aromatic rings [1]. HDS catalysts degrade over time and cannot be regenerated, resulting in waste consisting of the catalytic support, which is classified as hazardous waste by the US EPA. The sustainable management of the spent HDS catalysts must be addressed to valorize the 150–170 Kt/year of worldwide catalyst waste [2].

In the framework of the circular economy, catalyst wastes from the petrochemical industry could be an alternative raw material for the manufacture of silicate-based ceramics. Of these materials, those based on mullite ($3Al_2O_3 \cdot 2SiO_2$) may be a suitable option for the valorization of HDS catalyst waste. Mullite is characterized by its excellent technological properties, such as low coefficient of thermal expansion, resistance to high temperatures and ability to resist thermal shock, among others [3].

In this context, the crystalline transformation of an amorphous Ni-Mo catalyst waste when subjected to high temperatures has been studied. Thus, at 1150 °C the Ni-Mo waste develops crystalline phases, including mullite, corundum, aluminum phosphate, berlinite, cristobalite and powellite. As the temperature increases, the mullite and corundum content increases. Rietveld refinement reveals that the highest mullite (50%) and lowest amorphous content (4%) is achieved at 1200 °C.

The alumina/silica ratio (6.8) in the Ni-Mo waste exceeds the stoichiometric ratio of mullite (Al_2O_3/SiO_2=2.5), meaning that the alumina excess remains unreacted and crystallize as corundum. To favor the exclusive formation of mullite, 6, 12, 18 and 25 wt.% of amorphous silica were added to the waste. After thermal treatment at 1200 °C, the highest mullite content is reached with the addition of 12 wt.% of amorphous silica, yielding 64% mullite, 12% corundum and only 3% of amorphous content. SEM studies reveal a clear transformation from plate-like corundum crystals with tabular morphology and well-defined edges, to elongated mullite crystals with acicular and prismatic morphology.

Overall, the results demonstrate that the Ni-Mo waste, when suitably combined with silica, can be effectively converted into a mullite-rich material using short thermal cycles, providing a valuable route for both waste valorization and advanced ceramic synthesis.

References:

[1] L.A. Lozano; Y. Díaz; Y. Joaquín; L. Brito, Revista de La Facultad de Ingeniería U.C.V 27, (2012) 70.

[2] P. Dufresne, Applied Catalysis, 322 (2007) 67.

[3] C. Aksel, Ceramic International, 29 (2002) 183.

Innovative Food Packaging Materials with Pullulan and Essential Oils

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The extensive use of synthetic plastics in food packaging has raised serious environmental concerns due to their non-biodegradable nature and the growing accumulation of plastic waste in ecosystems. As consumer awareness and regulatory pressure increase, there is an urgent demand for sustainable alternatives that can ensure food safety while reducing environmental impact. In this context, biopolymer-based films have emerged as promising candidates, with pullulan - a natural, biodegradable polysaccharide - standing out for its film-forming ability and transparency. To enhance the functionality of these films, essential oils (EOs) have been incorporated as natural active agents, to yield active packaging that offer antioxidant and antimicrobial properties to extend food shelf life. In this context, the main goal of this work was to develop pullulan films incorporating two EOs - *Lavandula hybrida* (lavandin) and *Cymbopogon martinii* (palmarosa). The obtained results indicated that the EOs incorporation influenced the grammage and thickness of the pullulan films, depending on the preparation methodology. In films prepared solely with pullulan and glycerol, *L. hybrida* EO increased its grammage (from 77.29 to 81.52 g/m²) and thickness (from 52.70 to 56.70 µm), possibly due to its interference with the compaction of the polymer matrix. In contrast, the other methodology used for *C. martinii* EO, which includes Tween 40 and xanthan gum, showed the opposite effect (both grammage and thickness decreased). This result may be related to improved EO emulsification, leading to a more compact and homogeneous matrix with reduced air entrapment. Films containing the EOs showed reduced elongation at break, tensile index and elastic modulus, indicating that the EOs interfered with the hydrogen bonding between pullulan chains, loosening the polymer matrix structure and creating discontinuities that compromise the material's strength and elasticity. All the films presented high transparency with values above 90%, making them suitable for packaging applications requiring good product visibility. The antioxidant activity of the films was evaluated using DPPH and β-carotene bleaching assays. The films demonstrated antioxidant activity, with inhibitions of 1.73% and 3.66% in the DPPH assay, and 29.37% and 52.01% in the β-carotene assay, respectively. The antimicrobial activity of the films was evaluated against several microorganisms on the agar surface. The films containing *L. hybrida* EO reduced the growth of *Staphylococcus aureus*, *Candida tropicalis*, and *Bacillus cereus*. Films with *C. martinii* EO demonstrated a broader antimicrobial effect, including visible reductions in *S. aureus*, *Klebsiella pneumoniae*, and inhibition zones against *Escherichia coli* (6 mm), *Candida albicans* (6.10 mm), *Candida tropicalis* (6.41 mm), *Acinetobacter baumannii* (6.15 mm), *Listeria monocytogenes* (6 mm), *Enterococcus faecalis* (10.18 mm), and *Bacillus cereus* (6.97 mm).

Acknowledgments: Ester Ferreira acknowledges a cotutelle PhD fellowship from Fundação para a Ciência e a Tecnologia (Reference: 2024.11513.PRT) within the scope of UNITA Alliance.

Antifungal behavior of bio-based plasterboard composites: Integrating natural silkworm cocoon fibers to enhance indoor hygiene in healthcare buildings

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The rising incidence of fungal contamination in hospital environments poses a significant risk to immunocompromised patients and challenges existing hygiene protocols. Conventional wall coatings often lack long-term antifungal efficacy without relying on chemical biocides, which can raise health and environmental concerns. In this study, a novel composite material was developed by incorporating natural silkworm cocoon fibers into plasterboard, aiming to reduce fungal proliferation on indoor surfaces. Silk is a biopolymer rich in fibroin and antimicrobial peptides such as seroins, both known for their resistance to microbial colonization [1,2]. The composite plasterboard was evaluated against commercial products following standards procedures (EN 1015-11 and EN 1015-18) [3,4], assessing mechanical strength, water absorption by capillary, thermal behavior, flame resistance, and biological susceptibility to *Cladosporium halotolerans,* a common indoor fungus associated with allergic responses. Despite a decrease in flexural strength, the natural silk plasterboard (NSP) showed improved fire resistance and thermal insulation properties. After 30 days of incubation under controlled humidity and temperature, the NSP samples exhibited notably less fungal growth compared to control samples, suggesting a potential antifungal effect [5]. These results align with public health recommendations encouraging the replacement of toxic biocides with safer, bio-based alternatives [6]. This research highlights the potential of natural fibers like silk to enhance the performance and sustainability of construction materials in healthcare buildings, contributing to better indoor air quality, and infection control.

Acknowledgments: This work was supported by National Funds from FCT - Fundação para a Ciência e Tecnologia through project UIDB/00616/2025 and UIDP/00616/2025 for the Unit Institute CQ-VR.

References:

[1] Z. Dong; Q. Xia; P. Zhao, International Journal of Biological Macromolecules, 224 (2023) 68.
[2] Y. Qi; H. Wang; K. Wei; Y. Yang; R-Y. Zheng; I.S. Kim; K-Q. Zhang, International Journal of Biological Macromolecules, 18(3) (2017) 237.
[3] European Committee for Standardization (CEN), EN 1015-11:1999 - *Methods of test for mortar for masonry - Part 11: Determination of flexural and compressive strength of hardened mortar*, Brussels, 1999.
[4] European Committee for Standardization (CEN), EN 1015-18:2002 - *Methods of test for mortar for masonry - Part 18: Determination of water absorption coefficient due to capillary action of hardened mortar*, Brussels, 2002.
[5] F. Pietsch; A.J.O'Neill; A. Ivask; H. Jenssen; J. Inkinen; A. Kahru; M. Ahonen; F. Schreiber, Journal of Hospital iInfection, 106(1) (2020) 115.
[6] European Commission, Public Health - *Biocides Overview* [Online]. Available: https://health.ec.europa.eu/biocides/overview_en.

Evaluation of the Antimicrobial Activity of Glycerol Salicylate Against Different Pathogens and Study of Its Hemolytic Activity

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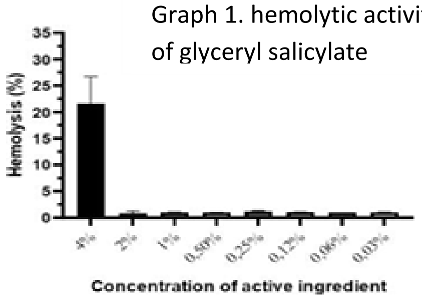
Glyceryl salicylate is widely studied and used in endodontic cements due to its antimicrobial properties [1; 2]. However, there are no reports of its hemolytic activity, a crucial factor for its safety in biomedical applications. This study evaluated its antimicrobial activity against different microorganisms using the Alamar Blue method and investigated its hemolytic potential (Graph 1). The compound showed antimicrobial efficacy against *S. typhimurium, S. agalactiae* (MIC 1.75 mg), *E. coli* (MIC 1.5 mg), and *S. aureus* (MIC 2 mg), while its hemolytic activity was significant only at high concentrations (4%).

Table 1. Inhibition by glyceryl salicylate using the disk diffusion method



Graph 1. hemolytic activity of glyceryl salicylate

In the hemolytic activity assay (Graph 1), a hemolysis index of 24% was observed at a concentration of 4 mg (4%) of the active ingredient. At lower concentrations, a hemolysis index below 2% was observed, indicating that this is a compound with low hemolytic activity. The results obtained in this study reinforce the potential of glyceryl salicylate as an effective antimicrobial agent, especially against clinically relevant strains such as *S. typhimurium, S. agalactiae, E. coli*, and *S. aureus*. Furthermore, the hemolytic activity assessment demonstrated that the compound presents a satisfactory safety profile, with low hemolysis rates at concentrations below 4%. These findings suggest that glyceryl salicylate is a promising alternative for biomedical applications, such as in endodontic cement formulations, combining antimicrobial efficacy with low hemolytic toxicity.

Acknowledgments: The authors would like to thank the Foundation for Research Support of the State of Minas Gerais - FAPEMIG (Universal Notice), code 0004022, CNPq, CAPES and the Dean of Research and Graduate Studies of the Federal University of the Jequitinhonha and Mucuri Valleys (PRPPG-UFVJM).

References:

[1] F.F. Portella; P.D. Santos; G.B. Lima; V.C.B. Leitune; C.L. Petzhold; F.M. Collares; S.M.W. Samuel, International Endodontic Journal 47(4) (2014) 339.
[2] J. Swanzy, *et al.* Preservative system. United States, 2014 US 20140274974A1.

Ethanol reduction in wine using *Saccharomyces* and non-*Saccharomyces* yeasts: a strategy to address climate change and consumer demand

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Climate change has significantly impacted viticulture, leading to earlier grape ripening and increased sugar accumulation, which results in wines with elevated alcohol levels, reduced acidity, and imbalanced sensory profiles. Concurrently, consumer preferences have shifted toward wines with lower alcohol content, driven by concerns about health and lifestyle. To meet these dual challenges, several technological solutions have been developed, including physical dealcoholization methods such as membrane separation and vacuum distillation. While effective, these approaches are often associated with high operational costs and significant energy demands, which may negatively impact wine aroma and structure.
In this context, biological strategies based on yeast selection have gained attention as sustainable alternatives. Certain non-*Saccharomyces* yeasts, such as *Lachancea thermotolerans*, can reduce ethanol production by redirecting sugar metabolism or increasing organic acid levels, thereby enhancing freshness and balance. Some *Saccharomyces cerevisiae* strains also show reduced ethanol yields under specific fermentation conditions. Understanding ethanol degradation pathways and yeast metabolic versatility may provide novel strategies to adjust wine composition after fermentation, offering new tools to handle climatic pressures.
Therefore, this study aimed to evaluate the effectiveness of selected *Saccharomyces* and non-*Saccharomyces* yeast strains in reducing ethanol content in white wines. The findings demonstrate that utilizing these strains represents a promising and biologically driven solution to address both the challenges posed by climate change and the increasing consumer demand for lower-alcohol wines.

Acknowledgments: The authors acknowledge the financial support provided by Vine & Wine Portugal-Driving Sustainable Growth Through Smart Innovation Project, number 67, AAC: 02/C05-i01/2022, sub-project B1.5.1.- Alcohol a la carte: Reducing alcohol in the wine after fermentation, without any loss of aromas. Financed by the Next Generation EU "Programa de Recuperação e Resiliência (PRR)/Alianças Mobilizadora". This work is supported by National Funds by FCT - Portuguese Foundation for Science and Technology, under the projects UID/04033: Centro de Investigação e de Tecnologias Agro-Ambientais e Biológicas and LA/P/0126/2020 (https://doi.org/10.54499/LA/P/0126/2020).

Comparative Study of Volatile Flavor Profiles and Physicochemical Traits in Organic vs. Conventional Pork

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Meat flavor is the main attribute assessed by the consumer when judging meat quality and is strongly associated with the generation of volatile compounds in the meat product. The "flavor" of a meat is deemed to be the combination of flavors and aromas [1] that confer a specific perception to the palate. This study analyzed the volatile compounds responsible for aroma and flavor in pork from the main breeds consumed in Spain: Duroc and white pigs, the latter reared under organic and conventional systems. Volatiles were identified using SPME-GC-MS across three anatomical cuts: ham, loin, and tenderloin. Physicochemical traits such as moisture, pH, and tenderness were also measured, though no significant correlations with volatile profiles were found.

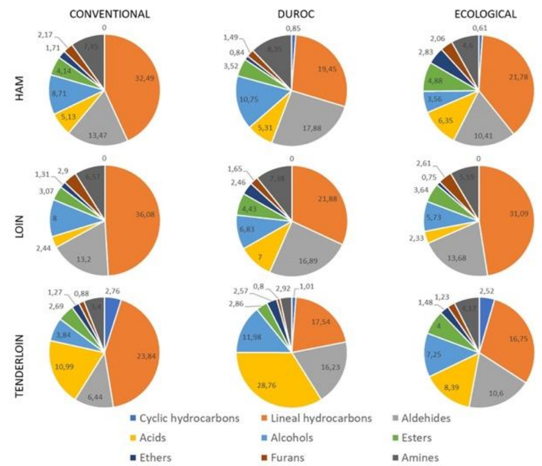

Figure 1. Percentage represented by each family of volatiles set of compounds by SPME-GC/MS.

Duroc samples showed a higher overall content of aldehydes and alcohols (26.8%) - associated with pleasant aromas - compared to white pig samples (17.5%). Among white pigs, organic tenderloin had a greater proportion of these volatiles (17.9%) than conventional ones (10.3%), suggesting enhanced flavor potential. However, in ham, conventional pork had higher levels (22.2% vs. 14.0%).
Principal Component Analysis (PCA) revealed clear associations between certain volatiles and production systems. Discriminant Analysis (DA) using selected volatiles successfully differentiated pork origins, confirming the method's potential for quality control and traceability.

References:

[1] X. Wang; L. Zhu; Y. Han; J. Jin; Y. Cai; H.Wang; Journal of Food Processing and Preservation, 42(2) (2018) 1.

Microalga as raw material for food ingredients: a study on protein extraction and functionality

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The global demand for protein ingredients is increasing, driven by population growth and an emphasis on health and nutrition, particularly regarding protein intake and its sources. Although animal-derived proteins possess high nutritional quality and a complete essential amino acid profile, their production is characterized by low efficiency and significant environmental impacts [1]. Microalgae represent a promising alternative protein source, offering high protein content and a balanced amino acid composition, while requiring substantially less land and water compared to conventional animal protein production systems [2]. The goal of this work was to obtain an aqueous extract from *Tetraselmis* sp. biomass *in* a clean label biorefinery pipeline, test different parameters in this pipeline, and analyze how these parameters impact the soluble protein yield, functionality and color of this extract [3]. Regarding the biorefinery pipeline, *Tetraselmis* sp. biomass was processed in a high-pressure homogenizer (HPH) to optimize the extraction of intracellular compounds, followed by a fractionation process through microfiltration membrane and as drying methods, both spray drying and freeze drying were tested. The soluble protein content in these extracts was analyzed with the modified Lowry method [4]. Regarding protein extraction, *Tetraselmis* sp., showed higher values of extraction for frozen biomass when compared to the spray dried biomass, at a higher concentration of resuspended biomass 10% (m/v), with two cycles of HPH. The best condition of the previous process, passed through the pipeline with two different drying processes in the end. To analyze the impact of this pipeline including the different drying method in the functionality, the water-holding capacity, emulsifying capacity, stability of these emulsions and solubility were tested. The results obtained from the biomass without any treatment and the aqueous extracts obtained showed an improvement in the solubility, emulsifying capacity, and the stability of this emulsion. In conclusion, results showed that using this clean label biorefinery pipeline increased the protein extraction from the studied microalga biomass and had a positive effect on functionality.

Acknowledgments: A special thanks goes to the Food Nutrition Working Group and the invaluable assistance From the Biorefinery team at Greencolab; FCT/MCTES (UIDP/04035/2020: https://doi.org/10.54499/UIDB/04035/2020 (GeoBioTec).

References:

[1] B. J. Revell, Journal of Agricultural Economics, 66 (2015) 573-614.

[2] E. Colla; D.L. Kalschne; R.A. da Silva-Buzanello; C. Canan; D.A. Drunkler; A.L.L. Menegotto, In Handbook of Algal Science, Technology and Medicine, Ozcan Konur (Eds), Academic Press, 2020, 507.

[3] L. Soto-Sierra; P. Stoykova; Z.L. Nikolov, Algal Research 36 (2018) 175.

[4] O.H. Lowry; N.J. Rosebrough; A.L. Farr; R.J. Randall, Journal of Biological Chemistry, 193 (1951) 265.

How Micro(nano)plastics and a High-Fat Diet Affect Brain Energy and Oxidative Balance in Mice

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Micro(nano)plastics (MNPs) are recognized as environmental pollutants that can impact human health. They can be found in different tissues and organs of the human body, such as the brain. Although the blood-brain barrier provides protection, MNPs can still be transferred and accumulated in the brain, potentially leading to adverse effects on its function. High-fat diets (HFD) may enhance the damage caused by MNPs by increasing the permeability of the blood-brain barrier [1]. Once in the brain, MNPs can trigger several molecular or cellular reactions that can damage the blood-brain barrier, cause oxidative stress, trigger inflammatory responses, affect neurotransmitter activity, and lead to mitochondrial dysfunction, impairing mitochondrial bioenergetics and affecting autophagy. These effects can trigger neurodegenerative changes and neurodevelopmental abnormalities [2]. This work aims to evaluate the impact of exposure to weathered MNP (w-MNP), at two different concentrations, on mice's brain bioenergetics and antioxidant system after ingesting a standard diet and a high-fat diet (42% of the energy value comes from fat). Forty-height mice (Strain: C57BL/6; Sex: Male; 5 weeks old) were randomly divided into six groups (n=4). Half of the groups were fed a standard diet (STD), and the other half a high-fat diet (HFD) for 13 weeks. After 13 weeks, MNPs were incorporated into the diets at two concentrations, low (L) and high (H), for 4 weeks. The experimental groups are Group 1 (Control: animals fed STD without w-MNP); Group 2 (animals fed STD with L-w-MNP); Group 3 (animals fed STD with H-w-MNP); Group 4 (animals fed a HFD without w-MNP); group 5 (animals fed a HFD with L-w-MNP) and group 6 (animals fed an HFD with H-w-MNP). After exposure time, brain samples were collected and processed accordingly. We will present results regarding changes in mitochondrial respiration supported by various substrates, the activity of key enzymes in the antioxidant system and indicators of oxidative stress and the redox state. These findings will help us understand how a hypercaloric diet, similar to a Western diet, may influence the toxicity of micro and nanoplastics on mitochondrial function and the brain's redox state.

Acknowledgments: Mónica G. Silva thanks the Fundação para a Ciência e Tecnologia (FCT), Portugal for the PhD Grant (https://doi.org/10.54499/UI/BD/151320/2021). Thanks are due to Centro de Química de Vila Real for the financial support (https://doi.org/10.54499/UIDB/00616/2020).

References:

[1] G. Davanzo; G. Castro; L. Monteiro; B. Castelucci; V.H. Jaccomo; F. Silva; A. Marques; C. Francelin; B. Campos; C. Aguiar; P. Joazeiro; S. Consonni; A. Farias; P. Moraes-Vieira, Multiple Sclerosis and Related Disorders, (2023) 72.

[2] S. Liu; Y. He; J. Yin; Q. Zhu; C. Liao; G. Jiang, Journal of Hazardous Materials, (2024), 469.

Aromatic Allies: Bioactivity of Essential Oils from Alentejo and Algarve in Functional Bread Development

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Essential oils (EOs), extracted from various parts of aromatic plants, have been used for centuries for their therapeutic properties. These natural compounds remain central in folk medicine across many cultures due to their wide-ranging medicinal benefits, including antioxidant, anti-inflammatory, analgesic, anticancer, hepatoprotective, and neuroprotective effects. As part of the *Albread* project - supported by the Promove 2023 competition and titled *"Aromatic plants from Alentejo, probiotics, and acorn flour in the development of functional bread"* - this study investigates the antioxidant and antifungal potential of EOs sourced from companies in the Alentejo and Algarve regions of Portugal. A total of 21 EOs were evaluated for their antioxidant activity using three complementary assays: DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging, ABTS (2-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)) radical scavenging, and the β-carotene/linoleic acid bleaching method. The results revealed distinct antioxidant profiles among the oils, with good qualitative agreement across the methods. The EOs were also tested for antifungal activity. Their chemical composition was analyzed by gas chromatography-mass spectrometry (GC-MS) to identify and quantify key constituents. This analysis helped establish preliminary links between the EOs' composition and their observed antioxidant and antifungal properties.

Acknowledgments: The authors acknowledge the financial support from the PL23-00025 - ALBread - "Projeto Plantas aromáticas do Alentejo, probióticos e farinha de bolota no desenvolvimento de pão funcional", Projeto I&D Mobilizadores financiado pela Fundação "La Caixa" em parceria com o BPI e a FCT - Fundação para a Ciência e Tecnologia I.P, Programa Promove o Futuro do Interior - Concurso 2023.

Electrochemical characterization of nanocomposites for the oxygen reduction reaction

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The oxygen reduction reaction (ORR) remains a key kinetic limitation in the development of efficient and cost-effective low-temperature fuel cells. This study introduces a novel nanocomposite design for ORR electrocatalysis, based on palladium (Pd) or gold (Au) nanoparticles supported on electrogenerated hydrophilic carbon (EHC) nanomaterials. Two distinct EHC matrices were prepared via electrochemical exfoliation of graphite: one in tartaric buffer (EHC@tartaric), which exhibits strong reducing properties enabling in situ metal ion reduction, and another in phosphate buffer (EHC@phosphate), known for its high oxygen storage capacity [1,2].

The dual functionality of EHC@tartaric, as both a reducing agent and nanoparticle support, was exploited to simplify synthesis while enhancing catalytic dispersion and stability. The resulting nanocomposites are denoted M-EHC@T and M-EHC@T,P, where M represents either Pd or Au, and T and P represent tartaric and phosphate buffer, respectively.

Electrochemical characterization using anodic stripping voltammetry and cyclic voltammetry confirmed the successful formation and immobilization of metal nanoparticles, while revealing distinct differences in catalyst utilization, surface accessibility, and long-term stability of the two nanocomposites formulations.

ORR performance evaluation demonstrated that Pd-EHC@T nanocomposites delivered superior catalytic activity, with higher onset potentials, higher mass activities, and better reproducibility compared to Pd-EHC@T, P. Atomic force microscopy further supported these findings, revealing time-dependent structural reorganization that influenced electrochemical accessibility.

Overall, the results highlight the potential of EHC-based nanocomposites as sustainable, platinum-free electrocatalyst platforms for next-generation fuel cell technologies.

Acknowledgments: Diana Carneiro and Ana S. Viana, from the Faculty of Sciences of the University of Lisbon (FCUL), are gratefully acknowledged for their contribution to the AFM analyses. Fundação para a Ciência e Tecnologia (UIDB/00616/2025, UIDP/00616/2025) and NORTE2020 (project OBTAIN, NORTE-01-0145-FEDER-000084).

References:

[1] A.D. Veloso; A.M. Botelho do Rego; A.M. Ferraria; L.F.V. Ferreira; D.P. Ferreira; P.B. Tavares; R. Videira; A.S. Viana; M.C. Oliveira, ChemElectroChem 4 (2017) 2693-2702.

[2] A.D. Veloso, R. Videira, M.C. Oliveira, Electrochimica Acta 525 (2025) 146071.

Lignocellulosic Biorefinery, production of chemicals, bioenergy, and carbon materials

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Biorefinery can be defined as the compilation of different technologies for the integral and sustainable conversion of biomass raw materials to produce high value-added products, such as biofuels, bioenergy, fertilizers, animal feed, pharmaceuticals, fibers, and materials for industrial and construction applications. These processes have a considerable environmental relevance due to their contribution to minimize the current high dependence of fossil and no renewable resources and to reduce CO_2 emissions. In this context, lignocellulosic biomass, such as wood, cellulose or lignin provide an abundant and renewable raw material that does not compete with food crops, for that, is a very promising feedstock also considering its availability and price. In this work, we present a scheme of an integrated lignocellulosic biorefinery, where different chemical, biochemical, and thermochemical processes are used to produce carbon materials, liquids, and gases, such as hydrogen, syn-gas, or short-chain hydrocarbons, ethanol, methanol, DME, etc.

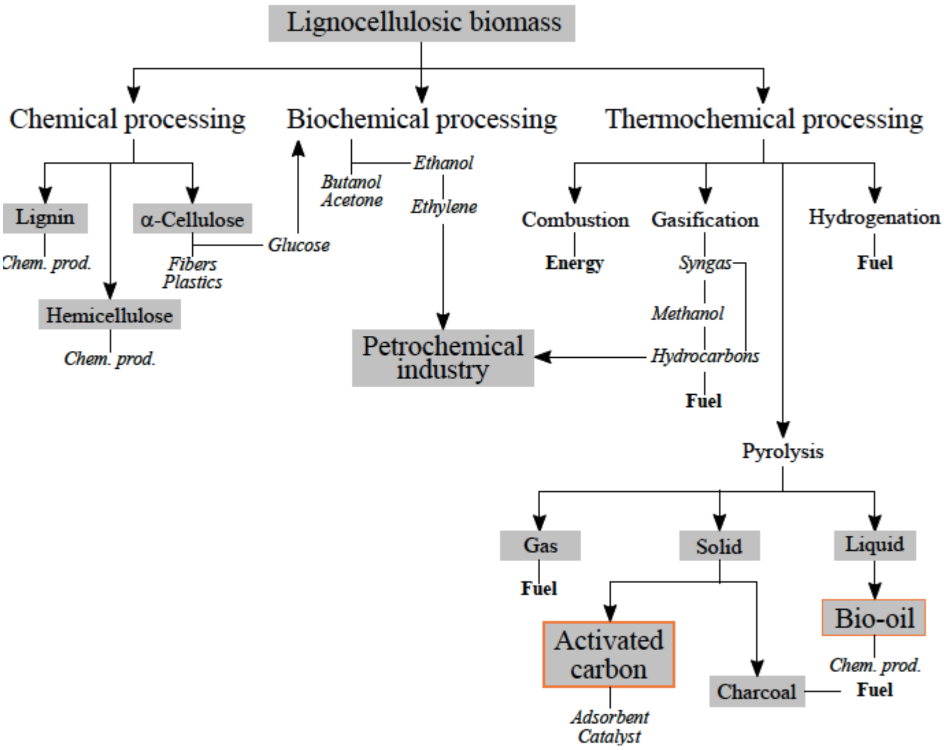

Figure 1. Routes for the valorization of lignocellulosic biomass.

Innovative Integration of Luminescent Carbon Dots into Di-Urea Crosslinked Siloxane Hybrids

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Global warming, driven by fossil fuels and energy-intensive systems, is a major global challenge. In buildings, HVAC systems use 40–60% of energy and contribute about 15% to global demand, partly due to inefficient windows that allow uncontrolled heat transfer [1]. Smart window technologies, especially electrochromic devices (ECDs), offer a sustainable way to reduce energy use. ECDs modulate light transmittance and reflectance with low voltage, enabling dynamic control of solar radiation. This reduces reliance on artificial lighting and HVAC [2].

In this study, we developed a flexible and transparent hybrid xerogel film, d-U'(400), based on a thermally stable di-ureasil matrix (up to 300 °C), and explored its potential as a functional component for future electrochromic devices. The film was doped with carbon dots (CDs), an ionic liquid (IL), and lithium triflate (LiTrif), selected for their complementary roles in enhancing the material's optical and ionic properties. FT-IR and photoluminescence analyses indicate dopant-induced reorganization of the hydrogen-bonding network and enhanced luminescent properties in the doped hybrid films. These findings demonstrate that the tailored optical and structural characteristics of the d-U'(400) system make it a strong candidate for integration into ECD.

Acknowledgments: The work was funded by projects SOLPOWINS – Solar-Powered Smart Windows for Sustainable Buildings (PTDC/CTM-REF/4304/2020)), financed by FCT and FEDER, Systems towards an Intelligent and Green Mobility". The research was also developed within the scope of the A-MoVeR project – Mobilizing Agenda for the Development of Products and Systems towards an Intelligent and Green Mobility (operation 02/C05-i01.01/2022, PC646908627-00000069), approved under the call 02/C05-i01/2022 Mobilizing Agendas for Business Innovation. The authors acknowledge funding from CQ-VR (UIDB/00616/2020 and UIDP/00616/2020) CICECO-Aveiro Institute of Materials (UIDB/50011/2020, UIDP/50011/2020 and LA/P/0006/2020) and Instituto de Telecomunicações (UIDB/50008/2020 and UIDP/50008/2020 and LA/P/0109/2020) financed by national funds through the FCT/MEC (PIDDAC), and FibEnTech-UBI (UIDB/00195/2020), financed by national funds through the FCT/MCTES (PIDDAC). S. C. Nunes and S.F.H.C acknowledges FCT for Assistant Research contract ((2020-00805.CEEIND and (2022.03740.CEECIND), respectively in the scope of Scientific Employment Stimulus.

References:

[1] J.E. González-Cruz, Nature Climate Change 14 (10) (2024) 1018.
[1] S. Wu; H. Sun; M. Duan; H. Mao.; Y. Wu; H. Zhao; B. Lin, Cell Reports Physical Science 4(5) (2023) 101370.
[3] S.C. Nunes; M. Fernandes; H.M.R. Gonçalves; J.L. Serrano; P. Almeida; V. de Zea Bermudez, Journal of Sol-Gel Science and Technology 95(3) (2020) 620.

Sodium electrolytes - can they be viable alternatives for electrochemical devices?

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The range of battery applications includes portable electronics (such as mobile phones, cameras, tablets, and notebooks), transportation (electric and hybrid vehicles), and stationary storage systems. This wide scope highlights the urgent need to develop safe and cost-effective rechargeable batteries. A battery's performance largely depends on its design and chemistry - especially the optimal combination of electrodes and electrolytes. While electrolytes play a critical role in battery performance, they have received considerably less attention than electrodes [1]. One of the key challenges in developing sodium-ion (Na-ion) batteries is identifying a solid electrolyte with sufficient Na^+ ion conductivity and low interfacial resistance at ambient temperature.

The aim of this work is to use the sol-gel method in the preparation of organic/inorganic biohybrid host matrix incorporating short poly(ε-caprolactone) (PCL(530), where 530 is the average molecular weight in g mol^{-1}) segments covalently bonded through an urethane (-NHC(=O)-) group to siliceous domains, doped for the first time with different amounts of sodium bis(trifluoromethanesulfonyl)imide (NaTFSI). According to the nomenclature previously adopted [2] this family of compounds was designated by means of the notation d-PCL(530)/siloxane$_{n'}$NaTFSI, where d means di and n' (composition) corresponds to the number of $(C(=O)(CH_2)_5O)$ repeat units of PCL(530) per sodium ion. The samples, obtained as thin, transparent films have been examined by means of thermogravimetric analysis (TGA), X-ray diffraction (XRD), atomic force microscopy (AFM), polarized optical microscopy (POM) and complex impedance spectroscopy. To evaluate the cation/urethane and cation/anion interactions Fourier Transform Infrared spectroscopy (FT-IR) was employed.

Acknowledgments: This work was funded by CQ-VR (CQVR-UIDB/0616) and developed under the project A-MoVeR - "Mobilizing Agenda for the Development of Products & Systems towards an Intellingent and Green Mobility", operation n.º 02/C05-i01.01/2022.PC646908627-00000069, approved under the terms of the call n.º 02/C05-i01/2022 – Mobilizing Agendas for Business Innovation, financed by European funds provided to Portugal by the Recovery and Resilience Plan (RRP), in the scope of the European Recovery and Resilience Facility (RRF), framed in the Next Generation UE, for the period from 2021 -2026. Thanks to the Electron Microscopy Unit (UME) at UTAD for collecting the XRD data. The authors thank the Fundação para a Ciência e Tecnologia (FCT) for financial support under the framework of Strategic Funding UID/00686: Centro de Química da Universidade do Minho (CQ-UM/UM). NGS-New Generation Storage, C644936001-00000045, supported by IAPMEI (Portugal) with funding from the European Union Next Generation EU (PRR).

References:

[1] J-Y. Hwang; S-T. Myung; Y-K. Sun, Chemical Society Review 46 (2017) 3529.
[2] M. Fernandes; R. Leones; S. Pereira; A.M.S. Costa; J.F. Mano; M.M. Silva; E. Fortunato; V. de Zea Bermudez; R. Rego, Electrochimica Acta 232 (2017) 484.

Structure and ionic conductivity of POP-based di-Ureasil ormolytes doped with $[BMIm]PF_6$

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Organic-inorganic hybrid materials processed by the sol-gel method are promising candidates for solid-state electrolytes in electrochromic devices (ECDs) due to their structural tunability and functional versatility [1]. Our group has been dedicated to the study of a class of compounds, prepared by the sol-gel process, named di-ureasils, which are composed of poly(oxyethylene) [2] and poly(oxypropylene) (POP) [3] chains covalently bonded at both ends to a siliceous backbone by means of urea cross-links. In this work, a family of POP-based di-ureasils, designated as d-U'(Y'), where Y' = 2000 or 4000 $gmol^{-1}$, was synthesized and doped with varying concentrations of the ionic liquid 1-butyl-3-methylimidazolium hexafluorophosphate ($[Bmim]PF_6$).
A characterization of the resulting ormolytes was carried out. Thermogravimetric analysis and differential scanning calorimetry (TGA/DSC) were used to evaluate the thermal stability. Atomic force microscopy (AFM) provided insights into the surface topography and roughness, while X-ray diffraction (XRD) allowed the assessment of structural organization. Fourier-transform infrared spectroscopy (FT-IR) was employed to investigate interactions and confirm the incorporation of $[Bmim]PF_6$ within the hybrid matrix. Wettability was studied via static contact angle measurements, and ionic conductivity was determined using electrochemical impedance spectroscopy (EIS).
The incorporation of $[Bmim]PF_6$ influenced both morphology and ionic conductivity, suggesting a synergistic interaction between the polymer matrix and the ionic species. These results are essential for guiding the formulation of next-generation solid electrolytes.

Acknowledgments: This work was funded by CQ-VR (CQVR-UIDB/0616) and developed under the project A-MoVeR – "Mobilizing Agenda for the Development of Products & Systems towards an Intellingent and Green Mobility", operation n.º 02/C05-i01.01/2022.PC646908627-00000069, approved under the terms of the call n.º 02/C05-i01/2022 – Mobilizing Agendas for Business Innovation, financed by European funds provided to Portugal by the Recovery and Resilience Plan (RRP), in the scope of the European Recovery and Resilience Facility (RRF), framed in the Next Generation UE, for the period from 2021-2026.

References:
[1] C.J. Brinker; G.W. Scherer, Sol-gel science: the physics and chemistry of sol-gel processing, Academic Press, 2013.
[2] P.J. Nunes; R.F.P. Pereira; S. Pereira; M.M. Silva; E. Fortunato; V.D.Z. Bermudez; M. Fernandes, Energies 16(1) (2023) 426.
[3] P.J. Nunes; W. Zając; K. Styszko; S. Pereira; E. Fortunato; V. de Zea Bermudez; M. Fernandes, Solid State Ionics 424 (2025) 116850.

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