Book of abstracts

SLiM 2026

SHELF LIFE INTERNATIONAL MEETING

12th Shelf Life International Meeting
June 8th – 11th 2026

Welcome Message

Dear Colleagues and Friends,

It is our great pleasure to welcome you to **SLIM 2026**, the twelfth edition of the renowned international congress dedicated to advancing knowledge and innovation in the shelf life of packaged foods. This edition will be held at the Faculty of Biology of the University of Santiago de Compostela (USC, Spain). It is organised by the FoodChemPack USC research group in collaboration with the Italian Scientific Group of Food Packaging (GSICA).

Over the years, the SLIM congress has become an important international forum for researchers, professionals, and industry leaders in food science, packaging, preservation technologies, and sustainability. The congress offers a unique opportunity to exchange ideas, discuss emerging challenges, and explore innovative solutions that contribute to safer, higher-quality, and more sustainable food systems.

The scientific programme of SLIM 2026 addresses key topics shaping the future of food shelf life and packaging, including:

- Shelf Life Modelling, Testing and Prediction
- Emerging and Innovative Technologies for Shelf Life Extension
- Sustainable Packaging, Materials Innovation and Safety Issues
- Food Quality, Safety and Shelf Life Interactions
- Policy, Consumer Trends and Sustainability in Shelf Life and Packaging Strategies

This year's congress features a multidisciplinary programme comprising lectures by five distinguished keynote speakers, 28 oral presentations, 18 short oral communications, and 55 poster presentations. Together, these contributions create a vibrant international forum where academia and industry share cutting-edge research and foster collaboration. A curated selection of full contributions will also be published in a Special Issue of *Sustainable Food Technology* (RSC, Q1).

We are especially pleased to welcome more than 100 participants from around the world, including representatives from Belgium, the Netherlands, Tunisia, Italy, Germany, South Korea, Ireland, Colombia, Norway, Portugal, the United States, France, Chile, Turkey, Brazil, and Spain, thereby fostering a truly international environment.

SLIM 2026 has been made possible thanks to the support of the University of Santiago de Compostela (USC), iMATUS, and our sponsors and collaborators: Xunta de Galicia (Consellería de Medio Ambiente y Cambio Climático and Consellería do Mar), Silvateam, Hijos de Rivera, Leboriz, Galicalab, Celta Ingenieros, Proquinorte, Cienytech, Büchi, Jasco, and Thermo Fisher Scientific.

We warmly welcome you to Santiago de Compostela and hope this congress will provide an inspiring environment for scientific discussion, networking, and new collaborations. Beyond the scientific programme, we hope you will also enjoy Galicia's rich culture, history, gastronomy, and hospitality.

We wish you a productive, enriching, and memorable experience at SLIM 2026.

With our warmest regards,

Letricia Barbosa Pereira

Ana Rodríguez Bernaldo de Quirós

Raquel Sendón García

Conference Chairs, SLIM 2026

ORGANIZING COMMITTEE (USC)

Letricia Barbosa Pereira

Ana Rodríguez Bernaldo de Quirós

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SCIENTIFIC COMMITTEE

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María Ángeles Romero Rodríguez, *University of Santiago de Compostela, Spain*

ABBREVIATED SCIENTIFIC PROGRAMME

Monday – June 8th 2026

11:00 Welcome and Registration
12:00 Lunch (at participants own expenses)
13:00 Open Ceremony and Welcome Addresses
13:30 Keynote Lecture
14:00 Oral Session
15:15 Coffee break – Poster Session
19:00 Welcome cocktail at Colegio de Fonseca

Tuesday – June 9th 2026

09:00 Keynote Lecture
09:30 Oral Session
11:15 Coffee break – Poster Session
12:10 Short Oral Session
13:00 Lunch – Poster Session
14:30 Keynote Lecture
15:00 Oral Session
16:15 Coffee break – Poster Session
17:10 Short Oral Session
20:30 Social Dinner at Monasterio de San Francisco

Wednesday – June 10th 2026

09:00 Keynote Lecture
09:30 Oral Session
11:00 Coffee break – Poster Session
11:50 Short Oral Session
13:00 Lunch – Poster Session
14:30 Keynote Lecture
15:00 Oral Session
16:15 Coffee break – Poster Session
17:05 Short Oral Session
18:00 Concluding Remarks
19:00 Cultural Visit Old Town (optional)

Thursday – June 11th 2026

08:00 Post-Conference Visits
13:00 Lunch
15:00 Arrival at Santiago City Center

SCIENTIFIC PROGRAMME
Oral Session

Monday – June 8th 2026	
11:00	***Welcome and Registration***
13:00 – 13:30	**Open Ceremony and Welcome Addresses** ***Inmaculada Otero***, Delegate for the Internationalization Strategy, USC ***Carmen Álvarez***, Director of iMATUS ***Fabio Licciardello***, President of GSICA - ITA ***Letricia Barbosa Pereira***, Chair of the Conference
Session: Shelf Life Modelling, Testing & Prediction *Chairs: Luciano Piergiovanni, Fabio Licciardello*	
13:30 – 14:00	**KEYNOTE LECTURE** **KS01 – Predictive Modelling, AI and Mitigation Strategies for Food Safety and Shelf-Life** ***Ana Sanches Silva**, University of Coimbra, Portugal*
14:00 – 14:15	OC01 – Identification of acceptability limits for shelf life studies by integrating sensory and analytical data: the case study of packed almonds. ***Marika Valentino**, Università degli Studi di Udine, Italy*
14:15 – 14:30	OC02 – Translating Microbial Spoilage Profiling into Predictive Shelf-Life Tool: Accelerating Innovation in Meat Products. ***Anh Linh Nguyen**, Corbion, The Netherlands*
14:30 – 14:45	OC03 – Shelf Life Prediction of Fresh Fish Using Printable CO_2 and pH Colorimetric Sensors Integrated with an Image-Based Web Application. ***Akshay D. Sonawane**, Leibniz Institute for Agricultural Engineering and Bioeconomy, Germany*
14:45 – 15:00	OC04 – Effect of gelatine-based emulsion packaging enriched with sunflower or olive oil on the sensory quality and aromatic profile of fresh truffles during storage. **Sara Vega-Diez,** *Agri-Food Institute of Aragon – CITA- University of Zaragoza, Spain*
15:00 – 15:15	OC05 – Unraveling the Interactions Between Quality, Safety, and Composition to Predict Shelf-Life stability in grape by-products kombuchas. ***Íker Pérez Berdor**, Agri-Food Institute of Aragon – CITA- University of Zaragoza, Spain*
15:15 – 16:00	Coffee break – Poster Session
19:00	***Welcome cocktail** at Colegio de Fonseca*

Tuesday – June 9th 2026	
Session: Emerging & Innovative Technologies for Shelf Life Extension *Chairs: Elena Torrieri, Dong Sun Lee*	
09:00 – 09:30	**KEYNOTE LECTURE** **KS02 – Active and intelligent packaging as strategies for food quality and safety** ***Miguel Cerqueira**, International Iberian Nanotechnology Laboratory (INL), Portugal*
09:30 – 09:45	OC06 – Enhanced Antioxidant Functionality in Electrospun PHBV Films Incorporating Resveratrol Solubilized in Deep Eutectic Solvents for Sustainable Food Packaging Applications. ***Cristina Prieto,** Institute of Agrochemistry and Food Technology (IATA-CSIC), Spain*
09:45 – 10:00	OC07 – Carbon Quantum Dot Washable Coatings for Shelf-Life Extension of *Capsicum frutescens L*. ***Nattinee Bumbudsanpharoke**, Kasetsart University, Thailand*
10:00 – 10:15	OC08 – Novel biodegradable antimicrobial film and its suitability as food contact material against *Campylobacter spp*. ***Filomena Silva**, University of Zaragoza, Spain*
10:15 – 10:30	OC09 – Antimicrobial packaging based on an environmentally friendly ethanol emitter to reduce decay in strawberries. ***Eva Almenar**, Michigan State University, USA*
10:30 – 10:45	OC10 – Synergistic Polyphenol-Capped Silver Nanoparticle Coatings for Enhanced Shelf-Life Stability of Date Fruits and Pastries. ***Khaoula Khwaldia**, Institut National de Recherche et d'Analyse Physico-Chimique (INRAP), Tunisia*
10:45 – 11:00	OC11 – Plasma-Polymerized Polycaprolactone Coatings with Encapsulated Citronellal for Preserving Cooked Pork Sausage. ***Maryam Zabihzadeh Khajavi**, University of Ghent, The Netherlands*
11:00 – 11:15	OC12 – Development and Evaluation of Prickly Pear Extract-Loaded Pectin Films for Extending Poultry Meat Shelf Life. ***Ana Luisa Fernando**, Nova University Lisbon, Portugal*
11:15 – 12:10	Coffee break – Poster Session
Session: Emerging & Innovative Technologies for Shelf Life Extension *Chairs: Carol López-de-Dicastillo, Manuel Vázquez*	
12:10 – 12:20	SOC01 – Development and validation of gas exchange models for microperforated packaging under dynamic pressure conditions. ***Sara Vega-Diez**, Agri-Food Institute of Aragon – CITA- University of Zaragoza, Spain*
12:20 – 12:30	SOC02 – Improving antioxidant activity of chitosan film by incorporating with lemon peel-derived carbon quantum dots. ***Ubonrat Siripatrawan**, Chulalongkorn University, Thailand*
12:30 – 12:40	SOC03 – Photoresponsive Chitosan-Riboflavin Films for Light-Activated Antimicrobial Food Packaging. ***Daniele Maria Martins**, University of Milan, Italy*
12:40 – 12:50	SOC07 – From forest by-products to active packaging: Phenolic Extracts from Pine and Eucalyptus Barks for Functional, Biodegradable Films. ***Danilo Escobar-Avello**, University of Concepción, Chile*
12:50 – 14:30	*Lunch – Poster Session*

Session: Sustainable Packaging, Materials Innovation and Safety Issues *Chairs: Eva Amenar, Ronan Cariou*	
14:30 – 15:00	**KEYNOTE LECTURE** **KS03 – New barrier packaging materials and application to plant-based protein foods** ***Fátima Poças,*** *CBQF – Portuguese Catholic University, Portugal*
15:00 – 15:15	OC13 – Revalorization of Post-Consumer PLA using Supercritical Technologies. ***Carol López de Dicastillo,*** *Institute of Agrochemistry and Food Technology (IATA-CSIC), Spain*
15:15 – 15:30	OC14 – Impact of Nanoemulsion Properties on the Physical and Functional Performance of By-Product-Based Biopolymeric Active Films. ***Angela Borriello,*** *University of Naples Federico II, Italy*
15:30 – 15:45	OC15 – Eugenol-Derived Carbon Dots as Bio-Based Nanofillers in Chitosan-Based Active Coatings for Food Packaging Applications. ***Mariamelia Stanzione****, National Research Council of Italy, Italy*
15:45 – 16:00	OC17 – Improving Functional and Barrier Performance of Paper through Biodegradable Polymer Coatings. ***Emanuela Lo Faro,*** *University of Modena and Reggio Emilia, Italy*
16:00 – 16:15	OC18 – Evaluation of Chitosan-Based Composite Aerogels Infused with Cocoa Pod Husk Powder for Enhanced Ethylene Absorption and Fruit Shelf-Life Extension. ***Wirongrong Tongdeesoontorn,*** *Mae Fah Luang University, Thailand*
16:15 – 17:10	Coffee break – Poster Session
Session: Sustainable Packaging, Materials Innovation and Safety Issues *Chairs: Amparo Chiralt, Miguel Cerqueira*	
17:10 – 17:20	SOC06 – Valorization of crustacean-derived chitin into reinforced, biodegradable bioplastics for food packaging applications. ***Susana Guzman Puyol****, IHSM, UMA-CSIC, Spain*
17:20 – 17:30	SOC08 – Sustainable and reinforced lacquers from tomato pomace and microcrystalline cellulose for metal food packaging. ***Francisco Javier Solano Moreno****, IHSM, UMA-CSIC, Spain*
17:30 – 17:40	SOC11 – Design of Sustainable Ultralight TPU-Based Composite materials with Tunable Porosity for Food Packaging Conservation. ***Nello Russo****, National Research Council of Italy, Italy*
17:40 – 17:50	SOC12 – Development of PBSA Composites with Red Grape Skins Powder. ***Yana Madonna****, Università Cattolica del Sacro Cuore, Italy*
17:50 – 18:00	SOC13 – Development of Antioxidant-Functionalized Bacterial Cellulose via In-Situ and Ex-Situ Approaches for Active Food Packaging Applications. ***Patricia Cazón****, University of Santiago de Compostela, Spain*
20:30	***Social Dinner*** *at Monasterio de San Francisco*

Wednesday – June 10th 2026	
Session: Food Quality, Safety & Shelf Life Interactions *Chairs: Khaoula Khwaldia, Fátima Poças*	
09:00 – 09:30	**KEYNOTE LECTURE** **KS04 – "Intelligent Shelf Life": Does It Exist? - Sensors and AI for Real-Time Food Quality and Prediction** ***Silvia Grassi**, University of Milan, Italy*
09:30 – 09:45	OC19 – Protecting rosé wine quality from light exposure using a colorless UV-filter coating on flint bottles. ***Jennifer Moriones**, Asociación de la Industria Navarra, Spain*
09:45 – 10:00	OC20 – Shelf-life evaluation of innovative bakery product enriched with *Chlorella vulgaris* under accelerated conditions (ASTL). ***Alessandra Riggio**, University of Modena and Reggio Emilia, Italy*
10:00 – 10:15	OC22 – Botanical Extracts as a Multifunctional Strategy for Shelf Life Extension and Quality Preservation in Lipid-Based Foods. ***Giulia Potenziani**, University of Turin, Italy*
10:15 – 10:30	OC23 – Doped Carbon Dots Derived from Biomass Enable Active Coatings for Cherry Tomato Shelf-Life Extension. ***Pornchanok Thanawutthiphong**, Kasetsart University, Thailand*
10:30 – 10:45	OC24 – Active-Intelligent microcrystalline cellulose-modified alginate film for preserving and monitoring meat quality. ***Ubonrat Siripatrawan**, Chulalongkorn University, Thailand*
10:45 – 11:40	*Coffee break – Poster Session*
Session: Food Quality, Safety & Shelf Life Interactions *Chairs: Mariamelia Stazione, Ana Luisa Fernando*	
11:40 – 11:50	SOC14 – Microstructural and Physicochemical Stability of a Sustainable Wolffia-Mung Bean Protein Reconstitutable Beverage: Impact of Hydrocolloid Stabilizers and Drum-Drying Processing. ***Wantida Homthawornchoo,** Mae Fah Luang University, Thailand*
11:50 – 12:00	SOC15 – Impact of fermentation with *Lactobacillus plantarum* and *Saccharomyces cerevisiae* on the acceptability of experimental breadsticks enriched with *Ulva lactuca*, and shelf-life study under tropical conditions. ***Marco Gammaitoni,** University of Modena and Reggio Emilia, Italy*
12:00 – 12:10	SOC16 – Evaluating Shelf-Life of Pasta in Innovative Paper-Based Packaging: A Sustainable Approach. ***Luca Svolacchia Brusoni & Pamela Iocca,** Food Contact Center S.r.l., Italy*
12:10 – 12:20	SOC17 – Biodegradable active packaging materials based on PBS and grape stalk for fresh salmon preservation. ***Maria Vargas,** Technical University of Valencia, Spain*
12:20 – 12:30	SOC18 – Efficiency of PHA-starch laminates Containing or not beer bagasse extract or ferulic acid on Refrigerated Pork Meat preservation. ***Chelo Gonzalez,** Technical University of Valencia, Spain*
12:30 – 12:40	SOC19 – Turning proteins into packaging: beeswax-coated egg white protein films for sweet cherries preservation. ***Victor Baquero Aznar,** Agri-Food Institute of Aragon – CITA- University of Zaragoza, Spain*
12:40 – 14:30	*Lunch – Poster Session*

Session: Policy, Consumer Trends & Sustainability in Shelf Life and Packaging Strategies *Chairs: Silvia Grassi, Giovanna Buonocore*	
14:30 – 15:00	**KEYNOTE LECTURE** **KS05 – Shelf life in fermented foods: looking at lambic beers** ***José M. L. Vilariño & Carlos J. Ávila,*** *HIJOS DE RIVERA S.A.U., Spain*
15:00 – 15:15	OC25 – Nanotechnology for Food Packaging: Promise, Performance or Uncertainty? ***Ana Rita Mendes,*** *Portuguese Catholic University, Portugal*
15:15 – 15:30	OC26 – Development of active food packaging films through the valorization of grape marc. ***Maialen Uribarrena,*** *University of the Basque Country, Spain*
15:30 – 15:45	OC27 – Impact of recycled content and ageing on IAS and NIAS in PET bottles. ***Marco Fontanarosa,*** *University of Parma, Italy*
15:45 – 16:00	OC28 – Modelling migration of dialkyl ketones (DAKs) from food contact moulded pulp trays with alkyl ketene dimer (AKD) sizing. **Srishti Singh,** *Portuguese Catholic University, Portugal*
16:00 – 16:15	OC30 – Upcycling of mango leaves as a source of bioactive compounds for thermoplastic polyurethane (TPU)-based food packaging. ***Diego Rodríguez,*** *IHSM, UMA-CSIC, Spain, Spain*
16:15 – 17:05	*Coffee break – Poster Session*
Session: Policy, Consumer Trends & Sustainability in Shelf Life and Packaging Strategies *Chairs: José M L Vilariño, Ana Sanches Silva*	
17:05 – 17:20	OC29 – Oligoesters migrating from food varnishes and coatings – Organic synthesis, in vitro testing and exposure assessment. ***Ronan Cariou****, Oniris, INRAE, LABERCA, France*
17:20 – 17:30	SOC20 – In vitro gastrointestinal fate and bioaccessibility of oligoesters migrated from food Packaging. ***Patricia Vázquez Loureiro****, University of Santiago de Compostela, Spain*
17:30 – 17:40	SOC23 – Paper-Laminated Biodegradable Film Packaging for Customized Single-Dose Solid Medicines in Elderly Care. ***Saurawee Yathaninyakorn***, *Kasetsart University, Thailand*
17:40– 18h00	***Concluding Remarks*** *GSICA & Organizing Committee*
19:00	***Cultural Visit Old town*** *(optional, not included in the registration fee)*

Thursday – June 11th 2026	
08:00 – 15:00	***Post-Conference Visits*** *The visit is sponsored by: Promoción Produtos Pesqueiros. Servizo de Mercados. Dirección Xeral de Pesca, Acuicultura e Innovación Tecnolóxica. Consellería do Mar, Xunta de Galicia.*

CIENTIFIC PROGRAMME
Poster Session

P01	Developing a shelf life predicting model for roasted coffee packed in a bioplastic capsule. ***Maria Cristina Nicoli**, Università degli Studi di Udine, Italy*
P02	Image-Based Modelling using Machine Learning for acceptability limits prediction of frozen pizza in shelf-life studies. ***Giulia Varutti,** Università degli Studi di Udine, Italy*
P03	Moisture Change Model for Active Package of Dry Dosage Form during Secondary Shelf Life Period. ***Dong Sun Lee,** Kyungnam University, South Korea*
P04	Development of a testing procedure for a Secondary Shelf Life (SSL) assessment: the case study of fruit puree. ***Maria Cristina Nicoli**, Università degli Studi di Udine, Italy*
P05	Technological Valorization of Lignin in Biodegradable Polymeric Matrices Using Electrohydrodynamic Techniques for Food Packaging Applications. ***Cristina Prieto,** Institute of Agrochemistry and Food Technology (IATA-CSIC), Spain*
P06	Nanocellulose Films Incorporated with Buffered Vinegars as Antimicrobials for Shelf-Life Extension of Plant-Based Meat Analogues. ***Ana Rita Mendes,** Portuguese Catholic University, Portugal*
P07	Effects of High Hydrostatic Pressure Processing (HPP) on color preservation and metmyoglobin content in tuna intended for raw consumption. ***Marika Valentino**, Università degli Studi di Udine, Italy*
P08	Chitosan-White Tea Active Coatings to Extend Sardine Shelf-Life under Refrigerated and Frozen Storage. ***Manuel Vázquez Vázquez**, University of Santiago de Compostela, Spain*
P09	Application of an olive by-product in hamburgers to increase their shelf life and nutritional value. ***Paz Otero,** University of Vigo, Spain*
P10	Extract rich in phenolic compounds obtained from olive pulp by Supercritical Fluid Extraction for food fortification and shelf-life improvement. ***Antía Torres,** University of Vigo, Spain*
P11	Project CardAPium: Exploring Cardoon (*Cynara cardunculus L.*) by-products to obtain cutting-edge Active Packaging for food applications. ***Ana Sanches Silva**, University of Coimbra, Portugal*
P12	Functional Edible Films Based on Sodium Caseinate Incorporating *Lactobacillus casei*: Toward Bioactive Food Packaging. ***Giovanna Buonocore,** National Research Council of Italy, Italy*
P13	Functionality, Safety, and Challenges of Bioactive Extracts for Active Packaging. ***Ana Sanches Silva**, University of Coimbra, Portugal*
P14	Smart Monitoring of Fresh-Cut Melon Quality: Integration of a Multi-Component pH-Sensitive Film for Shelf-Life Prediction. ***Wirongrong Tongdeesoontorn,** Mae Fah Luang University, Thailand*
P15	From Citrus Waste to Active Packaging: Whey Protein Films as a Circular Economy. ***Ana Rita Mateus,** University of Coimbra, Portugal*

P16	Reducing Postharvest Mechanical Damage in Apples During Transport: A Statistical Evaluation of Packaging Configurations Under Simulated Transportation Vibration. ***Eva Almenar**, Michigan State University, USA*
P17	Biodegradation behaviour of PLA–starch blends in a simulated Pelagic marine environment. ***Amparo Chiralt,** Technical University of Valencia, Spain*
P18	Safety assessment of chitin as a sustainable food packaging material using an integrated in vitro genotoxicity and mutagenicity approach. ***Antía Lestido Cardama**, University of Sevilla, Spain*
P19	Tentative identification of non-volatile migrants from two biodegradable food packaging materials: polybutylene succinate (PBS) and poly(butylene succinate-co-adipate) (PBSA). ***Antía Lestido Cardama**, University of Sevilla, Spain*
P20	Zein–pectin nanoparticles as carriers for carvacrol in active PVA biocomposite films. ***Maria Oliviero,** National Research Council of Italy, Italy*
P21	Toward Sustainable Food Ingredient Development: Zein–Pectin-Based Delivery Systems for Citrus By-Product Extract. ***Sandra Mariño Cortegoso**, University of Santiago de Compostela, Spain*
P22	Investigation of potential migrants in polylactic acid (PLA) drinking straws. ***Carlos Vivanco**, University of Santiago de Compostela, Spain*
P23	Pectin-based aerogels loaded with natural bioactive compounds for sustainable packaging. ***Isabel Rial,** University of Santiago de Compostela, Spain*
P24	Starch aerogels reprocessing: A circular and sustainable strategy for advanced food shelf-life applications. ***Isabel Rial,** University of Santiago de Compostela, Spain*
P25	Cellulose-Based Compostable Films (NatureFlex™) as Sustainable Packaging for Organic Strawberries (*Fragaria ananassa*): Effects on Quality Preservation during Refrigerated Storage. ***Ruben Palumbo,** University of Naples Federico II, Italy*
P26	Methodologies for the contamination of LDPE films with benzophenone for diffusion studies. ***Luca Puddu,** University of Santiago de Compostela, Spain*
P27	Overview on membranes for permeability assays after in vitro gastrointestinal digestion of biobased packaging chemicals. ***Alba Rodríguez Senra,** University of Santiago de Compostela, Spain*
P28	Antibacterial extracts from tiger nut milk processing waste to develop biodegradable active films. ***Eugenia Martin,** Technical University of Valencia, Spain*
P29	Evaluation of Triacetin as an Eco-Friendly Plasticizer for Polylactic Acid (PLA) Films: A Comparative Study on Functional Properties. ***Fabio Licciardello,** University of Modena and Reggio Emilia, Italy*
P30	Effects of chemical crosslinking and cold plasma surface treatment on the properties of carboxymethyl cellulose-based films for food packaging applications. ***Enrico Maurizzi**, University of Modena and Reggio Emilia, Italy*
PO31	Bio-based shellac coatings to improve barrier properties of kraft paper for compostable food packaging envision its use in insect-based foods. ***Vasco Martins**, International Iberian Nanotechnology Laboratory (INL), Portugal*
P32	High-barrier cellulose-based coatings produced by ultrasonic spray coating for insect flour preservation. ***Ana Gabriela Azevedo,** International Iberian Nanotechnology Laboratory (INL), Portugal*

P33	Bioaccessibility and in vitro digestion in food contact materials: a tool for risk assessment. ***Lara Pazos Soto,*** *University of Santiago de Compostela, Spain*
P34	Meat preservation using PLA/PVA laminates containing almond shell extracts obtained by subcritical water extraction. ***Amparo Chiralt,*** *Technical University of Valencia, Spain*
P35	Water-based bioactive coatings applied to compostable PLA packaging to extend blueberry shelf life. ***Catalina Obando***, *Institute of Agrochemistry and Food Technology (IATA-CSIC), Spain*
P36	Use of almond skin by-products to develop biodegradable active bilayers based on starch and Polihydroxibutirate. ***Chelo Gonzalez,*** *Technical University of Valencia, Spain*
P37	Next-Generation Biopolymer Coatings for Sustainable Paper-Based Food Packaging. ***Donghyun Jang****, Yonsei University, Republic of Korea*
P38	Chemical safety of biodegradable food contact materials: Screening of volatile compounds using P&T-GC-MS. ***Carlos Vivanco****, University of Santiago de Compostela, Spain*
P39	Valorization of low-starch potato peel to develop biodegradable laminates. ***Eugenia Martin***, *Technical University of Valencia, Spain*
P40	Safety Assessment of Recyclable Coffee Packaging: Screening Non-/Intentionally Added Substances and Quantifying Primary Aromatic Amines in Multilayer Polyolefin-Based Materials. ***Vittorio Bassi****, University of Milan, Italy*
P41	Effects of cold adaptation on *Listeria monocytogenes* growth in challenge tests of ready-to-eat (RTE) meat products. ***Anh Linh Nguyen****, Corbion, The Netherlands*
P42	Reducing Natamycin Dependence in Cheese Through Whey Protein-Based Coatings Incorporated with Cardoon Leaf Extract. ***Ana Sanches Silva****, University of Coimbra, Portugal*
P43	Valorisation of Lime By-Products in Gluten-Free Vegan Pancakes: Functional, Sensory, and Bioaccessibility Assessment. ***Sandra Mariño Cortegoso****, University of Santiago de Compostela, Spain*
P44	Postharvest quality of peaches under an ionizing atmosphere ***Jairo Alonso Torres García,*** *University of Santiago de Compostela, Spain*
P45	Impact of Germination on Volatile Compounds in White and Verdina Beans from Galicia ***Clicia María de Jesus Benevides****, University of State of Bahia, Brasil*
P46	Germination and thermal processing as strategies for modulating the nutritional and technology profile of creole corn flour. ***Clicia María de Jesus Benevides****, University of State of Bahia, Brasil*
P47	Volatile fingerprint of feijoa (*Acca sellowiana*) cultivated in Galicia. ***Rania Rochdi,*** *University of Santiago de Compostela, Spain*
P48	Differentiation of Brazilian Hop (*Humulus lupulus L.*) based on α/β-bitter acids: Effect cultivars and geographic origins. ***Rania Rochdi,*** *University of Santiago de Compostela, Spain*
P49	Stability of Red Beet (*Beta vulgaris*) Juice as a Natural Colorant in Flavored Yogurt Under Different Storage Conditions ***Deniz Elitez***, SÜTAŞ SÜT ÜRÜNLERİ A.Ş, Turkey

P50	Active films based on PBS and rice straw and citrus pruning waste extracts obtained by supercritical water extraction. ***María Vargas***, *Technical University of Valencia, Spain*
P51	Winery Residues as a Source of Bioactive Compounds for Smart Packaging: Development and Validation of a Fish Freshness Indicator. ***Andrea Pulvirenti***, *University of Modena and Reggio Emilia, Italy*
P52	Development of a Sustainable Pomegranate-Based pH-Indicator for Real-Time Fish Freshness Monitoring: A Green Approach Integrated with AI. ***Andrea Pulvirenti***, *University of Modena and Reggio Emilia, Italy*
P53	Performance evaluation of novel bio-based films for active packaging of refrigerated fish fillets. ***Enrico Maurizzi***, *University of Modena and Reggio Emilia, Italy*
P54	Enhancing Shelf Life and Marketability of 'Kim Ju' Guava Using Argon-Based Active Modified Atmosphere Packaging. ***Thamarath Pranamornkith****, Mae Fah Luang University, Thailand*
P55	Oxidative shelf-life stability of Hermetia illucens oil for food applications: a preliminary literature review. ***Ruben Palumo****, University of Napoles, Italy*

Keynote Speaker Abstracts

KS01 Predictive Modelling, AI and Mitigation Strategies for Food Safety and Shelf-Life

[1,2,3]**Ana Sanches Silva**

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Ensuring food safety and extending shelf life are among the main challenges facing modern food systems, particularly in the context of climate change, globalized supply chains, and increasing consumer expectations. Artificial Intelligence (AI) has emerged as a powerful tool to address these challenges by enabling rapid data analysis, real-time monitoring, predictive modelling, and enhanced decision-making throughout the food chain (1). Through the integration of AI with analytical technologies and chemometric approaches, new opportunities are arising to improve contaminants detection, quality assessment, and risk management strategies.

This keynote lecture will explore recent advances in AI-driven predictive modelling for food safety and shelf-life evaluation, highlighting applications ranging from quality control and spoilage prediction to contaminant monitoring and risk assessment.

A specific focus will be placed on the occurrence of mycotoxins in cereals, one of the most significant food safety concerns worldwide. Mycotoxins, such as aflatoxins, fumonisins, deoxynivalenol, and zearalenone, are produced by fungi whose growth is strongly influenced by environmental and agronomic factors. AI-based models are increasingly being employed to predict mycotoxin contamination by integrating meteorological, geographical, crop management, and analytical data. These predictive systems can support early-warning strategies, identify high-risk areas and periods, and guide targeted mitigation measures before contamination reaches critical levels.

The lecture will also discuss the strengths and limitations of current AI methodologies. While hybrid approaches combining multiple algorithms have demonstrated improved predictive performance, challenges remain regarding data quality, good interpretation of the models, computational demands, and transferability across different production systems. By examining both opportunities and challenges, this presentation will demonstrate how predictive modelling and artificial intelligence can contribute to safer cereal-based food systems, reduced food losses, and enhanced global food security.

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KS02 Active and intelligent packaging as strategies for food quality and safety

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Abstract

Current market trends are challenging the food packaging industry as we know it. A global market imposes longer transportation and storage times, and consumers demand not only fresh, healthy food products but also convenience (e.g., ready-to-go meals or microwavable mono-dose units) and access to comprehensive information about composition, nutritional facts, origin or traceability of the products they consume. In addition, consumers and regulators have demanded more bio-based and sustainable materials.[1] Current challenges such as recyclability, biodegradability and high-performance materials have been addressed in food packaging, and several new structures and materials have appeared in the scientific community and industry.[2] Nevertheless, developing new and innovative structures for active and intelligent packaging development still needs to be improved.

In this regard, we have been using bio-based materials to produce functional micro and nano-structures aiming to develop an active and intelligent structure for food packaging applications.

In the active packaging applications, we have been using biomolecules and microorganisms with antioxidant and antimicrobial properties that can be added to plastic and paper through innovative technologies such as electrohydrodynamic processing and ultrasonic atomization, but also through nanoencapsulation.

For intelligent packaging, we have focused on indicators that can give us information regarding the quality of the food products, but also the environment where they are stored, and tags that can be used during the food chain and guarantee food traceability. With this aim, we have been using imprint technologies and magnetron sputtering to develop structures able to humidity and oxygen. We have also been working on producing unclonable tags by developing fluorescent materials through in situ electron irradiation.

The presented examples of different active and intelligent applications were, in most cases, developed using flexible materials such as paper and bioplastics, with the aim of their use in compostable packaging, but can be easily adapted to other types of materials (e.g., petroleum-based plastics).

We foresee that such applications could help increase product shelf life, thereby reducing food waste (active packaging) and ensuring food quality and safety (intelligent packaging).

Keywords: food packaging; nanotechnology; smart packaging; sustainability.

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KS03 New barrier packaging materials and application to plant-based protein foods

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In the context of circular economy, optimization of food packaging systems, with the lowest environmental footprint, and still providing the required shelf-life in terms of product quality and safety is of great interest.

Modified atmosphere packaging (MAP) is used for preservation of many foods. MAP requires materials with high barrier to gases to maintain the gas mixture concentration as long as possible. This requires structures composed of multiple layers of different materials, including polyethylene (PE) for better heat sealing and/or ethylene vinyl alcohol (EVOH) for high barrier to gases. These multilayer structures do not meet the criteria set for conventional mechanical recycling. Therefore, efforts to promote more circular packaging systems are in action, through two main approaches recognised as pillars for sustainable packaging: (i) the use of monomaterial (or simplified structures) to allow recycling and through incorporation of recycled material in the packages, and (ii) on the development of bio-based materials, to reduce the fossil resources dependency. It should be noted that the updated principles and requirements under the Regulation (EU) 2025/40 on packaging waste, attribute the most importance to reducing and recycling packaging and consider biodegradability relevant only in very specific applications of food packaging. This work reviews the developments regarding materials with high barrier, discussing the pros and cons of each, the applicability and the implications for safety and quality of the products. A case study is presented for a plant-based product illustrating the trade-off between the shelf life and safety, and the environmental impact of the packaging system.

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KS04 "Intelligent Shelf Life": Does It Exist? Sensors and AI for Real-Time Food Quality and Prediction

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Shelf life is traditionally assigned as a fixed time limit based on product formulation, processing, packaging and expected storage conditions. However, real food systems are dynamic: batch variability, temperature fluctuations, package atmosphere, microbial activity and quality degradation may substantially modify the actual remaining shelf life of a product. In this context, the concept of "intelligent shelf life" is emerging as a possible evolution from static dating towards real-time, data-driven food quality prediction.

From a scientific perspective, "intelligent shelf life" can be defined as a system-level approach in which sensor-derived information, food quality indicators and predictive models are integrated to estimate product quality and remaining shelf life under dynamic storage and distribution conditions.

Current developments rely on the convergence of sensor technologies, predictive modelling and AI-based data interpretation. Optical and spectral methods, such as near-infrared spectroscopy, hyperspectral imaging and machine vision, can detect changes in composition, colour, morphological features or texture. Gas and volatile sensors, including electronic noses, can capture spoilage-related signatures associated with microbial and enzymatic activity. Connected packaging and cold-chain monitoring systems can integrate time-temperature history, gas composition and logistics data to support dynamic shelf-life estimation.

These approaches show clear potential in different food categories, including fresh produce, fish and meat products, dairy foods, ready-to-eat meals and packaged chilled products (Grassi et al., 2023; Cozzolino et al., 2024). Nevertheless, several barriers still limit routine application: small and product-specific datasets, difficult definition of shelf-life endpoints, limited external validation, sensor calibration issues, poor model transferability and the need for explainable predictions. Therefore, intelligent shelf life should be seen as a validated hybrid framework combining food science, sensors, predictive microbiology, mathematical modelling and AI. Its significance lies in moving from expiry dates to dynamic food quality intelligence, with potential applications in quality management, logistics, waste reduction and consumer information.

Keywords: shelf life; artificial intelligence; food quality; sensors; predictive modelling.

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KS05 Shelf life in fermented foods: looking at lambic beers

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The food industry's interest in the development of new fermented foods is evident and has become increasingly visible in the menus offered by gourmet restaurants over the past decade. In the beverage sector, products such as kombucha and other fermented developments within the NoLo category, beverages with no or low alcohol content, are a good example of this trend.

The challenge for these new developments in Europe lies in regulations that are overly ambiguous and restrictive in the case of fermented foods containing active microbiology. In practice, this would almost require a food safety guarantee for every production batch, since in many cases there is no exhaustive knowledge of the species (bacteria and yeasts) responsible for the fermentation process. At the same time, however, Belgium is home to a variety of beers known as lambic beers, whose production system is based on a centuries-old tradition in which fermentation occurs through what producers themselves describe as "wild fermentation." In these cases, the fermentation process takes place in the coolships "open vessels" in breweries located in rural areas in order to capture the surrounding environmental microbiological diversity. Under these conditions, which would be almost impossible to extend to other food products, lambic beers have been commercialized for decades with best-before periods of 20–25 years or even longer.

This may be excessive for other types of food, but it is necessary to study how regulations can ensure the safety of products intended for consumption while at the same time leaving open the possibility for the rise of new products that will create new industrial opportunities and, in turn, provide tasty ways of incorporating healthy foods into our diet.

Keywords: lambic beers, nolo drinks, fermentation.

Oral Communication Abstracts

OC01 Identification of acceptability limits for shelf life studies by integrating sensory and analytical data: the case study of packed almonds

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Identifying the acceptability limit is essential for conducting shelf-life studies. Accurate quantification of the limit is key to ensuring correct food labelling and minimising unnecessary food waste. For shelf-stable foods prone to oxidation, such as almonds, consumer sensory response is a highly sensitive indicator of product quality decay during storage. Accordingly, the relevant acceptability limit is a sensory threshold. However, assessing consumer sensory acceptability requires complex and costly experimental designs, which are not feasible at an industrial level for routine shelf life studies. In the work, the oxidation of packaged almonds stored at 23, 35 and 45 °C was assessed by monitoring the kinetics of peroxide value (PV) and the evolution of consumer sensory rejection over time. The experimental findings revealed a significant correlation ($r > 0.98$) between sensory rejection and PV, regardless of storage temperature. A model predicting consumer rejection based on PV levels was thus identified and used to convert the sensory acceptability limit, defined as 50% sensory rejection, into a PV acceptability limit (15 mEqO2 kgoil-1). Using a simple quality indicator, such as PV, which accounts for consumers' response according to a defined predictive model, can make routine shelf life assessment easier and more cost-effective within industrial-level R&D and quality assurance frameworks. Furthermore, the outcome substantiates the applicability of accelerated shelf life testing (ASLT) as a methodological approach to establish correlations between analytical (PV) and sensory acceptability limits in foods suffering oxidative alteration during storage, thereby markedly reducing the time required for shelf life studies.

Keywords: oxidation, peroxide value, sensory threshold, ASLT

This work was supported by the European Union Next Generation EU, PNRR M4C2 - Project title "Fighting the waste of food undergoing oxidation through the development of a scientific-based approach for date marking"- PRIN 2022 Prot. 2022ZXHTCS.

OC02 Translating Microbial Spoilage Profiling into Predictive Shelf-Life Tool: Accelerating Innovation in Meat Products

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New product development or reformulations often presents significant food safety and shelf-life challenges for food businesses. Challenge and shelf-life (SL) tests are standard methods, but costly, time-consuming, and provide little indication of potential success. To address this challenge, a multi-year study was conducted aiming to translate target spoilage microorganisms' identification into a practical, decision-support predictive shelf-life tool, validated in meat products.

The top 5 spoilage microorganisms of 73 cooked meat products were investigated using culture-based methods and metagenomics (16s rDNA). Effects of pH, aw, and organic acid salts on their maximum growth rates were determined in BHI using Bioscreen C and exponential model fitting2. The top spoilers were also inoculated in uncured cooked ham at 7oC and μ estimated using Excel add-in DMFit3_5 1. Both broth and food μ for each strain were used for model calibration. Gamma concept was applied to describe the inhibitory effect of each food factor and used to calculate microbial growth rate at given conditions. The predictive model was validated through: Parity plots, Bias, and Accuracy factors.

The top 5 lactic acid bacteria (LAB) identified Latilactobacillus sakei, Leuconostoc mesenteroides, Leuconostoc carnosum, Lactiplantibacillus plantarum, Latilactobacillus curvatus accounted for 72% of spoilage cases, although their abundance varied with geographical region. Their μ was 10-22 day-1 in broth, and 0.1-0.3 day-1 in meat. The obtained data (μ, calibration factors, critical growth limits) were used to build an Excel-based tool aimed to predict days to spoilage, SL (days) and % SL extension, based on specified threshold at given conditions in meat products. Good agreement was observed between observed and predicted data, with model performance indicators of Bias=1.09 and accuracy =1.46 (time to 3 log growth).

The developed predictive shelf-life tool represents a transverse process from laboratory data to users. Incorporating actual spoilage microorganisms and single strains enables a better evaluation of different preservation systems to predict desired shelf lives The tool can support data-driven decision-making, reduce R&D costs, and accelerate innovation for the meat industry by improving success rates in challenge tests.

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OC03 Shelf Life Prediction of Fresh Fish Using Printable CO_2 and pH Colorimetric Sensors Integrated with an Image-Based Web Application

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Rapid and reliable freshness assessment of packaged fish remains a major challenge due to dynamic biochemical changes during storage. This study presents an intelligent packaging approach that combines colorimetric sensors with an image-acquisition web application for real-time shelf-life prediction. A printable CO2 indicator patch based on a curcumin beta cyclodextrin complex immobilized in a hydroxypropyl methylcellulose matrix was developed and tested under controlled headspace conditions (0 to 30% CO2). The patch showed a clear monotonic colour response to increasing CO2 concentrations and remained stable against variations in oxygen concentration and moderate temperature changes. In parallel, a pH-responsive freshness sensor was developed and evaluated across a wide pH range (pH 5 to 14). The pH response was correlated with total volatile basic nitrogen (TVB-N), a key spoilage indicator in fish. Both sensing elements were integrated into a multi-element patch containing black and white reference markers for image normalization. Images of the patch are captured and analysed using a web application that automatically identifies the sensing regions, corrects lighting variations, and extracts RGB and chroma values. The backend models convert the colour information into pH values and CO2, and estimate the remaining shelf life under different temperature conditions based on TVB-N correlation. The system was further validated using packaged fish stored under refrigerated conditions, where the web application successfully tracked freshness changes and predicted shelf life. This integrated sensing and digital analysis platform provides a simple, low-cost, and user-friendly solution for intelligent fish packaging and supply chain monitoring.

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This work was supported by a NOVISHPAK European Union project (PRIMA) (Project number: 02WPM1728).

OC04 Effect of gelatine-based emulsion packaging enriched with sunflower or olive oil on the sensory quality and aromatic profile of fresh truffles during storage

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Fresh black truffles are highly valued for their distinctive and complex aromatic profile; however, they are extremely perishable. Gelatine-based packaging systems have recently emerged as a promising alternative to conventional packaging due to their ability to regulate gas exchange and maintain low microbial loads, thereby extending the shelf life of the product [1]. Moreover, key volatile organic compounds (VOCs) released by truffles may be retained within the gelatine matrix during storage. This study evaluated whether the incorporation of a lipidic phase into the gelatine matrix enhances aroma retention and its impact on sensory quality and consumer perception.

Fresh truffles were individually packaged in three gelatine-based systems: gelatine (control), gelatine-sunflower oil emulsion, and gelatine-olive oil emulsion, and stored at 4 °C for 35 days. Sensory analysis was conducted weekly by a trained panel to assess truffle aroma, physical degradation, and aroma perception in the gelatine matrix, including aroma retention and oily notes. Microbiological analyses were performed in parallel. VOCs were analysed in truffles and gelatine matrices at days 0 and 14 using gas chromatography–mass spectrometry and gas chromatography–olfactometry. Additionally, a consumer test (n≈60) was conducted using béchamel sauces prepared with the three gelatine matrices, with and without truffle infusion, resulting in six formulations.

Sensory and instrumental analyses confirmed the retention of characteristic truffle aroma compounds in the gelatine matrices. Among the oil-enriched systems, sunflower oil-gelatine exhibited higher sensory acceptance, with enhanced truffle aroma perception and reduced fatty notes. Consumer evaluation supported these findings, as truffle aroma was more clearly perceived in béchamel formulations prepared with sunflower oil-enriched gelatine.

Sunflower oil–enriched gelatine packaging represents a promising strategy to preserve truffle aroma while generating an aromatic edible gel with potential culinary applications, contributing to both product preservation and value-added food innovations.

Keywords: Fresh truffles;Gelatine packaging;Aroma retention; Sunflower oil; Olive oil.

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OC05 Unraveling the Interactions Between Quality, Safety, and Composition to Predict Shelf-Life stability in grape by-products kombuchas

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The valorization of grape by-products through fermentation represents a sustainable strategy for developing functional beverages while contributing to circular economy practices. However, beyond product development, understanding the interactions between compositional, sensory, and safety-related parameters is essential to ensure adequate shelf-life performance. This study evaluates multidimensional stability indicators during the fermentation of kombuchas produced from grape skins, seeds, and stems using three different SCOBY consortia, with particular emphasis on their implications for subsequent shelf-life control.

Fermentations were monitored over 21 days, assessing pH, dissolved sugars, ethanol content, soluble proteins, total phenolic content, antioxidant activity (DPPH assay), and volatile composition (GC-FID and GC-O). These parameters were interpreted as integrated markers of compositional stabilization, functional preservation, and potential sensory stability prior to storage.

All formulations maintained microbiologically safe pH values and ethanol concentrations below 1% throughout fermentation, ensuring product safety. A rapid reduction in dissolved sugars was observed within the first 7–14 days, significantly limiting residual fermentable substrates, reducing the risk of post-fermentation microbial activity, and contributing to compositional stability. Total phenolic content increased markedly, particularly in seed- and stem-based kombuchas, leading to enhanced antioxidant capacity and contributing to functional and oxidative stability. Volatile profiling revealed matrix- and consortium-dependent aromatic patterns, with distinct olfactometric signatures, suggesting that microbial selection modulates the potential evolution of sensory quality during shelf-life.

The integration of physicochemical, functional, and aromatic data enabled the identification of optimal fermentation endpoints (days 10–14), balancing reduced residual sugars, high phenolic concentration, controlled ethanol production, and favorable aromatic profiles. These findings demonstrate that fermentation time and microbial consortium selection govern the interactions between quality, safety, and compositional attributes, acting as critical determinants of the initial stability state of grape by-product kombuchas and as key control parameters for subsequent shelf-life management and quality preservation strategies.

Keywords: antioxidants, shelf-life stability, by-products, bioactive

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OC06 Enhanced Antioxidant Functionality in Electrospun PHBV Films Incorporating Resveratrol Solubilized in Deep Eutectic Solvents for Sustainable Food Packaging Applications

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This study demonstrates the effective use of deep eutectic solvents (DES) to significantly enhance the antioxidant performance of resveratrol (Res), a natural antioxidant with limited solubility, within biodegradable poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) films. The incorporation of DES addresses a major bottleneck in the application of poorly soluble natural antioxidants in polymer matrices.

Several DES formulations were screened, and the selected composition exhibited a remarkable improvement in Res solubility—17,400-fold higher than in water and 25-fold higher than in dimethyl sulfoxide (DMSO). This DES-solubilized Res was subsequently incorporated into PHBV films produced by electrospinning followed by thermal annealing, yielding continuous, non-porous films with enhanced antioxidant performance. Notably, films containing DES-solubilized Res displayed a 30% increase in antioxidant activity and material efficiency compared with films loaded with the same amount of non-solubilized Res. Comprehensive characterization—including wide-angle X-ray diffraction, optical, mechanical, and barrier property analyses—confirmed that the integration of DES-solubilized Res improved the functional performance of PHBV films without compromising their structural integrity.

Overall, this work establishes a new benchmark for active food packaging by increasing the effectiveness of resveratrol loading in polymeric films, enhancing active properties, reducing material cost, and contributing to potential shelf-life extension of food products. These findings highlight DES as a powerful strategy for overcoming solubility limitations of natural antioxidants, paving the way for more efficient and sustainable active packaging solutions.

Keywords: PHBV, DES, resveratrol, electrospinning, active packaging

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OC07 Carbon Quantum Dot Washable Coatings for Shelf-Life Extension of Capsicum frutescens L.

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Carbon quantum dots (CDs) derived from biomass precursors have emerged as multifunctional nanomaterials for active food packaging due to their antioxidant and antimicrobial properties. In this study, CDs were synthesized from Zanthoxylum limonella Alston, a phytochemical-rich tropical fruit, and incorporated into a washable edible coating to extend the shelflife of Capsicum frutescens L. (Jinda chili). Hydrothermal synthesis using precursor concentrations of 10, 20, and 40 wt% produced CDs with tunable surface chemistry and solid contents of 1.68, 2.97, and 5.22 wt%, respectively. Spectroscopic and microscopic analyses confirmed that the CDs contained abundant oxygen- and nitrogen-containing functional groups, including hydroxyl, carbonyl, ether, and amide moieties together with pyridinic, pyrrolic, and graphitic nitrogen species. The CDs exhibited strong UV absorption in the range of 220–320 nm and amorphous spherical morphology with particle sizes below 10 nm. The CDs demonstrated high antioxidant performance, with DPPH radical scavenging activity reaching 94.9% at 100× dilution for the 1.68% CD sample. Antibacterial activity increased with precursor concentration, producing inhibition zones of up to 18.03 mm against Escherichia coli and 15.28 mm against Staphylococcus aureus for the 5.22% CD sample. Strong antifungal activity against Colletotrichum capsici was also observed, yielding a clear zone of 21.44 mm. For practical application, the CDs were incorporated into a xanthan gum–carboxymethyl cellulose washable coating. Coated chilies showed reduced moisture loss, improved firmness, and delayed quality deterioration under both ambient and refrigerated storage compared with uncoated controls. The coating could be completely removed by simple rinsing, addressing consumer concerns regarding ingestible coatings. Overall, this work demonstrates a sustainable pathway from phytochemical-rich biomass to a consumer-friendly washable active coating for fresh produce preservation.

Kasetsart University Research and Development Institute (KURDI) and Faculty of Agro-Industry, Kasetsart University, Thailand

OC08 Novel biodegradable antimicrobial film and its suitability as food contact material against Campylobacter spp.

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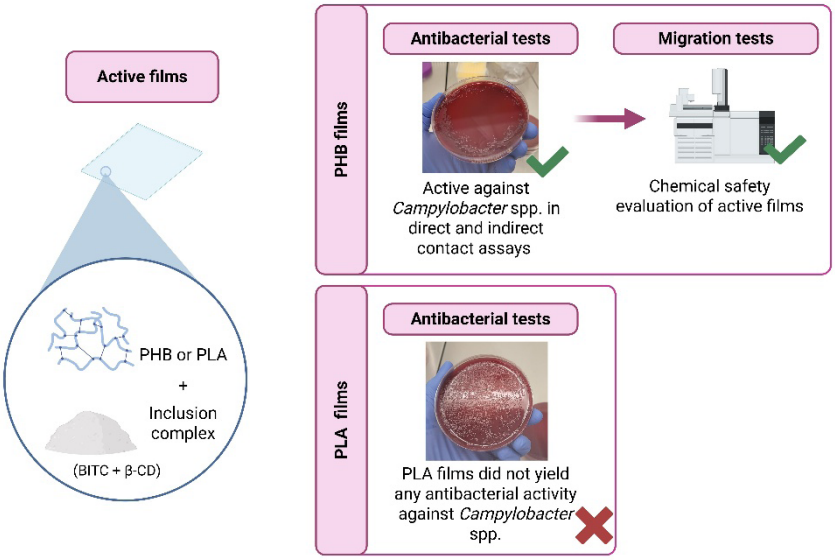
Our study focused on developing biodegradable active films with antibacterial properties against pathogenic Campylobacter spp. For that purpose, an Inclusion Complex (IC) synthesized with β-cyclodextrin, and benzyl isothiocyanate (BITC), was incorporated by extrusion into polyhydroxybutyrate (PHB) and polylactic acid (PLA), at 2.5 and 5 %, and films were prepared by hot-pressing. The anti-Campylobacter effect was assessed by direct contact and in vapour phase. The IC alone exhibited strong antibacterial activity comparable to pure BITC. PHB_IC films showed good antibacterial performance, achieving total inhibition of C. jejuni at 2.5 % and C. coli at 5 %, and yielding inhibition halos up to 50 mm in vapour phase. Contrarily, PLA_IC films showed no antibacterial effect, and BITC was not detected, likely due to differences in polymer matrix or extrusion conditions. To further investigate the use of these films as food contact materials, migration tests into food simulants were conducted. Volatile and non-volatile compounds were identified by GC-MS and UPLC-QTOF-MS, with most being intentionally added and only three detected as non-intentionally added substances. Overall, the developed PHB-based material showed strong anti-Campylobacter spp., no detectable migrants from the IC, and industrial scalability, supporting its potential for active food packaging, although further studies are needed.



Graphical abstract

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OC09 ANTIMICROBIAL PACKAGING BASED ON AN ENVIROMETALLY FRIENDLY ETHANOL EMITTER TO REDUCE DECAY IN STRAWBERRIES

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Ethanol emitters often consisting of a microperforated petroleum-based sachet filled with silica dioxide have been used as packaging inserts to prevent the growth of postharvest diseases, thereby extending produce shelf life. Due to the current shift toward sustainability and public health concerns, bio-based, biodegradable, and non-toxic materials are desired in packaging. This study aimed to develop a more environmentally friendly ethanol emitter consisting of ethanol-releasing shellac-coated bagasse paperboard and validate its effectiveness against fungal growth in packaged strawberries. Bagasse paperboard coated with single to multiple layers of shellac with trapped ethanol were developed using the bar coating technique and assessed for ethanol release using gas chromatography for screening. The in-vitro effectiveness assessment of the paper-based ethanol emitter was performed using two main postharvest pathogens, gray mold (Botrytis cinerea) and blue mold (Penicillium spp.), grew on Petri dishes within bioassay systems with and without the emitter for 7 days at 23 °C. The best-performing emitter, with an ethanol release of up to 176 µL/L per cm2 of paperboard via first-order release kinetics reduced the growth of Botrytis cinerea by > 98% for 7 days and Penicillium spp. by 50% for 4 days inside the bioassay systems. A 5-day shelf-life study of strawberries, infected with Botrytis cinerea and stored in sealed plastic packages on bagasse paperboard, showed decay was reduced by 30% when the bagasse paperboard had the shellac coating (71-266 µL ethanol/L air). The emitter also delayed strawberry darkening ($p < 0.05$) and had no effect ($p > 0.05$) on strawberry respiration, transpiration, and firmness. The above shows that the developed ethanol-emitting shellac-coated bagasse paperboard can preserve the freshness of packaged strawberries. This study demonstrates the potential of a bio-based, biodegradable, and non-toxic ethanol emitter on extending the shelf life of strawberries and, most likely other food products.

Keywords: fruit, antimicrobial packaging, shelf-life extension, sustainability, shellac

OC10 Synergistic Polyphenol-Capped Silver Nanoparticle Coatings for Enhanced Shelf-Life Stability of Date Fruits and Pastries

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Introduction: Moisture migration, oxidative degradation, and fungal contamination are major factors limiting the shelf life of sugar-rich foods. This study aimed to develop a multifunctional edible coating based on zein-hydroxypropyl methylcellulose (HPMC), simultaneously incorporating date seed extract (DSE) and its derived biosynthesized silver nanoparticles (AgNPs), to achieve synergistic structural and bioactive effects.

Materials and Methods: AgNPs were green-synthesized using DSE as both reducing and capping agent and incorporated into zein-HPMC films at concentrations up to 0.025%. Structural (SEM), mechanical, optical, and barrier properties were evaluated. Molecular docking was performed to investigate interactions between polyphenol-capped AgNPs, the zein matrix, and key fungal enzymes. The optimized coating was applied to date fruits and pastries, and quality parameters were monitored during storage.

Results: SEM analysis revealed a compact and homogeneous morphology in nanocomposite films, reflecting strong molecular interactions within the matrix. These interactions resulted in concentration-dependent reinforcement: tensile strength increased by 27.4%, elongation at break by 152.1%, while water vapor permeability decreased by 48.6% and light transmittance dropped below 2%. Biologically, the coating exhibited dual functionality through antioxidant activity from DSE and antimicrobial efficacy of AgNPs. Coated samples retained over 70% of initial firmness and showed 86% and 60% lower weight loss in fruits and pastries, respectively. Fungal growth was reduced by up to 87% in fruits and 77% in pastries ($p<0.05$). Docking simulations confirmed strong binding affinities between capped nanoparticles and fungal enzymes, supporting a mechanistic explanation for antifungal activity.

Conclusion: Embedding both DSE and its derived AgNPs within a biodegradable matrix generated synergistic improvements in structural integrity and preservation efficiency. This nanostructured coating effectively extended shelf life while valorizing agro-industrial by-products, offering a sustainable and scalable strategy for active food packaging applications.

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OC11 Plasma-Polymerized Polycaprolactone Coatings with Encapsulated Citronellal for Preserving Cooked Pork Sausage

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Background: The growing demand for minimally processed foods without synthetic preservatives has intensified the need for sustainable active packaging technologies capable of extending shelf life. This study aimed to develop an antimicrobial coating based on plasma-polymerized polycaprolactone with encapsulated citronellal, enabling controlled release of a natural antimicrobial compound for the preservation of cooked pork sausage.

Methods: Plasma-polymerized polycaprolactone (PCL) coatings containing 10, 15, and 20 wt% citronellal were deposited on polylactic acid films using aerosol-assisted atmospheric pressure plasma deposition. Citronellal was co-introduced with the polycaprolactone precursor in aerosol form, allowing its physical encapsulation within the growing plasma-polymerized polymer network. The coatings were characterized using atomic force microscopy, scanning electron microscopy, X-ray photoelectron spectroscopy, and water contact angle measurements. Citronellal release was quantified over ten days in food simulants using headspace solid-phase microextraction coupled with gas chromatography–mass spectrometry. Antimicrobial performance was evaluated in vacuum-packed cooked pork sausage inoculated with Listeria monocytogenes (L. monocytogenes) and lactic acid bacteria (LAB) and stored at 7 °C for eleven days.

Results: The results confirmed successful citronellal encapsulation, evidenced by systematic increases in coating thickness from 323 nm to 472 nm and surface roughness from 26.4 nm to 37.5 nm with increasing citronellal content. Surface hydrophobicity increased accordingly, with water contact angle values rising from 75.0 ° to 91.9 °. Release studies showed a sustained citronellal release, with faster diffusion in ethanol-based simulants and slower, prolonged release in aqueous systems. Antimicrobial tests demonstrated a clear concentration-dependent effect, with the 20 wt% citronellal coating achieving reductions of 5.75 CFU/ml for L. monocytogenes and 5.48 CFU/ml for LAB after eleven days compared to the control.

Conclusion: These findings demonstrate that plasma-assisted encapsulation enables controlled release and sustained antimicrobial activity, offering a solvent-free and environmentally friendly approach for extending the shelf life.

OC12 Development and Evaluation of Prickly Pear Extract-Loaded Pectin Films for Extending Poultry Meat Shelf Life

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Food waste represents a major challenge today, driving the search for innovative solutions to increase the shelf life and safety of food products. In this context, active packaging has stood out for its functional properties, interacting with food and extending its shelf life. Opuntia ficus-indica (OFI) fruit (prickly pear), is rich in sugars, minerals, dietary fiber, and bioactive compounds (e.g. ascorbic acid, betalains, flavonoids, phenolics). Therefore, this study aimed to evaluate the effectiveness of pectin- films incorporated with hydroalcoholic extracts of OFI in extending the shelf life of poultry meat. Due to its high content of unsaturated fatty acids, poultry meat is particularly susceptible to lipid oxidation and microbial spoilage, making it suitable for active packaging applications. Extracts obtained from the pulp and peel (red variety) were characterized (pH, extraction yield, color, °Brix, total phenolic content, betalains, and antioxidant activity). Films (pristine pectin and pectin with 1% pulp or peel extract) were applied to poultry meat, and quality parameters—color, moisture, pH, total volatile basic nitrogen, lipid oxidation, and microbial load—were monitored during refrigerated storage. Results showed that OFI-pectin films effectively inhibited lipid oxidation throughout storage (less 30-40% compared to pristine pectin), highlighting their antioxidant potential. However, no significant improvement in antimicrobial activity was observed compared to pristine pectin films, possibly due to the low extract concentration (1%) and interactions between phenolic compounds and pectin. Nevertheless, all pectin films reduced microbial growth relative to unwrapped samples. After 14 days of storage, reductions of 0.50–0.73 log CFU/g (mesophilic), 0.44–0.63 log CFU/g (psychrotrophic), and up to 1.15 to 1.24 log CFU/g (Enterobacteriaceae) were observed. In conclusion, OFI-pectin films show considerable potential as active packaging materials, primarily due to their antioxidant properties, although further optimization is needed to enhance antimicrobial performance.

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OC13 Revalorization of Post-Consumer PLA using Supercritical Technologies

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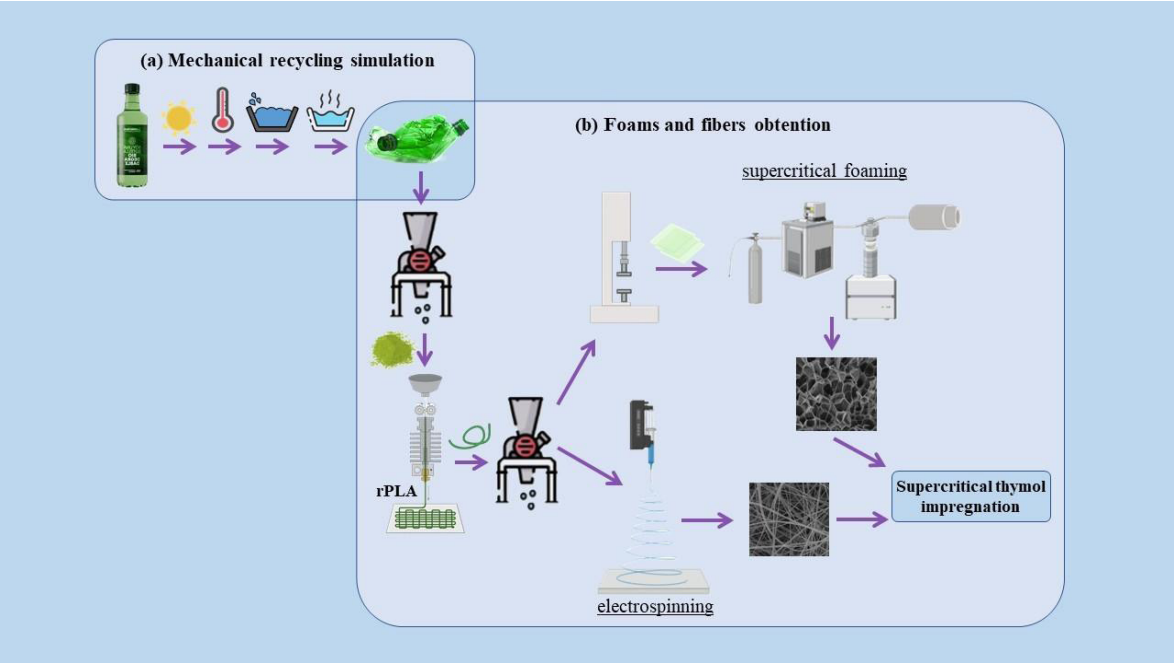
The widespread use of conventional plastics has caused significant environmental problems due to their persistence after disposal. Polylactic acid (PLA), which is derived from renewable sources, has attracted interest as an alternative material for food packaging. However, the management of PLA at the end of its life remains limited. In this context, reusing post-consumer PLA to create functional materials is a strategy that aligns with the principles of the circular economy. Supercritical CO_2 technology was employed to infuse bioactive compounds into recycled PLA matrices, resulting in the development of foamed structures and polymer fibers with potential applications in active packaging. The materials retained their morphology and thermal stability following recycling and functionalization, and release studies demonstrated the sustained release of bioactive compounds, which was more efficient in foams than in fibers. Additionally, biological tests revealed significant antimicrobial activity against Salmonella enterica and Penicillium expansum, indicating the potential of these materials for use in active food packaging.



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OC14 Impact of Nanoemulsion Properties on the Physical and Functional Performance of By-Product-Based Biopolymeric Active Films

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Agri-food by-products are increasingly recognized as sustainable sources of active compounds (ACs) for food packaging applications. Tomato by-products oleoresins (TBO) are rich in carotenoids, tocopherols, and polyphenols, while mustard essential oil (MEO) represents a valuable source of allyl isothiocyanate and natural antioxidants.

This study aims to develop and characterize biopolymeric active films from agri-food by-products by systematically studying how the dispersion of the oil phase in biopolymer solutions affects the film properties.

TBO was incorporated into sodium caseinate–guar gum–beeswax films cross-linked with microbial transglutaminase via ultrasonication, progressively replacing beeswax across five formulations. MEO was incorporated into alginate films cross-linked with Ca^{2+} ions via high-pressure homogenization, using two MEO concentrations (0.0128% and 0.0512%), two pressure levels (400bar and 800bar), and one or three homogenization cycles, for a total of eight formulations. A common methodological framework was applied to investigate the relationships among nanoemulsion viscosity, particle size distribution (PSD), physical stability, and the resulting film's physical and functional performance.

Replacing beeswax with TBO enhanced nanoemulsion stability and viscosity while narrowing PSD. The resulting film showed worse mechanical strength and elongation, but increased water solubility, surface hydrophobicity, and thermal stability. Films from nanoemulsions with narrower PSD exhibited higher antioxidant activity (40% DPPH and 60% ABTS inhibition). MEO nanoemulsions showed comparable viscosity and ζ-potential across all formulations. Higher MEO concentrations produced narrower, unimodal PSD but reduced physical stability. Stable nanoemulsions with a smaller hydrodynamic diameter yield films with reduced water solubility and opacity, enhanced water vapour barrier and mechanical properties. Films from more homogeneous nanoemulsions exhibited higher antioxidant activity (50% ABTS inhibition).

Overall, this study highlights the key role of nanoemulsion properties in governing the structure-property relationships of complex biopolymer films, supporting the valorization of agri-food by-products and the development of innovative active packaging solutions for food preservation.

Keywords: tomato by-product oleoresins, mustard essential oil, particle size distribution, sustainable film, antioxidant packaging

OC15 Eugenol-Derived Carbon Dots as Bio-Based Nanofillers in Chitosan-Based Active Coatings for Food Packaging Applications

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Carbon dots (CDs) are fluorescent carbon-based nanomaterials widely investigated for their tuneable optical properties, chemical stability, and multifunctional surface chemistry 1,2. The sustainable synthesis of CDs from renewable bio-based precursors offers green alternatives for the development of active materials 3,4. In this work, eugenol, a natural phenolic compound from clove oil with known antioxidant activity, was employed as a carbon source to synthesize bioactive eugenol-derived CDs (Eug-CDs). Furthermore, Eug-CDs were subsequently incorporated at different concentrations into chitosan (CS) solutions to develop active coatings on low-density polyethylene (LDPE) substrates for potential food packaging applications 5.

Eug-CDs were synthesized via a bottom-up thermal treatment under controlled heating and characterized in terms of their physicochemical and structural properties. Structural characterization was performed by Fourier Transform Infrared Spectroscopy (FTIR) to identify surface functional groups. The release profile was analysed by UV–Vis absorption, while electronic transitions and emission behaviour were investigated by fluorescence spectroscopy. The antioxidant activity of both pristine eugenol (Eug) and Eug-CDs was determined by the DPPH radical scavenging assay. CS-based active coatings on LDPE containing either unmodified Eug or Eug-CDs were prepared and comparatively analysed.

FTIR spectra confirmed the presence of hydroxyl, aromatic, and oxygen-containing functional groups on the CD surface, indicating partial retention of eugenol-derived functionalities after carbonization. UV–Vis analysis showed characteristic π–π^* and n–π^* transitions, while fluorescence spectroscopy revealed excitation-dependent emission typical of carbon dots. The DPPH inhibition results demonstrated that Eug-CDs significantly enhanced antioxidant activity compared to pristine Eug, with inhibition reaching up to 99.7% at 50 mg/L. Eug-CDs were embedded at various concentrations in CS solution used to coat LDPE films and the resulting active materials were thoroughly characterised. Importantly, the presence of CDs may modulate the release kinetics, resulting in higher cumulative release and better dispersion in the polymer matrix than the corresponding coatings containing unmodified Eug.

These findings indicate that the Eug-CDs not only enhances antioxidant functionality but also modulates release behaviour when incorporated into polysaccharide-based coatings. The study highlights the potential of Eug-CDs as bio-based nanofillers for developing sustainable active packaging materials with improved antioxidant performance.

Keywords: Eugenol-derived carbon dots; Active packaging; Antioxidant activity; DPPH inhibition; Chitosan-based coatings

 x

Figure 1. Image of aqueous samples under UV irradiation, showing the bright green fluorescence of Eug-CDs (centre) compared to the non-fluorescent control solutions (left and right), confirming CDs synthesis.

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PNRR Project MICS Made in Italy Circolare e Sostenibile

OC17 Improving Functional and Barrier Performance of Paper through Biodegradable Polymer Coatings

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Consumers have traditionally viewed food packaging negatively due to its reliance on petrochemical resources and polluting waste, driving interest in sustainable alternatives using renewable materials, biodegradable plastics, and improved recyclability. Paper and cardboard are increasingly favoured as environmentally friendly options, combining functionality and degradability, but their limited moisture and grease resistance restricts direct use in food contact applications, motivating research on biodegradable coatings. This study aimed to enhance paper performance for direct food contact by coating it with biodegradable polymers, specifically polycaprolactone (PCL), poly(butylene succinate) (PBS), poly(3-hydroxybutyrate-co-3-hydr oxyhexanoate) (PHBH) and cutin, a side-stream product derived from tomato peels and seeds. Various formulations, using individual polymers or blends with cutin, were applied on paper sheets via bar coating; the samples were characterized for grammage, thickness, and microstructure via SEM, the latter showing effective pore occlusion in all cases. Grease resistance was tested with the T 559 pm-02 ("Kit 12") method, including folded samples to simulate mechanical stress. PCL coatings maintained high resistance after folding, whereas PBS and PHBH showed reduced performance. Additional analyses—including Cobb60, water and oil contact angle, mechanical properties, heat-sealability, and WVTR—confirmed improved barrier performance; indeed, WVTR measurements showed significant reductions, in some cases up to 90%, although values remain high for high shelf-life food packaging. Soil degradation tests demonstrated notable biodegradability, and practical trials on cooked ham and cookies ('amaretti') showed a possible future applicability for real food packaging. Biodegradable polymer coatings can significantly improve paper's barrier properties while maintaining environmental degradability, enabling use in direct food contact and sealed packaging. Some formulations already show promise for practical applications, though further optimization is required for long shelf-life foods.

OC18 Evaluation of Chitosan-Based Composite Aerogels Infused with Cocoa Pod Husk Powder for Enhanced Ethylene Absorption and Fruit Shelf-Life Extension

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Biopolymer aerogels have excellent porosity for sustainable materials, but cocoa pod husk (CPH), a 20-million-ton yearly waste stream, is underutilized. This study investigates the development of a novel composite aerogel utilizing CPH as a functional filler to evaluate its physicochemical characteristics and ethylene-absorbing potential for fruit preservation. Aerogels were synthesized via lyophilization using a matrix of 2% chitosan (CH) and 0.2% hydroxypropyl methylcellulose (HPMC). The matrix was reinforced with CPH powder at 10% and 20% (w/w) and CPH-based activated carbon (CPH-AC) at 10% (w/w). Scaffolds were conditioned at 25°C and 50% relative humidity prior to evaluating physical, mechanical, and physicochemical properties. Morphological and structural analyses were conducted using SEM, XRD, and FT-IR. CPH inclusion significantly influenced aerogel properties, decreasing lightness (L*) while increasing redness (a*) and surface wettability; contact angles increased from 86.22° (control) to 91.77° for CPH-AC treatments. Mechanical performance showed that tensile strength improved with CPH concentration (CH < CH+10%CPH < CH+20%CPH < CH+10%CPH-AC). CPH also increased compression strength, while CPH-AC had a little drop compared to regular CPH mixes. All treatments had high water absorption (93.94%–96.15%). SEM showed a well-defined 3D porous architecture in all formulations, while XRD and FT-IR showed no significant chemical fingerprint shifts in the chitosan matrix after CPH integration. Functionally, CH+10%CPH-AC aerogel absorbed ethylene (96%) more than CH+10%CPH aerogel (75%), CH aerogel (65%), and pure CPH powder (25%). In application, after 5 days at 25°C, bananas stored with CH+10%CPH-AC aerogels retained their freshness and color better than the control, proving their ethylene scavenging ability. This research demonstrates that CPH can be successfully upcycled into high-value biopolymer aerogels. These composites provide a sustainable, bio-based solution for ethylene management, supporting the transition toward circular bio-economy models in fruit preservation technology.

OC19 PROTECTING ROSÉ WINE QUALITY FROM LIGHT EXPOSURE USING A COLORLESS UV-FILTER COATING ON FLINT BOTTLES

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Introduction: Rosé wines are highly sensitive to light because of their low anthocyanin content, widespread use of transparent bottles, and the presence of photosensitizers such as riboflavin, which promote color loss and light-struck taste. This study aimed to evaluate the photoprotective performance of a commercial, colorless sol–gel UV-filter coating applied to flint bottles, compared with uncoated flint and Antique Green glass, under natural and accelerated light exposure.

Materials and methods: Rosé wine was bottled in flint, coated flint, and Antique Green bottles. Those bottles were subjected to accelerated irradiation under fluorescent light for 24 h or exposed to natural light for up to 64 weeks, using dark-stored wines as controls. CIELab color parameters, total anthocyanins, individual phenolics, and riboflavin were monitored by spectrophotometry and HPLC.

Results: In flint bottles, both light stimuli caused marked decreases in a*, increases inb*, and large ΔE values, accompanied by substantial losses of total anthocyanins, hydroxycinnamic acids, and rapid, near-complete riboflavin degradation. The UV-filter coating consistently slowed the phenolic loss compared to uncoated flint bottles but did not prevent perceptible color changes or riboflavin depletion after prolonged exposure. Antique Green bottles showed the highest chromatic stability, particularly under accelerated irradiation, with ΔE values below the usual visual threshold and more limited anthocyanin degradation, although progressive yellowing still occurred under long natural storage.

Conclusion: The commercial colorless UV filtering coating establishes a new intermediate level of photoprotection between unprotected Flint and colored glass, offering partial preservation of rosé wine colour and phenolic integrity without altering bottle appearance. This transparent coating concept opens a promising route to tailor light protection in wine packaging according to product sensitivity and marketing demands.

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OC20 Shelf-life evaluation of innovative bakery product enriched with Chlorella vulgaris under accelerated conditions (ASTL)

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In the current scenario, characterized by rising consumer demand for highly nutritional and functional foods, microalgae such as Chlorella vulgaris are gaining significant attention as sustainable ingredients with a high nutritional profile. Indeed, this microalga is rich in high-quality proteins (51-58%), fibers (~11%), polyunsaturated fatty acids, minerals, and vitamins. While incorporating this microalga into bakery products enhances their nutritional profile, it also substantially changes their characteristics (technological, rheological, sensorial), which can significantly affect the shelf-life of the specific product.

This study aims to evaluate the shelf-life behavior of an industrial-scale breadstick prototype, produced by an Italian bakery and enriched with 5% C. vulgaris (w/w on total flour).

Preliminarily, the influence of introducing aromatic herbs into the recipe on the mitigation of the typical algae off-flavours, to improve the breadsticks' sensory acceptability, was evaluated. A consumer test was conducted on three different prototypes: the control (without any aromatic herbs) and two enriched breadsticks, one with fennel seeds (1% w/w of the total flour) and the other with rosemary (1.5% w/w of the total flour), in order to collect their liking scores and choose the favourite one. After this step, the best product (resulting from the consumer responses) was produced and then packaged by an industrial partner into a secondary white polypropylene package, containing 6 small transparent polypropylene packs of approximately 20 g each. Multipacks were stored in a climate chamber under tropical conditions (38°C, 90% RH), to conduct an accelerated shelf-life test (ASLT). A total of eight sampling times were established, occurring precisely every seven days. The quality of the product was evaluated by monitoring different parameters at each time point, notably water activity (aw) and moisture content (M), colour parameters (CIELab) and sensory properties judged by trained panellists, in order to establish the durability of the novel breadsticks.

OC22 Botanical Extracts as a Multifunctional Strategy for Shelf Life Extension and Quality Preservation in Lipid-Based Foods

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Introduction

The replacement of synthetic antioxidants with natural alternatives represents a key challenge in the development of sustainable and clean-label food products. Among plant-derived compounds, botanical extracts rich in polyphenols have gained increasing attention due to their antioxidant potential. However, their application in foods rich in lipids is often limited by solubility constraints and technological challenges. This study explores the use of polyphenols-rich extracts as multifunctional ingredients to improve shelf life, oxidative stability, and overall food quality across different lipid-based systems.

Materials and Methods

The effectiveness of the botanical extracts was evaluated in different model and real food systems, including water-in-oil emulsions, bulk oils, and meat products. Innovative delivery strategies, such as emulsified systems, were applied to enhance the dispersion and functionality of hydrophilic compounds in lipid environments. Oxidative stability was assessed through primary and secondary oxidation markers (e.g., hydroperoxides, TBARS, organic volatile compounds), while physical stability and quality attributes (color, texture, and sensory perception) were also investigated.

Results

The enrichment with polyphenols extracts consistently improved oxidative stability across all tested systems, significantly reducing lipid oxidation markers and extending lag phases compared to controls ($p < 0.05$). In several cases, their performance was comparable to or better than conventional synthetic antioxidants, such as BHT and tocopherols. In addition, these extracts contributed to maintaining or enhancing key quality attributes, such as color stability in meat and sensory acceptance in fried products, without negatively affecting texture or overall consumer perception. The use of emulsified systems further enhanced antioxidant effectiveness, highlighting the importance of delivery strategies in shelf life optimization.

Conclusion

These findings demonstrate the potential of botanical extracts as sustainable, natural solutions for protecting food quality and extending product shelf life. When combined with innovative formulation approaches, they enable the development of clean-label products aligned with current consumer expectations and food industry needs.

OC23 Doped Carbon Dots Derived from Biomass Enable Active Coatings for Cherry Tomato Shelf-Life Extension

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A key challenge in the food packaging industry is maintaining the freshness and quality of fresh produce while extending shelf life in a sustainable manner. This study investigates the potential of biomass-derived, nitrogen-doped carbon dots (CDs) as functional nanomaterials for active food packaging applications. CDs, known for their rich surface chemistry, tunable optical properties, and environmentally friendly synthesis, were successfully synthesized via a hydrothermal method using pineapple cores as the primary carbon source and edamame peels as a natural nitrogen dopant. Spectroscopic characterization revealed a strong ultraviolet absorption band at 230–280 nm, attributed to π–π^* transitions within aromatic carbon domains, along with a secondary shoulder at approximately 300–350 nm associated with n–π^* transitions of surface functional groups, the intensity of which increased with nitrogen doping. Under ambient conditions, the aqueous CD dispersions appeared yellowish-brown and exhibited bright blue fluorescence under ultraviolet irradiation, indicating the formation of stable emissive centers. Transmission electron microscopy confirmed the formation of uniformly dispersed nanoscale particles with partially graphitized structures and lattice spacings of approximately 0.20–0.25 nm, reflecting a balance between ordered carbon frameworks and dopant-induced defects. The synthesized CDs were subsequently incorporated into a polyvinyl alcohol (PVA) matrix to form uniform and transparent coatings. When applied to fresh tomatoes, the CD-based coatings significantly reduced weight loss, delayed ripening, and suppressed spoilage during storage compared with uncoated samples. These improvements are attributed to the combined barrier and active functionalities of the CDs, including their interactions with moisture and oxidative processes. Overall, this study demonstrates an effective strategy for converting agricultural waste into high-value carbon nanomaterials and highlights their strong potential for use in sustainable, multifunctional food packaging systems.

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OC24 Active-Intelligent microcrystalline cellulose-modified alginate film for preserving and monitoring meat quality

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This research guides future food packaging innovation toward sustainable active and intelligent packaging that combine the functions of biodegradable alginate-based film, microcrystalline cellulose, pH-sensitive anthocyanin, and green tea extract. Biodegradable active-intelligent packaging film was prepared from sodium alginate (SA) modified with microcrystalline cellulose (MCC) to improve its physical properties. The film was also incorporated with red cabbage (Brassica oleracea) anthocyanin (RCA) as a natural colorimetric pH indicator, and green tea extract (GTE) as antioxidant and antimicrobial agents. The developed film was analyzed for physical properties, antioxidant activity (TPC, DPPH, and ABTS), antimicrobial activity (against Escherichia coli and Staphylococcus aureus), and pH sensitivity. The results suggested that the addition of MCC improved the tensile strength, water vapor and oxygen barrier properties, and opacity of the SA film. When incorporated with RCA, the SA-MCC film showed enhanced antioxidant activity and UV-blocking and exhibited a distinct color response to pH and ammonia vapor. Moreover, GTE significantly improved antioxidant and antimicrobial activities of the film. The optimal fabricated film was then applied as active-intelligent packaging for preserving and monitoring fresh meat quality. The developed film can simultaneously preserve quality of fresh meat by exhibiting antimicrobial and antioxidant effects and can alter its color according to the meat quality. These results indicated that sodium alginate-microcrystalline cellulose film containing red cabbage anthocyanin and green tea extract has potential to be used as a biodegradable active-intelligent packaging for monitoring and preserving food quality. The film allows consumer to visually verify the meat freshness. This study offers the promising biodegradable multifunctional active-intelligent packaging for the preservation of food quality and enhancement of food safety.

Keywords: Active-intelligent packaging, Microcrystalline cellulose, Red cabbage, Anthocyanin, Green tea extract

OC25 Nanotechnology for Food Packaging: Promise, Performance or Uncertainty?

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Nanotechnology offers promising strategies for active packaging systems, enhancing food safety and extending shelf-life. Zinc oxide nanoparticles (ZnONPs) have gained attention due to their functional performance when incorporated into polymeric matrices. However, variability in size, morphology, and physicochemical properties across commercial and laboratory-synthesised ZnONPs challenges consistent evaluation of their functionality. This work critically assesses the potential and limitations of ZnONPs for food packaging by integrating functional, migration and toxicological analyses.

ZnONPs with different morphologies were synthesized, thoroughly characterized, and incorporated into nanocellulose films to develop antimicrobial packaging for fresh-cut melon. Antibacterial activity, reactive oxygen species (ROS) generation, and electrostatic interactions were evaluated under different conditions. Zn migration was assessed using food simulants and melon model. Cytotoxic effects of commercial ZnONPs were evaluated following simulated gastrointestinal digestion.

ZnONPs alone and nanocellulose/ZnONPs films demonstrated antimicrobial activity against E. coli and S. aureus, supported by ROS generation studies. Melon trials confirmed that films containing ZnONPs significantly reduced microbial growth. Migration studies confirmed the morphology- and temperature-dependent release of Zn species. Cytotoxicity assays revealed dose-dependent reductions in Caco-2 cell viability after gastrointestinal digestion of commercial ZnONPs. Overall, results demonstrated that nanoparticle behaviour arises from complex interactions among particle properties, polymer matrix, and food environment. A survey of commercial ZnONPs revealed incomplete physicochemical characterization in supplier information. Variability in morphology, size distribution, and aggregation behaviour is a reality in all the samples but only laboratory produced ZnONPs were sufficiently characterized to allow reliable interpretation.

Despite the current enthusiasm in nanotechnology, ZnONPs are highly variable and often unstable materials. Different morphologies yield different functional outcomes, and commercial nanoparticles frequently lack essential physicochemical data. This gap between well characterized laboratory-produced nanoparticles and poorly defined commercial products remains a critical barrier to the reliable and safe implementation of ZnONPs in extending food shelf-life when applied to food packaging.

OC26 Development of active food packaging films through the valorization of grape marc

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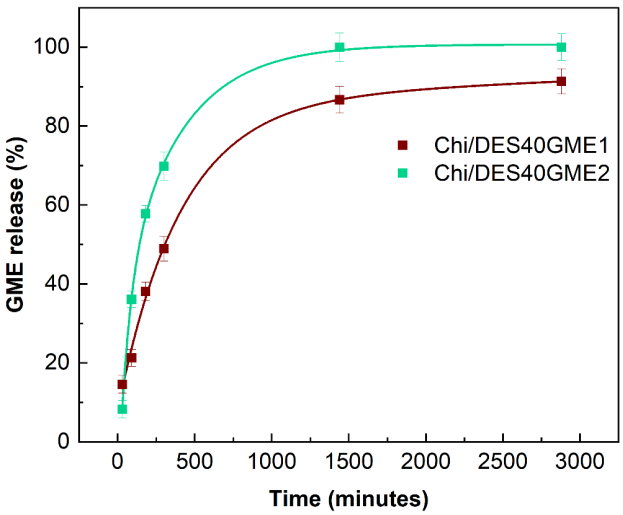
INTRODUCTION: The valorization of bio-based by-products is a key strategy for developing sustainable and active food packaging. In this context, chitin and grape marc extract, obtained from fruit fly pupae and wine industry, respectively, represent resources with potential to develop added value products. The aim of this work was to develop gelatin-based films with grape marc extract to provide the films with antioxidant functionality and improve food shelf life.

Materials and Methods: Gelatin-based films were prepared by compression molding. Chitin was dissolved using a choline chloride–citric acid (1:1) deep eutectic solvent (DES). Films containing different chitin/DES contents were produced, and those with 40 wt % chitin/DES were selected based on their mechanical and barrier properties. Grape marc extract was incorporated at 1 and 2 wt % to obtain active films. Film properties were evaluated by FTIR, UV–Vis spectroscopy, mechanical testing, water-related barrier measurements, antioxidant release assays, and DPPH radical scavenging activity.

RESULTS: The incorporation of chitin modified the mechanical behavior of gelatin films, providing high elongation at break while maintaining suitable tensile strength for packaging applications. The incorporation of grape marc extract significantly enhanced UV-blocking properties without compromising film integrity. Release studies showed a rapid initial release followed by sustained release, reaching 91 % and 100 % release after 48 h for the films containing 1 and 2 wt % extract, respectively. Antioxidant activity assays confirmed effective radical scavenging, achieving inhibition values of 73 %.

CONCLUSION: The results demonstrate that the incorporation of chitin into gelatin-based formulations enhances the film mechanical properties. Additionally, grape marc extract provides the films with antioxidant functionality. Therefore, these bio-based films show potential as active food packaging for the extension of food shelf life.

KEYWORDS: Grape marc extract; chitin; gelatin films; antioxidant capacity; active packaging.



Antioxidant release from gelatin films with different contents of grape marc extract.

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OC27 Impact of recycled content and ageing on IAS and NIAS in PET bottles

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Introduction

Environmental issues related to plastic pollution have come to the forefront, leading to regulatory actions as the European Packaging and Packaging Waste Regulation (PPWR), which introduced mandatory targets for minimum recycled content in plastic packaging. However, there is a growing concern about the safety and stability of these food contact materials (FCMs). Increasing recycled content in FCMs implies an increase in non-intentionally added substances (NIAS), due to improper post-consumer contamination or the degradation of intentionally added substances (IAS) [1]. UV light and high temperatures act as ageing factors for FCMs, accelerating polymer degradation and the additional formation of NIAS [2]. This study investigates how ageing and recycled content affect the qualitative and quantitative IAS and NIAS patterns in PET bottles.

Materials and methods

PET samples with different recycled content were aged in a climatic chamber at 60°C under UV light for 10 days. A combined characterization was carried out by HS-SPME-GC-MS, UHPLC-MS-QTOF, and UHPLC-QqQ-MS after dissolution-reprecipitation solvent extraction with HFIP-MeOH. The MS-DIAL platform was applied for compound identification. Quantification was performed in external or internal mode using calibration curves from reference standards.

Results

The analytical approach demonstrated to be capable to identify 62 compounds across different chemical classes. Both ageing and recycled content significantly affected the NIAS profile, i.e. for bisphenol A (BPA), benzaldehyde and nonanal. Higher recycled content led to a progressive rise in BPA, whereas ageing induced a decrease (13.94%-42.06%) [3]. Conversely, benzaldehyde concentration increased after treatment (up to 59.15%), whereas nonanal decreased (up to 27.12%), indicating concurrent formation and degradation pathways.

Conclusions

These findings highlight the interplay between recycling and environmental stressors on the chemical safety of rPET. The study underscores the importance of comprehensive NIAS assessment for FCMs in real-life scenarios and can contribute to the development of future regulatory guidelines.

Keywords: rPET, NIAS, BPA, FCMs

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[2] C. Bach et al., Food Chem., vol. 162, pp. 63–71, Nov. 2014, doi: 10.1016/j.foodchem.2014.04.020.
[3] N. Dreolin et al., Food Chem., vol. 274, pp. 246–253, Feb. 2019, doi: 10.1016/j.foodchem.2018.08.109.

OC28 Modelling migration of dialkyl ketones (DAKs) from food contact moulded pulp trays with alkyl ketene dimer (AKD) sizing

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Moulded pulp (MP) trays and other articles are increasingly used as sustainable alternatives for direct contact with fatty and moist foods. Following the ban of PFAS, alkyl ketene dimers (AKDs) are used as sizing agents. However, AKDs can hydrolyse to form dialkyl ketones (DAKs), which may migrate into food. DAKs are classified as Crammer Class II (intermediate toxicity) with a recommended migration limit given of 5 mgkg-1 foodstuff (BfR, 2023).

In this study, tailor-made MP trays incorporating AKD at 1.5, 3 and 4.5% (relative to sizing dispersion) was used. Migration of DAKs into 95% ethanol and isooctane (fatty food simulants) was evaluated according to EN 15519 at 20, 40 and 60 ºC over time. Three DAKs were identified and quantified by GC-MS, including palmitone and stearone. The trays exhibited strong hydrophobicity (contact angle > 115º), confirming effective sizing.

Migration showed a typical pattern observed for paper-based materials, with an initial rapid increase followed by a lower plateau. The extent of migration was strongly influenced by simulant type, temperature and the initial AKD dosage. At 20 °C, total DAK migration into isooctane (17.6 to 64.8 mgkg-1 food) was consistently higher than into 95% ethanol (7.5 to 15.5 mgkg-1 food), highlighting the lipophilic nature of DAKs. At elevated temperatures, this difference was narrowed due to enhanced swelling and diffusion. A Weibull-based model successfully describes the migration behaviour and migration at equilibrium was observed as a function of temperature and AKD concentration.

Under all tested conditions, migration levels exceeded the BfR limit. Although, this limit is applied to real food and not simulants, the results indicate a potential concern. This study showcases a relationship between the sizing formulation and use conditions on the migration of DAKS and provides a way to estimate DAK migration levels under the tested conditions without the need of further experiments.

BfR, 2023. German Federal Institute of risk assessment. Obtained at http://www.bfr.bund.de/de/methodensammlung_papier__karton_und_pappe-

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OC29 Oligoesters migrating from food varnishes and coatings – Organic synthesis, in vitro testing and exposure assessment

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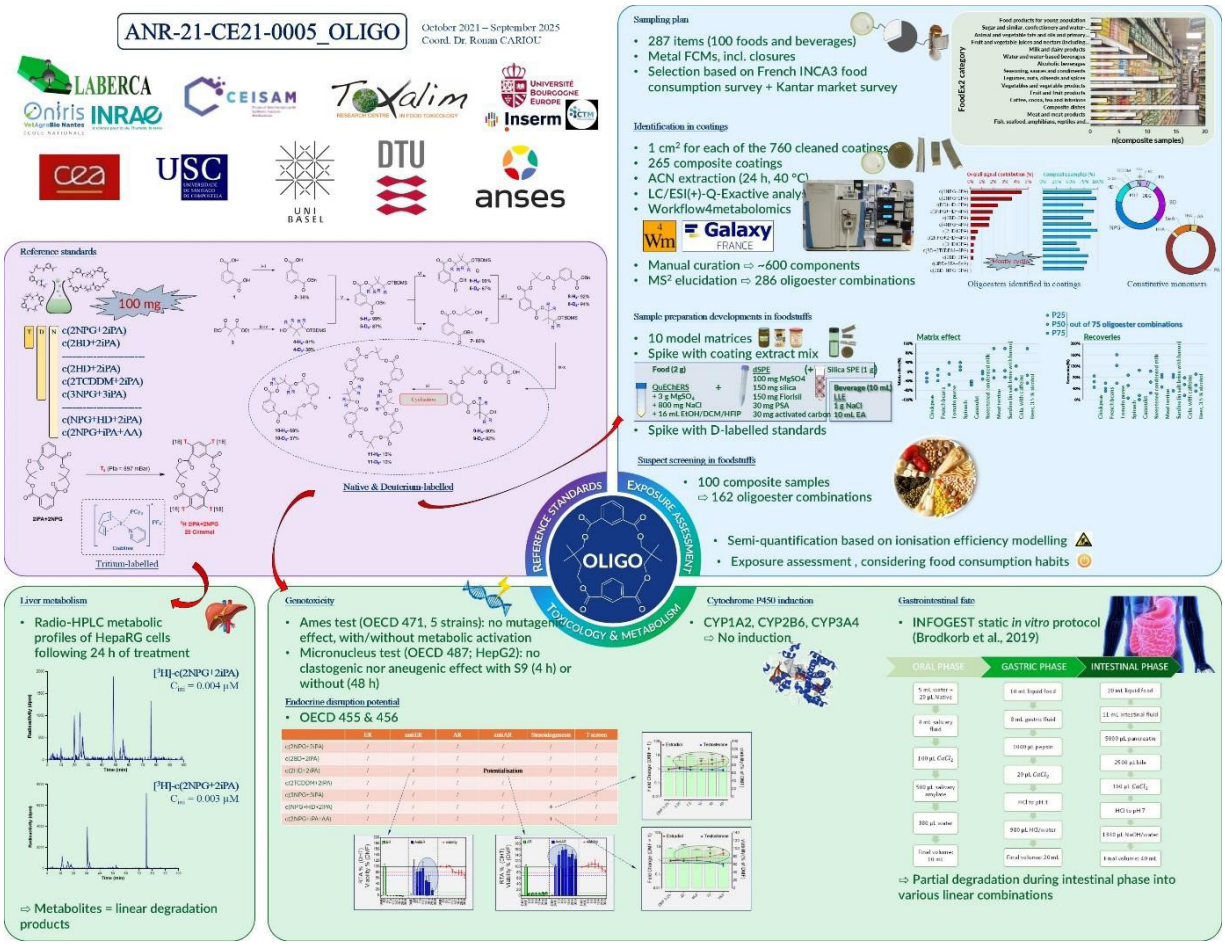
With the recent ban of bisphenol A from food contact materials (Reg EU 2024-3190), varnishes and coatings are set to undergo a shift towards polyester-based formulations as it already happened in France ten years ago (JORF, 2012). However, the diversity of monomers brings forth various oligoesters, a class of non-intentionally added substances (NIAS) for which extensive identifications and comprehensive safety assessment are still lacking. In the project OLIGO, seven cyclic oligoesters were selected and chemically synthesised step-by-step, five of which were also deuterium-labelled, two were tritium-labelled. Linear dimers and tetramers were also purified (natives, deuterated). Ames and micronucleus tests, conducted in accordance with OECD guidelines, demonstrated the expected absence of genotoxicity for the seven cyclic compounds. They did not induce cytochrome P450 enzymes in the liver either (CYP1A2, 2B6 and 3A4). However, tests for (anti-)oestrogenic, (anti-)androgenic and steroidogenic activity revealed endocrine-disrupting potential for three cyclic combinations, necessitating further testing to confirm or refute these concerns in vivo. Hepatic fate investigations on radiolabelled compounds demonstrated metabolism into linear oligoesters of progressively smaller size, accompanied by additional oxidation. Gastrointestinal fate investigations also demonstrated that the hydrolysis of the cyclic compounds had already begun upon contact with intestinal enzymes. In parallel, a sampling plan was defined based on dietary habits and consumption surveys of the French population (n=100 food items). Samples were collected from supermarkets (n=287 items). Analysis of the inner coatings allowed identifying 286 combinations (each potentially comprising several isomers) involving 10 different diols and 5 different diacids. The migration of 162 combinations was objectified in 99 of the 100 foodstuffs (22 combinations on average). Semi-quantification based on an ionization efficiency–guided machine learning framework indicated an average cumulative concentration of 200 µg/kg (max. 2400 µg/kg). Population exposure calculations (stratification) are underway.



Synopsis of the project OLIGO.

Reg EU 2024-3190. Commission Regulation (EU) 2024/3190 of 19 December 2024 on the use of bisphenol A (BPA) and other bisphenols and bisphenol derivatives with harmonised classification for specific hazardous properties in certain materials and articles intended […].

JORF n°0300 du 26 décembre 2012. LOI n° 2012-1442 du 24 décembre 2012 visant à la suspension de la fabrication, de l'importation, de l'exportation et de la mise sur le marché de tout conditionnement à vocation alimentaire contenant du bisphénol A.

S. Lama, M. Fauvel, P. Covès, C. Tatol, C. Barboux, M. Mathé-Allainmat, D. Dubreuil, J. Lebreton, L. Dahbi, A. Pissis, L. Da Costa, V. Febvret, M. Elzbieta Chraniuk, A. Odermatt, S. Bruel, L. Urien, T. Simat, C. Nerín, Å. Bergman, E. Barthélémy for technical support and/or scientific advice.

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OC30 Upcycling of mango leaves as a source of bioactive compounds for thermoplastic polyurethane (TPU)-based food packaging

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Mango (Mangifera indica L.) has become one of the most relevant subtropical crops in Spain, in particular Andalusia, with more than 30,000 tons produced in 2025. The expansion of mango cultivation has led to the generation of large volumes of agricultural residues, mainly leaves, which are typically eliminated by burning or used in excess for natural mulching. In the current transition towards a circular bioeconomy model, there is a trend to explore sustainable strategies for the upcycling of different agricultural residues and food by-products. Several studies have described mango leaves as a source rich in bioactive compounds with applications in biomedicine and nutrition. In addition, these bioactive compounds have recently attracted attention as functional additives in active food packaging. In this work, we have valorized mango leaves through the extraction of the bioactive fraction by using different solvents: tetrahydrofuran (THF), 2-methyltetrahydrofuran (2-MeTHF), and cyclopentyl methyl ether (CPME). The extraction process was experimentally optimized considering both extraction efficiency and functional properties. This was achieved by determination of the extraction yield, total flavonoid content, and antioxidant capacity. Furthermore, the composition of the extracts, analyzed by liquid Chromatography coupled to tandem mass spectrometry (LC-MS/MS), was rich in mangiferin and orobol, among others. Then, based on the overall extraction performance and antioxidant capacity, THF was selected as the most suitable solvent. Afterwards, extracts from THF were incorporated into thermoplastic polyurethane (TPU) films at different weight ratios to prepare bioplastics. They were characterized in terms of morphological, chemical, and hydrodynamic properties, mechanical performance, thermal resistance, and antioxidant capacity. Finally, their appropriateness as food packaging materials for dry foodstuffs was assessed by determination of migration values using Tenax® simulant following the Commission Regulation (EU) N° 10/2011.

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Short Oral Communication Abstracts

SOC01 Development and validation of gas exchange models for microperforated packaging under dynamic pressure conditions

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The use of microperforations in modified atmosphere packaging (MAP) is a useful strategy to increase gas exchange through the package and extend the shelf life of high-respiring fresh fruits and vegetables. During transport, packaged products are exposed to dynamic atmospheric pressure variations due to changes in altitude, which can significantly affect convective gas transfer through microperforations. Although previous studies have highlighted the relevance of pressure fluctuations on gas composition inside the package, experimental systems capable of reproducing realistic transport-related pressure profiles and validating mathematical models under controlled conditions remain limited. The aim of this work was to develop an experimental set-up to validate the predictions obtained from a previously published computational model that considers the spatial-time and pressure dependence of gas composition [1].

A controlled pressure chamber was developed to reproduce predefined pressure-time profiles representative of different transport scenarios. Packages in which gas exchange occurred exclusively through microperforations, where placed inside the chamber and instrumented with CO2 sensors. Several dynamic pressure profiles were applied, and the temporal evolution of CO2 concentration inside the packages was continuously monitored. Experimental results were compared with numerical simulations obtained using a finite-element multiphysics model coupling mass transfer and momentum transport, in which the imposed pressure profiles were incorporated as boundary conditions. A strong agreement was observed between experimental measurements and model predictions, confirming the capability of the model to accurately describe gas exchange under dynamic pressure conditions.

Once validated, the mathematical model constitutes a robust framework for predicting gas exchange in microperforated MAP under realistic transport conditions. This approach can support the design and optimisation of microperforated packages for fresh fruit and vegetables, contributing to improved shelf-life management.

Keywords: Modified atmosphere packaging; Microperforation; Pressure variation; Gas exchange modelling; Shelf-life prediction

[1] Vega-Diez, S.; Salvador, M.L.; González-Buesa, J. J. Food. Eng. 2024, 375, 112060.

SOC02 Improving antioxidant activity of chitosan film by incorporating with lemon peel-derived carbon quantum dots

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The rising consumer demand for preservative-free food products has stimulated the use of active food packaging incorporating bioactive ingredients. Chitosan (CS), a functional biopolymer, has high potential to be used as active packaging material. Although chitosan has intrinsic antioxidant property, there are some limitations in being a practical antioxidant. This research aimed to improve functional properties of CS films by incorporating with multifunctional carbon quantum dots (CQD) derived from lemon peel. The CQD was synthesized via hydrothermal carbonization using different operating temperatures (120 and 200 °C) and times (3 and 6 h). The optimal CQD exhibited an average particle size of 5.066 ± 0.580 nm and a quantum yield of 35.71%. The CS and CS incorporated with CQDs (CS-CQD) films were prepared using the solution casting method. The antioxidant activities of CQD, neat CS film, and CS-CQD film were evaluated using 2,2-Diphenyl-1-picrylhydrazyl (DPPH) and 2,2-azino-bis-3-ethylbenzothiazoline-6-sulphonic acid (ABTS) assays. The half-maximal inhibitory concentration (IC50) values of the CQD were 60.97 ± 0.59 and 49.04 ± 1.30 μg/ml for DPPH and ABTS, respectively. The CS-CQD film exhibited significantly higher antioxidant activity compared to the neat CS film. Fourier transform infrared spectroscopy (FTIR) analysis attributed this enhancement to the increased abundance of hydroxyl and carbonyl functional groups originating from the surface of CQDs. These functional groups serve as effective hydrogen atom and electron donors to stabilize free radicals and cation radicals. The CS-CQD film also showed better tensile strength and water vapor barrier than neat CS film. The developed CS-CQD film demonstrates significant potential as an antioxidant packaging for food applications.

Keywords: Active film, Antioxidant activity, Carbon Quantum Dots, Hydrothermal carbonization

SOC03 Photoresponsive Chitosan-Riboflavin Films for Light-Activated Antimicrobial Food Packaging

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Developing functional and sustainable packaging materials is crucial for improving food safety and maintaining product quality during storage. In this study, chitosan-riboflavin (CS/RF) films were prepared as light-activated antimicrobial materials and examinated for their suitability in chilled food applications. Their behavior under light exposure was investigated by analysing photochemical changes, optical stability, reactive oxygen species (ROS) generation, and antimicrobial activity. Repeated irradiation cycles with different light sources were conducted to determine activation efficiency, reversibility, and material stability. Additional measurements included color properties, light transmission, and photoconversion kinetics, while ROS productionwas linked to microbial inhibition against Listeria innocua and Pseudomonas fluorescens. The films were also applied to chicken fillets under controlled illumination to evaluate performance in a realistic food setting. The CS/RF films showed stable and consistent responses to light without affecting film integrity or handling qualities. Illumination promoted ROS generation, leading to marked reductions in bacterial growth by up to 75% after 1h and up to 93% after 2h, greatly exceeding chitosan-only controls. When applied to chicken, the films effectively limited microbial development and contributed to extended shelf life under light activation. Overall, these results emphasize the potential of naturally derived photosensitizers incorporated into biodegradable films to deliver controlled antimicrobial activity and strengthen food preservation strategies. Light activated CS/RF films present a practical and environmentally friendly option for active packaging applications aimed at improving food safety and reducing waste.

SOC06 Valorization of crustacean-derived chitin into reinforced, biodegradable bioplastics for food packaging applications

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Conventional petroleum-based plastics are extensively used in food packaging, representing the largest share of plastic applications worldwide. However, their environmental impact has intensified the search for sustainable and biodegradable alternatives capable of ensuring food quality and shelf-life preservation. In this context, chitin, the second most abundant natural polymer, emerges as a highly attractive bio-based material, as it is mainly obtained from seafood processing waste generated in large volumes annually. However, despite its biodegradability and intrinsic functional properties, the high crystallinity and strong intermolecular hydrogen bonding of chitin render it insoluble in most of the common solvents and hinder its processability using conventional polymer technologies.

In this work, chitin nanowhiskers were obtained from crustacean-derived chitin by alkaline treatment, followed by mild acidification and high-pressure homogenization and subsequently characterized by Transmission Electron Microscopy (TEM) to determine their morphology and size distribution. These nanostructures were then incorporated at different loadings into glycerol-plasticized chitin bioplastics to obtain fully bio-based nanocomposite films. The resulting materials were systematically characterized in terms of their optical, morphological, mechanical, thermal, and hydrodynamic properties. The incorporation of chitin nanowhiskers significantly influenced the final performance of the bioplastics, leading to notable changes in mechanical behavior and water-related properties as a function of nanofiller content. In addition, the biodegradability of the films was assessed by determining the biological oxygen demand (BOD) during exposure to seawater for 30 days, confirming an excellent biodegradation in marine environments. Finally, overall migration tests were carried out using food simulants for dry foods in accordance with Commission Regulation (EU) No 10/2011, showing migration values below the established limits for materials intended for direct food contact.

Keywords: Food packaging; Chitin; Bio-based plastics; Biomass; Circular bioeconomy.

This work has been partially supported by the Spanish "Ministerio de Ciencia, Innovación y Universidades" project RYC2023–042483-I/ MICIU/AEI/10.13039/501100011033 (cofinanced by the ESF+) and by the Spanish Research Council (CSIC) project 20254AT003.

SOC07 From forest by-products to active packaging: Phenolic Extracts from Pine and Eucalyptus Barks for Functional, Biodegradable Films

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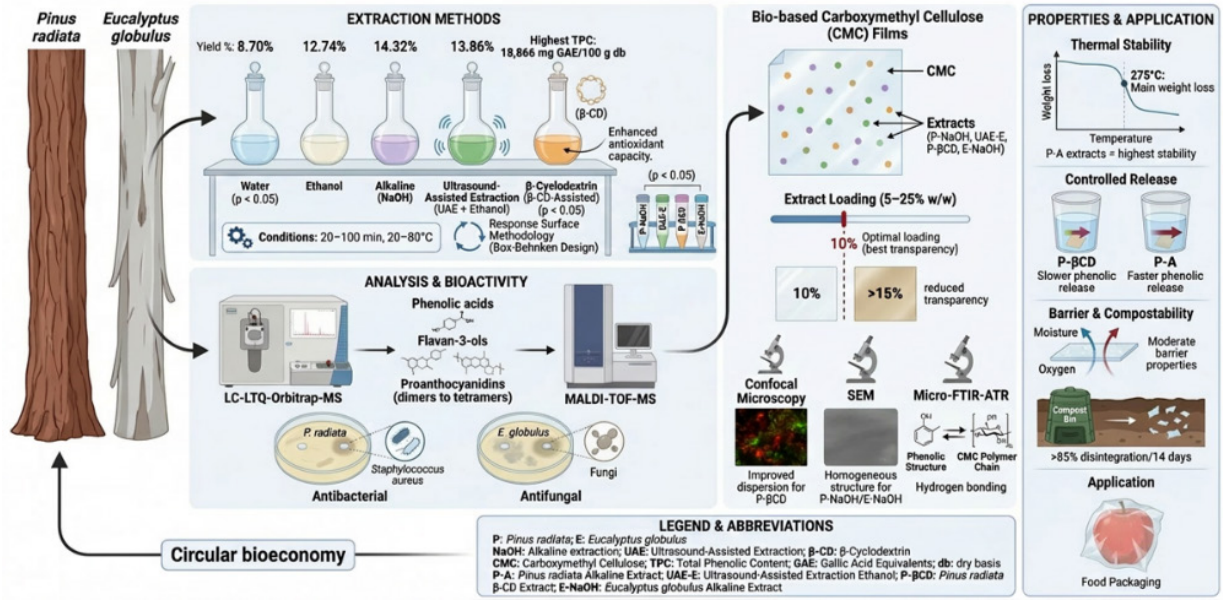
The valorization of forest by-products as a source of phenolic compounds (PCs) offers a sustainable pathway for developing active, bio-based materials. In this work, conventional (water, ethanol, alkaline) and emerging extraction systems (ultrasound-assisted extraction, UAE; β-cyclodextrin, β-CD) were optimized for Pinus radiata bark using Response Surface Methodology (Box–Behnken Design). Extraction conditions (20–100 min, 20–80 °C) significantly influenced yield and composition, with alkaline extraction reaching 14.32%, and UAE-ethanol 13.86%, followed by ethanol (12.74%). Although β-CD concentration was not statistically significant ($p>0.05$), it enabled the highest total phenolic content (18,866 mg GAE/100 g db) and enhanced antioxidant capacity. LC-LTQ-Orbitrap-MS and MALDI-TOF-MS analyses identified phenolic acids, flavan-3-ols and proanthocyanidin oligomers (dimers to tetramers), confirming a rich phenolic profile. Antibacterial assays revealed activity against Staphylococcus aureus (1). Additionally, an alkaline extract from Eucalyptus globulus with antifungal activity was also considered for biomaterial development.

Selected extracts with antimicrobial potential, namely, alkaline (P-NaOH), UAE-ethanol (UAE-E), and β-CD-assisted extracts (P-βCD), together with the alkaline E. globulus extract (E-NaOH), were incorporated into carboxymethyl cellulose (CMC) matrices (5–25% w/w) to develop bio-based films. Optical analysis showed that transparency decreased significantly above 15% loading, establishing 10% as an adequate concentration. Confocal microscopy demonstrated improved dispersion for P-βCD films, whereas SEM analysis revealed homogeneous morphologies for alkaline (E-NaOH) and P-NaOH films. Micro-FTIR-ATR showed hydrogen bonding interactions between PCs and CMC.

Thermal analysis revealed degradation with major weight loss at around 275 °C. Films with P-A extracts showed the highest thermal stability. Controlled release studies indicated slower phenolic release for P-βCD films compared to P-A. Films displayed moderate barrier properties and compostability (>85% disintegration after 14 days). These results demonstrate the potential of P. radiata and E. globulus bark-derived phenolics for sustainable, biodegradable, and functional packaging materials within a circular bioeconomy.



Graphical Abstract: From forest by-products to active packaging: Phenolic Extracts from Pine and Eucalyptus Barks for Functional, Biodegradable Films

1. Escobar-Avello D.; Oñate-Valdés T.; Ferrer V.; Fuentealba C.; Benavides-Valenzuela S.; Cabrera-Barjas G.; Bravo-Arrepol G.; Giordano A.; Gullón B.; Santos J. Antioxidants 2026, 15, 565.

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SOC08 Sustainable and reinforced lacquers from tomato pomace and microcrystalline cellulose for metal food packaging

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Metal packaging plays a crucial role in the preservation of canned foods, as it allows long-term storage while protecting food from external agents and microbial deterioration. However, direct contact between metal and food must be avoided, as metal oxidation can promote corrosion and the subsequent release of toxic substances. For this reason, petroleum-based coatings such as bisphenol A (BPA) have been used as protective barriers. Nevertheless, BPA is associated with adverse health effects, leading to its ban in the European Union, and creating the need for safe and sustainable alternatives. Here, we propose the replacement of BPA-based coatings with biodegradable lacquers derived from agri-food byproducts such as the tomato pomace, the main residue of the tomato processing industry. It does not have any added value and is typically eliminated by incineration in large quantities. In particular, tomato pomace has been used for the isolation of the lipid fraction by using a green methodology based on hydrolysis in aqueous NaOH solutions and subsequent precipitation by neutralization with HCl. This fraction was applied onto aluminum foils as a uniform coating using an optimized electrospray procedure and then polymerized by melt-polycondensation in an oven without the use of any catalyst. In a second step, microcrystalline cellulose (MCC, a food-contact-approved additive) was incorporated as a reinforcing agent to improve the mechanical performance of the coatings. Polymerization kinetics were studied at different MCC concentrations to determine optimal processing conditions by changing temperature and time of the melt-polycondensation. Moreover, the effect of the MCC content on the thermal and mechanical properties was investigated. Finally, the suitability of these materials for food packaging applications was assessed by corrosion resistance and sterilization tests, and migration assays.

Keywords: Metal food packaging; Tomato Pomace; Microcrystalline Cellulose; Electrospray; Bio-based lacquers.

This work has been partially supported by the Spanish "Ministerio de Ciencia, Innovación y Universidades" project PID2023 funded by MCIU/AEI/10.13039/501100011033/FEDER, UE.

SOC11 Design of Sustainable Ultralight TPU-Based Composite materials with Tunable Porosity for Food Packaging Conservation

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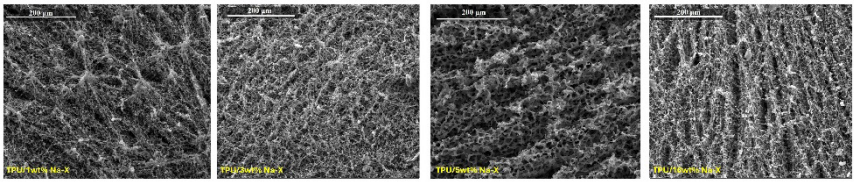
The increasing demand for sustainable and functional materials in food packaging has stimulated the development of advanced systems capable of providing thermal insulation, moisture resistance, and improved preservation performance throughout the food supply chain. Maintaining optimal temperature and barrier properties during storage and transportation remains a major challenge, particularly for perishable products. In this study, sustainable ultralight thermoplastic polyurethane (TPU)/Na-X zeolite composite [1] were developed for food-chain packaging applications using a Thermal-Induced Phase Separation (TIPS) [2] approach coupled with freeze-drying. First, Na-X zeolite (1, 3, 5, and 10 wt% with respect to TPU mass) was dispersed in a dioxane/water (9:1 v/v) solution under ambient stirring for 1h, followed by TPU addition and dissolution at 80°C for 2h (400 rpm). The homogeneous solution was placed into a liquid nitrogen bath to induce the phase separation and then frozen at -18°C for 48 h to complete it and finally freeze-dried at -40°C and 0.2 mbar for 24 h to obtain porous structure (i.e. ultralight). Structural and functional properties were investigated by FTIR, SEM, thermogravimetric analysis (TGA), density measurements, and water contact angle analysis. Results demonstrated that Na-X zeolite concentration significantly influenced TPU supramolecular organization and pore morphology, inducing a transition from microporous (20-50 μm) to nanoporous structures (see Figure 1). The composite foams exhibited very low densities (<0.12 g·cm-3) and improved thermal stability, with degradation onset temperatures increasing by up to 10°C compared to pristine TPU (from 308°C to 320°C). Additionally, optimized zeolite content (5 wt%) enhanced surface hydrophobicity, improving moisture resistance. These findings indicate that ultralight composites TPU/Na-X possess tunable morphology, enhanced thermal performance, and functional surface properties, making them promising candidates for lightweight, thermally insulating, and sustainable food packaging applications.



SEM micrographs of Ultralight TPU/Na-X zeolite compositeat different Na-X zeolite percentage

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Acknowledgement: This work was supported by the project TERRA-DEVELOPMENT OF PVC-FREE BLOOD BAGS MADE FROM THERMOPLASTIC POLYMERS HIGHLY RECYCLABLE WITH HIGH BARRIER PROPERTIES, CUP B89J23001620005

SOC12 Development of PBSA Composites with Red Grape Skins Powder

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This research aimed to develop and evaluate a bioplastic material, PBSA (poly(butylene succinate co-adipate)), with integrated bioactive fillers derived from agri-food waste to enhance the valorisation of red grape skin residues, decrease the amount of plastic, and develop an active material able to release bioactive substances, such as antioxidant or antimicrobial compounds, to potentially extend the shelf-life of food. For the experiments, a red grape skin powder was selected and characterised for moisture, colour, ash, proteins, carbohydrates, particle size distribution, dietary fibre, structural carbohydrates, total phenolic content, and antioxidant activity. The analyses showed a promising composition, and the powder was compounded with PBSA, obtaining films with different percentages of red grape skin incorporation. Analysis of the melting flow rate of the blends showed an increase in the viscosity with increasing percentage of red grape skin powder. The films were characterised for mechanical properties, revealing a decrease in mechanical properties due to grape skin powder incorporation. The films obtained were also subjected to global migration tests according to Reg. (EU) 10/2011, which confirmed compliance with the legislative limits regarding global migration with simulants ethanol 10%, acetic acid 3%, and vegetable oils, after 10 days at 40°C. In addition, tests were performed to evaluate antimicrobial activity, polyphenol release, and antioxidant capacity. The results showed significant antimicrobial activity and polyphenol release in the food simulants tested, but no effect against lipid oxidation.

In conclusion, the incorporation of red grape skin powder into PBSA has enabled the production of active films that valorise agri-food waste, reduce the plastic amount, and confer antimicrobial activity to the material, demonstrating the potential of these materials for food packaging applications.

Keywords: active packaging, polyphenols, PBSA, bioplastic, red grape skin powder.

Acknowledgment: The research received funding from ECOSISTER - Ecosystem for Sustainable Transition in Emilia-Romagna", project funded by European Union under the National Recovery and Resilience Plan (NRRP), Mission 04 Component 2 Investment 1.5—NextGenerationEU, Call for tender n. 3277 dated 30/12/2021, Award Number: 0001052 dated 23/06/2022.

SOC13 Development of Antioxidant-Functionalized Bacterial Cellulose via In-Situ and Ex-Situ Approaches for Active Food Packaging Applications

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Bacterial cellulose (BC) is a nanofibrillar biopolymer with high purity, crystallinity, and mechanical strength, making it a promising platform for sustainable packaging applications. However, native BC lacks intrinsic antioxidant activity required for active food packaging systems. Functionalization strategies, either in-situ during biosynthesis or ex-situ after film formation, can impart bioactive properties and enhance the overall functional performance of BC-based films.

In this work, different strategies to functionalize BC films for the development of antioxidant-active packaging materials are presented. In-situ functionalization involves the incorporation of bioactive compounds during BC biosynthesis using agro-industrial residues such as grape bagasse as sustainable sources of phenolic compounds. The resulting films exhibited total phenolic contents of 0.31–1.32 mg GAE/g dry film and high radical scavenging activity (DPPH: 57–78%; ABTS: 86–89%). Additionally, UV-barrier properties were markedly improved (transmittance 0.02–0.38%), and water vapor permeability was significantly reduced (~3.4×10^{-12} g/m·s·Pa), while maintaining suitable mechanical properties.

Ex-situ functionalization involves post-synthesis modification of pre-formed BC films. Laminated BC-chitosan films enriched with grape bagasse extract and glycerol exhibited strong polymeric interactions, compact structures, and enhanced mechanical and thermal properties. Tensile strength ranged from 8.69 to 59.18 MPa, while elongation increased from 1.1% to 8.63%. Puncture resistance was significantly improved, and films showed notable antioxidant activity (TPC: 0–1.75 mg GAE/g; DPPH: 0–90.71%; ABTS: 0–99.28%). In a practical application, laminated films used as separators for Havarti cheese reduced lipid oxidation by 67.3% over 60 days of storage.

Overall, the combination of in-situ and ex-situ strategies enables the design of multifunctional BC films that balance mechanical strength, barrier performance, and antioxidant activity, highlighting their strong potential as sustainable, bioactive food packaging materials.

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SOC14 Microstructural and Physicochemical Stability of a Sustainable Wolffia-Mung Bean Protein Reconstitutable Beverage: Impact of Hydrocolloid Stabilizers and Drum-Drying Processing

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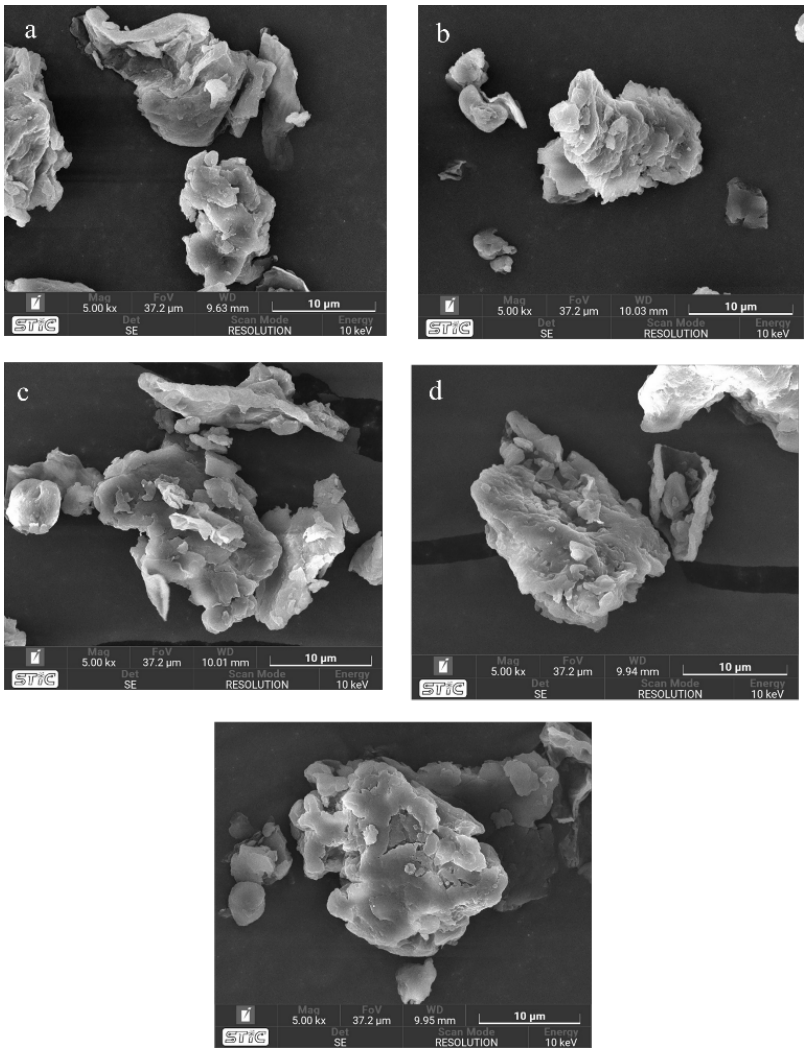
As global demand for sustainable nutrition rises, Wolffia globosa and mung bean (Vigna radiata) offer promising high-protein alternatives. However, the shelf-life quality of plant-based powders is dictated by their physical stability and rehydration behavior. This study optimized a protein-enriched (29.18%) drink powder, investigating the influence of stabilizer types and drum-drying on its physicochemical, structural, and sensory attributes. Scanning Electron Microscopy (SEM) revealed that the drum-drying process produced characteristic flaky, disrupted starch granules with irregular, jagged surfaces. This morphology suggests limited agglomeration, which influences rehydration kinetics due to the fragmented surface texture and mechanical shear applied during processing. Despite these structural complexities, the incorporation of stabilizers (carrageenan and xanthan gum) at 0.02% and 0.05% w/w significantly modulated functional performance. The formulation with 0.05% xanthan gum achieved the highest colloidal stability, exhibiting the smallest mean particle size (85.49 μm), maximal emulsion capacity (51.46%), and stability (52.22%). Conversely, 0.02% carrageenan enhanced fiber content and water absorption capacity (7.94 g/g) while maintaining superior sensory preference (7.31/9). Molecular and thermal stability were validated via Fourier-transform infrared spectroscopy (FTIR) and differential scanning calorimetry (DSC). All formulations exhibited high thermal stability (Td 130.67–132.67°C) and intact protein secondary structures, suggesting robust resistance to molecular dissociation during storage. Furthermore, the products maintained significant antioxidant potential, with total phenolic content (0.42–0.52 mg GAE/g) and DPPH activity (13.06–13.50 mg TE/g). These findings demonstrate that while drum-drying dictates the initial flaky microstructure, the strategic selection of hydrocolloids allows for the engineering of a stable, high-protein beverage with optimized functional and sensory characteristics. This research provides a foundation for developing shelf-stable, sustainable plant-based beverages for aging populations.

Keywords: Colloidal stability, Drum-drying, Microstructure, Plant-based protein, Wolffia globosa



Microstructure of drink powders: (a) Control; (b-e) with Carrageenan/Xanthan stabilizers (0.02-0.05%).

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The authors sincerely thank the Research Center of Innovative Food Packaging and Biomaterials (IFPB), Mae Fah Luang University, for providing the essential technical resources. We also express our gratitude to Mae Fah Luang University, Thailand, for the financial support and research equipment provided. Furthermore, we acknowledge the Scientific and Technological Instruments Center (STIC) for the laboratory support and specialized facilities used during the research work.

SOC15 Impact of fermentation with Lactobacillus plantarum and Saccharomyces cerevisiae on the acceptability of experimental breadsticks enriched with Ulva lactuca, and shelf-life study under tropical conditions

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The use of macroalgae in baked goods represents an increasingly widespread fortification strategy. Ulva lactuca is an innovative ingredient of great interest due to its high mineral content. However, how it influences the stability of baked products during storage remains scarcely investigated.

The present work aimed to evaluate the shelf-life under tropical conditions (38 °C and 90% RH) of experimental breadsticks enriched with 5% U. Lactuca (w/w in relation to flour), preceded by an assessment of a fermentative pre-treatment on the seaweed in order to optimize its sensory profile.

Fermentative pre-treatment on the seaweed was carried out using Lactobacillus plantarum and Saccharomyces cerevisiae (in pure or mixed cultures for 24 and 48 h) and then the culture was incorporated into make experimental breadsticks.

To investigate the effectiveness of this mitigation strategy on the "marine" aromatic profile, a consumer test was conducted. However, the results did not justify the implementation of the fermentation technology on a production scale from an applicative perspective, steering the shelf-life study towards the formulation made with unfermented seaweed. The effect on the antioxidant power and the determination of the free amino acid content of the breadsticks were also evaluated.

The breadsticks were packaged in polypropylene bags (approximately 12 g each). Sampling occurred at 7-day intervals for physical analyses, including water activity (aW), moisture content, and colour parameters (CIELab space), alongside the evaluation of texture and aromatic profile performed by a trained panel. The shelf-life monitoring highlighted a progressive qualitative deterioration of the product, allowing the determination of a shelf-life of 28 days under the analyzed conditions. The results demonstrate that the storage limitations that emerged are mainly attributable to the reduced barrier properties of the packaging material when subjected to stressful environmental conditions.

SOC16 Evaluating Shelf-Life of Pasta in Innovative Paper-Based Packaging: A Sustainable Approach

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Introduction: The growing use of recycled paper and cardboard, alongside reduced plastic content, is a key strategy for enhancing packaging sustainability and minimizing environmental impact. (1) However, sustainable solutions must maintain adequate product protection, safety, and quality throughout the shelf-life, especially for food-contact applications. Efficient and sustainable analytical strategies are essential to support innovation and assess the performance of novel packaging.

Materials and Methods: A comparative shelf-life study was conducted on dry pasta packaged in innovative paper-based materials with minimal plastic content, versus conventional multimaterial packaging containing plastics. Accelerated aging tests were performed, followed by chemical, sensory, and physical evaluations of both the pasta and the packaging. Critical parameters for the food product were monitored to ensure correct interpretation of barrier performance.

Results: The accelerated tests demonstrated that paper-based packaging, when appropriately designed, can provide protection comparable to traditional multimaterial solutions. Key indicators, including chemical stability, sensory quality, and physical integrity of the pasta, remained within acceptable limits throughout the test period. The results highlighted the importance of selecting parameters relevant to the food product to correctly assess packaging performance and inform sustainable redesign.

Conclusions: This study provides evidence that well-designed paper and cardboard packaging can ensure food safety and shelf-life stability while reducing plastic use. The findings support the adoption of sustainable packaging strategies and demonstrate the effectiveness of analytical approaches in evaluating and optimizing barrier performance in food-contact applications.

Keywords: Sustainable packaging, Shelf-life, Paper-based packaging, Food safety, Barrier performance

(1): Adibi et al. ; Progress in Organic Coatings, Volume 181, August 2023, 107566

SOC17 Biodegradable active packaging materials based on PBS and grape stalk for fresh salmon preservation

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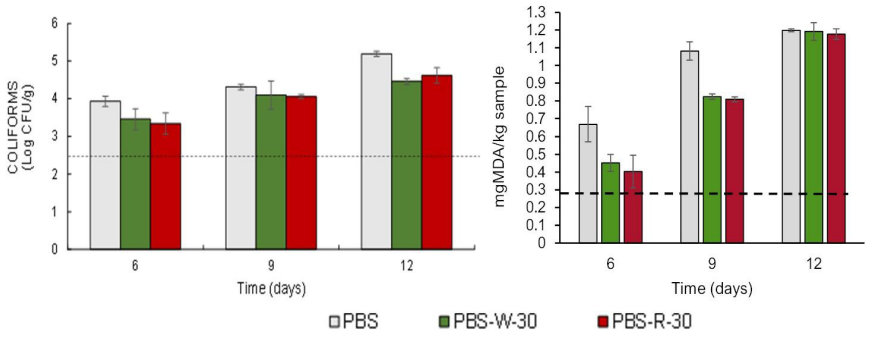
The recovery of agri-food waste in the development of sustainable food packaging materials is attracting attention due to the interesting composition of much of this waste. Grape stalks are an abundant residue in the wine-making industry with high content of phenols that show bioactive properties (1). This study focuses on the production of biodegradable composite films based on polybutylene succinate (PBS) and GS powder as a filler in different ratios. The high phenol content of GS could diffuse to the polymer matrix during melt blending with the polymer, providing the films with active properties and food preservation capacity.

The films obtained were characterized as to their water vapor and oxygen permeability and UV-light blocking effect. Likewise, the global and specific migration (in terms of total polyphenols) in different food simulants was analyzed to evaluate their potential for releasing the active compounds to the food substrate. In addition, fresh salmon fillets were packaged in bags from these materials, and their microbial quality and oxidation level were evaluated during cold storage (4ºC) up to 12 days. The highest filler concentrations improved both the oxygen and the light barrier properties of the biocomposites, while the overall migration and that of total polyphenols were increased in all the tested food simulants. As compared with neat PBS bags, the films containing the GS fillers at 30% promoted a slight decrease in the microbial counts, and delayed lipid oxidation in the salmon samples (Figure 1). In conclusion, the addition of grape stalk powder into biodegradable PBS films yielded lower cost packaging materials with potential active properties for fresh salmon preservation.



Coliform counts and TBARS of salmon fillets packed in bags made with neat PBS and PBS with 30% red (R) or white (W) grape stalk fillers stored at 4ºC. Error bars indicate the standard deviation. The dashed line represents the initial counts.

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SOC18 Efficiency of PHA-starch laminates Containing or not beer bagasse extract or ferulic acid on Refrigerated Pork Meat preservation

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This study evaluated the effectiveness of using laminates composed of a polyhydroxyalkanoate (PHA) layer laminated with a modified thermoplastic cassava starch (TPSm) layer, incorporating or not beer bagasse extract (E) or ferulic acid (F), for the preservation of pork tenderloin under refrigerated conditions. To this end, pork meat was packaged using free-extract bilayers (control), bilayers with 6% beer bagasse extract (Bilayer-E) obtained by subcritical water extraction at 170ºC or ferulic acid (Bilayer-F), and commercial low-density polyethylene packaging materials. The characterization results showed that the incorporation of the extract did not affect the moisture content or barrier properties of the control bilayer ($p>0.05$) while Bilayer-F showed slightly lower OP values ($p<0.05$) in agreement with that found in the literature (1). In the validation tests carried out with pork meat, microbiological analysis results revealed that the commercial packaging exceeded the legal limit for total viable bacteria (TV) (10^6 CFU/g) on the third day of storage, while the bilayers kept the bacterial count below the limit for a longer period, extending the product's shelf life. Similarly, the coliform count was lower in the bilayer packaging material, regardless of the beer bagasse extract incorporation. This effect was likely due to the greater sensitivity of aerobic and coliform bacteria to changes in the composition of the atmosphere due to the lower oxygen permeability of the bilayers compared to the commercial polyethylene-based film. Of the active bilayers, samples incorporating ferulic acid (Bilayer-F) exhibited the strongest inhibitory effect on bacterial growth, particularly against total viable bacteria (TV), achieving a reduction of up to 2 log units compared to commercial bags. Similar trends were observed by (2). These results indicate that selectively incorporating bioactive compounds enables tuning of bilayer performance according to specific preservation objectives, reinforcing its potential as a functional and environmentally sustainable alternative for fresh meat packaging.

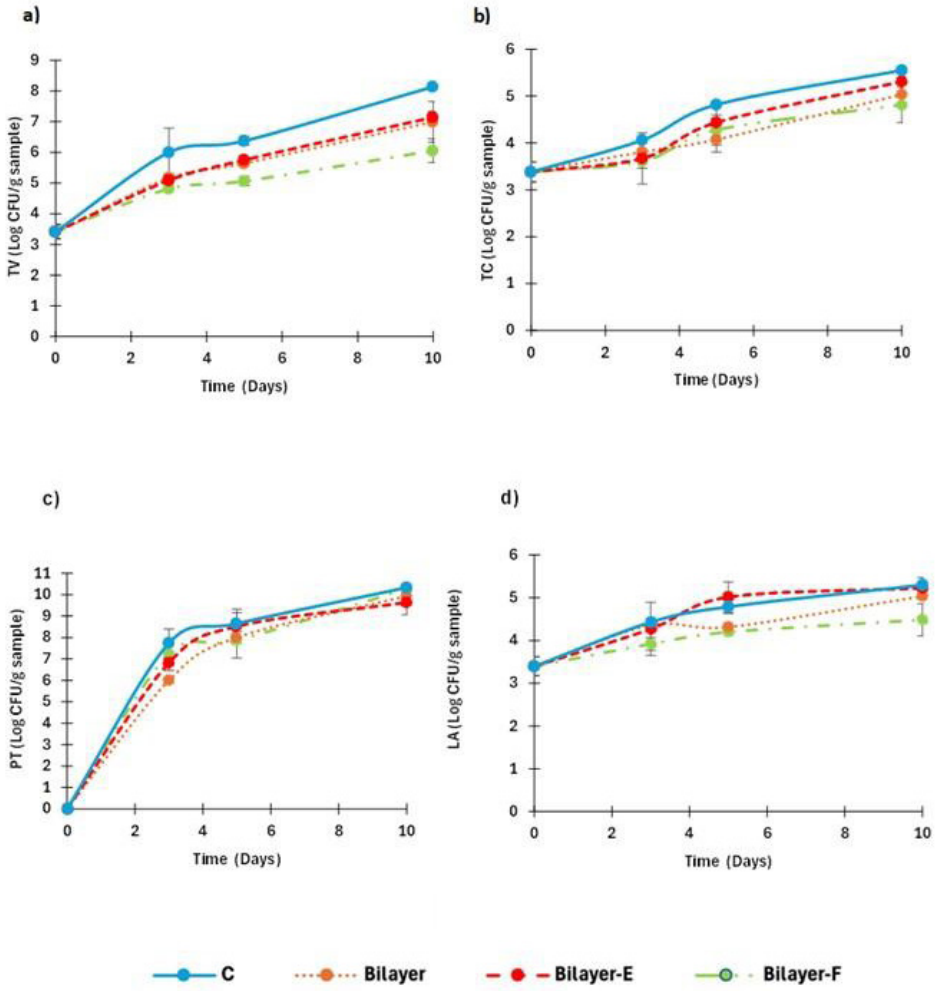

Figure 2. Development of the microbial counts (lactic acid bacteria: LAB, psychrotrophic bacteria: PB, total viable counts: TV and total coliforms: TC) of pork meat samples stored at 4 °C for 10 days packaged in commercial bags (C) and in the different bilayers. Mean values and 95% LSD intervals.

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2. *Eva Moll, Amparo Chiralt (2025). Active PHBV films with ferulic acid or rice straw extracts for food preservation, LWT, 228, 118115.*

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SOC19 Turning proteins into packaging: beeswax-coated egg white protein films for sweet cherries preservation

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Protein-based materials are sustainable alternatives to petroleum-based polymers; however, their application in fresh fruit and vegetables packaging is limited by poor water vapour barrier properties and high sensitivity to moisture. Hydrophobic coatings, such as natural waxes, may help overcome these limitations. The aim of this study was to evaluate the effect of a beeswax (BW) coating on the optical and barrier properties of egg white protein (EWP) films and to assess their suitability for modified atmosphere packaging and extend the shelf-life of sweet cherries. Compression-moulded EWP films were produced (EWP-C) and some of them were surface-coated with BW (EWP–BW). Sweet cherries were packaged in EWP-C, EWP–BW, polylactic acid (PLA), and oriented polypropylene (OPP) bags and stored at 4 °C for 18 days. The water vapour permeability (WVP) of EWP-BW at 23 °C and 90% HR was $0.018 \pm 0.007 \times 10^{-13}$ kg m m^{-2} s^{-1} Pa^{-1}, which is more than two orders of magnitude lower than the WVP of EWP-C under the same conditions ($8.453 \pm 1.704 \times 10^{-13}$ kg m m^{-2} s^{-1} Pa^{-1}). At the end of storage, cherries packaged in EWP-C exhibited the highest weight loss (11.6%). The BW coating reduced weight loss to 7.14%, slightly higher than that of PLA (5.95%), while OPP limited weight loss below 1%. Stem dehydration was visually evident in all materials except OPP, which maintained stem diameter. No significant differences were found in colour and firmness of sweet cherries stored in the different packaging materials. Microbiological analyses showed no increase in mould and yeast counts in cherries packaged in protein-based bags, whereas higher counts were observed in the other packaging materials as PLA or OPP. Overall, EWP-BW films represent a promising bio-based packaging alternative for cherries, with performance approaching that of commercial PLA.

Keywords: Egg white protein films, beeswax coating, water vapour permeability, modified atmosphere packaging, cherry

SOC20 In vitro gastrointestinal fate and bioaccessibility of oligoesters migrated from food Packaging

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Polyester resins are applied as inner coatings of food cans to prevent metal corrosion and food spoilage. As consequence of numerous monomers employed in their manufacture, multiple oligomer combinations can be formed as non-intentionally added substances (NIAS) for which no toxicological data or extensive studies are available. A great variety of them were found in food migrated from can coating [1, 2]. In this work, a set of oligoesters synthesized step-by-step were investigated following a standardized protocol focused on gastrointestinal digestion as part of the risk assessment. Several parameters were studied, such as the effect of gastric pH (1, 2, 3, 4), digestion phase (salivary, gastric and intestinal), presence of digestive enzymes, to evaluate the bioaccessibility, and degradation of native parent compounds. Results, obtained by LC-HRMS, highlighted that some oligoesters were available to be absorbed at the intestinal phase and bioaccessibility increased specifically for c(2NPG+2iPA). Also, enzymes were responsible for the partial degradation at intestinal phase for most cyclic oligoesters such as c(2HD+2iPA), c(2TCDDM+2iPA), c(3NPG+3iPA) and c(4NPG+4iPA). Several transformation products were found, such as lin(4NPG+4iPA), lin(3NPG+3iPA), lin(2NPG+2iPA), lin(2HD+2iPA), lin(2TCDDM+2iPA), lin(HD+iPA) or lin(TCDDM+iPA).

Finally, a stronger affinity of native parent compounds (cyclic) for pellet (non bioaccessible fraction) was observed, while linear compounds (transformation products) seemed to be more soluble in the supernatant fraction or presented more affinity and consequently, they remained bioaccessible to be absorbed in the intestine. From the food safety point of view, this fact is positive, since linear compounds exhibit lower toxicity potential according to the Cramer rules.

Keywords: polyester resin, oligoesters, in vitro bioaccessibility, degradation, transformation products

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SOC23 Paper-Laminated Biodegradable Film Packaging for Customized Single-Dose Solid Medicines in Elderly Care

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The growing adoption of customized single-dose solid medicines in elderly care has led to a substantial increase in the consumption of single-use, short-shelf-life pharmaceutical packaging. As global populations continue to age, the demand for patient-specific medication systems is expected to rise accordingly. Packaging for customized single-dose solid medicines must not only protect the product throughout the prescribed dosing period but also provide user-friendly features, such as easy tearing and transparent windows for tablet identification. Currently, non-biodegradable polyolefin-based plastic films are predominantly used for this application because of their excellent barrier and mechanical properties; however, their widespread use raises significant environmental concerns. This study develops a sustainable paper-based packaging alternative using machine-glazed (MG) paper laminated with poly(butylene adipate-co-terephthalate) (PBAT)-based biodegradable films for customized single-dose solid medicines. Three polymer systems including neat PBAT, PBAT/thermoplastic starch (TPS), and PBAT/poly(butylene succinate) (PBS) were investigated, with conventional low-density polyethylene (LDPE) used as a control. The laminates were fabricated via a thermal lamination process under optimized conditions to ensure uniform interfacial adhesion. Scanning electron microscopy revealed that the Paper/PBAT-PBS laminate exhibited excellent interfacial bonding between the paper fibers and polymer matrix, with surface smoothness comparable to that of Paper/LDPE. The Paper/PBAT-PBS laminate also exhibited a significantly lower tearing strength (172 mN) than the Paper/LDPE control (529 mN), enabling easier opening for elderly users. In terms of barrier performance, this laminate provided the most effective moisture protection among the biodegradable systems, achieving a water vapor permeability of 3.6 g·mm/m²·day·KPa. In addition, UV–visible light transmission was limited to below 2%, offering strong protection for photosensitive pharmaceuticals. Soil burial tests showed that Paper/PBAT-PBS achieved the highest biodegradation rate, with 71.67% mass loss after 90 days. Overall, PBAT-based laminated paper, particularly Paper/PBAT-PBS, offers a promising route toward fully biodegradable and user-friendly pharmaceutical packaging for elderly care.

Poster Session Abstracts

P01 Developing a shelf life predicting model for roasted coffee packed in a bioplastic capsule

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Dry foods are known requiring packaging systems with effective moisture barrier properties to preserve quality. However, current growing demand and actions issued from regulatory bodies intended for replacing petroleum-based plastics with bioplastics, is exposing the food sector to a critical gap. In fact, in contrast to their petroleum-based counterparts, bioplastics tend to exhibit medium-low water vapor barrier properties (WVBP) that can depend on environmental relative humidity. Existing predictive models, developed for plastics, fail in forecasting food quality decay as assume constant WVBP. Based on these considerations, this work aimed to develop, as a case study, a shelf life (SL) predictive model for ground roasted coffee packaged in polyhydroxyalkanoate (PHA)-based capsules.

First-order kinetic model was derived to describe the evolution coffee brew pH as a critical quality indicator, assuming humidity-dependent WVBP. Bulk and encapsulated ground coffee (EGC) were stored under controlled aw conditions (0.23–0.82) to determine sorption isotherms and pH kinetics. The WVBP of capsule were assessed by varying environmental aw from 0.23 to 0.90. Validation data were obtained by assessing pH evolution of extracted brew from EGC stored under selected aw conditions (0.43, 0.54, 0.65). All tests were conducted at 23 °C. The prediction goodness of SL was expresses as the error ($\bar{E}$%) between predicted and validation data. $\bar{E}$%

The PHA capsule exhibited both low WVBP and strong humidity-dependent behavior. Consequently, EGC exhibited a pH decay under all tested conditions, with faster rates occurring at higher environmental aw levels. Despite the pronounced humidity-dependent dynamics, the developed SL model resulted in prediction of coffee staling kinetics with $\bar{E}$% ~ 1% among all tested conditions. Results highlight the need to adapt SL models to predict lifetime of dry foods packaged with bioplastics. This approach provides accurate predictions and a practical tool to support material selection, packaging design, and SL assessment for industrial applications.

Keywords: shelf life, predictive modelling, dry foods, ground roasted coffee, bioplastics

P02 Image-Based Modelling using Machine Learning for acceptability limits prediction of frozen pizza in shelf-life studies

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Shelf-life of frozen foods depends on food-consumers interactions [1]; therefore, accurate prediction of acceptability is essential for reliable shelf-life estimation [2]. Nevertheless, assessing consumer acceptability requires extensive and costly experimental designs, and shelf-life studies of frozen products are further complicated by long storage periods and limited applicability of accelerated shelf-life testing. Machine learning offers a promising strategy to reduce the effort required for consumer acceptability evaluation and data processing [3]. This study proposes a non-destructive, image-based approach combined with machine learning to estimate consumer acceptability of frozen pizza. Samples were stored at -12 and -18 °C for up to 200 days and acceptability limits were identified by matching image acquisition and acceptability tests. Results showed that consumers identified tomato sauce colour as the primary driver of visual rejection, making it the main indicator of product quality decay during storage. A dedicated image-processing pipeline was developed to isolate the sauce region for colour extraction. Mean saturation in the HSV colour space emerged as the most reliable feature capturing visual freshness and degradation. A second-degree polynomial regression model described the temporal evolution of saturation (R2 = 0.68; RMSE = 12.8). In parallel, a logistic regression classifier predicted binary consumer acceptability based on saturation and storage duration, achieving 88.2% accuracy and an AUC of 0.93. To consolidate performance of the two components, a composite confidence score (CCC = 0.75) was introduced, integrating explanatory and discriminative capabilities in a weighted manner. The resulting framework enables early, non-invasive estimation of product acceptability and establishes a correlation between visual quality decay and consumer perception, offering practical tool for shelf-life assessment in the frozen food industry.

Keywords: consumer acceptability, colour saturation, image-processing, logistic regression classifier, non-destructive method.

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3. *Cui F.; Zheng S.; Wang D.; Tan X.; Li Q.; Li J.; Li T. Compr. Rev. Food Sci. Food Saf. 2023, 22, 1257.*

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P03 Moisture Change Model for Active Package of Dry Dosage Form during Secondary Shelf Life Period

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A simple mathematical model was developed to estimate moisture contents of dry dosage products in plastic bottle or bag packages incorporated with desiccant during the secondary shelf life period. The developed model was based on the mass balance of moisture linking package's water vapor transmission and linear moisture sorption isotherms of product and desiccant equilibrated with the package headspace. Firstly, the moisture prediction model was formulated for in-package storage as function of a lumped water vapor transmission parameter and sorption isotherm parameters for any given package conditions, which was verified by comparing the prediction to literature data of dry tablet and desiccant in high density polyethylene (HDPE) bottle. Then for the secondary shelf life period where each dosage is taken out periodically, sequential summation of individual steps of package layer's moisture transmission and internal equilibration among the headspace, product, and desiccant was undertaken to build simple analytical solutions. The model was tested by two experimental packages of HDPE bottle and low density polyethylene film bag, initially containing 60 (about 71 g) and 30 (about 32 g) dry nutraceutical tablets, respectively together with 1 g silica gel each, which were submitted to sequential tablet removal every day during the storage at 25 C and 85% relative humidity. The predicted moisture contents were in good agreement with experimental data with acceptable accuracy. The model would be useful for package design of dry dosage products to have optimal amount of desiccant for the required secondary shelf life.

1. *Lee DS. Theoretical analysis of secondary shelf life: Interactive relationship with package opening time and food quality degradation rate shift. Food Packaging & Shelf Life. 2024, 41, 101238.*
2. *An DS; Lee DS. Modeling moisture change of packaged dry tablet dosage forms under consumer use condition. Drug Development and Industrial Pharmacy. 2024, 50(7), 639-645.*

P04 Development of a testing procedure for a Secondary Shelf Life (SSL) assessment: the case study of fruit puree

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Secondary shelf life (SSL) is the period during which the product remains safe and suitable for consumption after the package has been opened. The lack of adequate assessment and management of SSL may heighten food safety risks and/or contribute to unnecessary food waste. When the packaging is opened, the food product is exposed to abrupt changes in the environmental conditions. The latter leads to selection of the spoilage events, often different and much faster than those occurring in the packed product. The design of the testing phase is the most critical step, as it must be carefully planned to accurately simulate the product's conditions of use or consumption. This study aimed to design a standardized testing procedure to assess the SSL of a pasteurized fruit puree (aw=0.98 and pH=4.03) intended for consumers. The testing phase was designed to simulate consumer fractionated consumption of the product during storage after opening. This involved initially shaking the jar screw cap to open jar, exposing the fruit puree to air for 2 min, removing 20 g of its contents with a spoon, reclosing the cap, and subsequently storing the product at 8 °C to simulate both correct and abusive storage conditions. This procedure was repeated every 2 days for up to 23 days. Total microbial count, as well as yeasts, moulds and Lactic Acid Bacteria (LAB), were considered as spoilage descriptors. The acceptability limit was chosen based on GMP indications referred to fresh RTE fruit derivatives (102-103 CFU/g). The results showed a progressive increase in microbial load, reaching a value of 10^6 CFU/g by day 23 of storage. No growth of yeast, moulds and LAB was detected. This value significantly exceeds the guidance limits for ready-to-eat fruit products, definitively indicating the end of the product's stability due to a hygiene failure.

Keywords: Consumer simulation, microbiological contamination, food safety, pack opening

P05 Technological Valorization of Lignin in Biodegradable Polymeric Matrices Using Electrohydrodynamic Techniques for Food Packaging Applications

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Lignin, a complex and heterogeneous aromatic biopolymer, exhibits a wide variety of properties and structural features depending on its botanical origin, particle size, and extraction process. This work presents a comprehensive characterization of lignin obtained from γ-valerolactone (GVL) fractionation of lignocellulosic biomass, covering their morphology, chemical structure, thermal behavior, and active properties. This lignin was subsequently valorized as bioactive fillers for the development of sustainable polymeric materials with potential applications in food packaging. For this purpose, lignin was incorporated into a bio based poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) matrix using electrohydrodynamic processing.

The studied lignin displayed excellent antioxidant activity, achieving approximately 90% DPPH inhibition, as well as strong antimicrobial performance ($R \geq 3$). Incorporation into PHBV enabled the production of materials with complete UV–visible light blocking (100%) and remarkable antioxidant activity. All lignin types contributed to the antimicrobial behavior of the composite materials exhibiting strong activity against Staphylococcus aureus ($R \geq 3$). Importantly, lignin addition did not compromise the mechanical performance or water barrier properties of neat PHBV. The resulting materials maintained good oxygen barrier performance, supporting their potential as functional additives for advanced food packaging materials.

Overall, these results demonstrate that low cost, abundant lignin resources represent a highly promising additive for biodegradable polymer matrices, enabling the development of sustainable, high value added materials with enhanced active and barrier properties.

Keywords: lignin, sustainable food packaging, PHBV, active properties, electrospinning

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P06 Nanocellulose Films Incorporated with Buffered Vinegars as Antimicrobials for Shelf-Life Extension of Plant-Based Meat Analogues

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The growing demand for sustainable and clean-label strategies in plant-based foods has driven the development of innovative active packaging solutions. At the same time, the high susceptibility of these products to microbial spoilage remains a major concern, reinforcing the need for effective preservation approaches. In this study, nanocellulose (NC)-based films incorporating buffered vinegar-based antimicrobial agents (Arvim and Bacout) were developed as inter-slices inserts for vegetarian products composed of broccoli and carrot (meat analogues).

NC/Arvim and NC/Bacout films were produced via solvent casting method, incorporating 2, 5, 15 and 30% (w/w) of the respective antimicrobial agent. The antimicrobial activity of the films was assessed using agar diffusion assay against Bacillus cereus, Listeria monocytogenes, and Escherichia coli. Based on superior inhibition performance, NC/Arvim films were selected for further evaluation in a real food system, where inserts were placed between slices of meat analogues and stored under refrigeration. Shelf-life studies monitored microbial growth, pH, water activity, and sensory attributes.

NC/Arvim film produced larger inhibition halos than NC/Bacout, indicating higher antimicrobial effectiveness. No significant differences were observed among the different concentrations tested (2–30%), suggesting a concentration-independent effect under the tested conditions. A 5% Arvim loading was therefore selected for further application in inter-slices inserts, as it allows reducing microbial growth without compromising efficacy. Preliminary observations from ongoing shelf-life trials suggest the potential of NC/Arvim inserts to limit microbial growth while maintaining stable physicochemical and sensory properties during storage.

Overall, nanocellulose inter-slices inserts incorporating acetic acid-based antimicrobials show promising potential as a sustainable strategy to enhance the microbial stability of plant-based meat analogues under real storage conditions.

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P07 Effects of High Hydrostatic Pressure Processing (HPP) on color preservation and metmyoglobin content in tuna intended for raw consumption

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Fresh tuna is a highly valued seafood product, widely consumed raw, thanks to its nutritional profile and sensory attributes. Its red and vibrant color is a key factor in quality assessment and consumer acceptance. According to European and Italian legislation, fish intended for consumption in its raw state, such as in the preparation of sashimi, must be frozen at -20 °C for at least 24 hours to eliminate potential parasitic hazards, particularly Anisakis larvae. While this treatment is essential for ensuring product safety, it may affect tuna color, contributing to its degradation. High hydrostatic pressure (HHP) technology has emerged as a promising non-thermal alternative technology for ensuring high safety and hygiene standards while preserving the product's 'fresh-like' characteristics. A preliminary study found that the Anisakis parasite could be inactivated at pressures between 150 and 200 MPa for treatment times between 1 and 10 minutes. These parameters were identified as effective for achieving sufficient Anisakis inactivation. Building on these findings, this study aimed to assess the effects of high-pressure processing within the required range for Anisakis inactivation on the color retention of raw tuna. To this end, tuna samples were packaged into plastic bags and subjected to pressure treatments ranging from 150 to 200 MPa for up to 10 minutes. The effect of HPP treatment on raw tuna was assessed by measuring color, expressed as the chromatic parameter ΔE^*, and the percentage of metmyoglobin content. The results enabled the identification of pressure/time conditions that maintain suitable color retention with no significant changes in metmyoglobin levels. These results provide a robust foundation for balancing the need for parasite safety with the preservation of the commercial and sensory qualities of fresh tuna.

Keywords: Anisakis inactivation, color degradation, fresh fish, non-thermal technology, tuna.

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P08 Chitosan-White Tea Active Coatings to Extend Sardine Shelf-Life under Refrigerated and Frozen Storage

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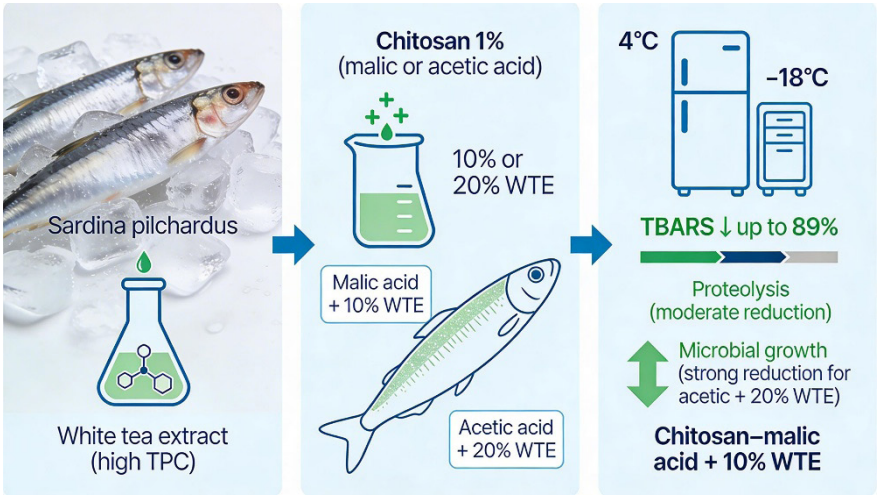
The high perishability of fatty fish such as sardine (Sardina pilchardus) is mainly driven by lipid oxidation, proteolysis and microbial spoilage, leading to substantial postharvest and economic losses. This work explores chitosan-based edible coatings enriched with white tea extract (WTE) as a sustainable strategy to preserve sardine quality during refrigerated and frozen storage. WTE was selected for its high total phenolic content (427.93 ± 21.82 mg GAE/g) and incorporated at 10% or 20% (v/v) into 1% (w/v) chitosan solutions prepared with malic or acetic acid (2% v/v). Fresh sardines were dipped in the formulations, packaged, and stored at 4 °C for up to 8 days or at -22 °C for up to 6 months. Lipid oxidation (TBARS), proteolysis (OPA method) and microbial counts (Enterobacteriaceae and mesophilic aerobes) were monitored and data analyzed by ANOVA-Tukey ($p < 0.05$). The most effective treatment for controlling lipid oxidation was chitosan in malic acid with 10% WTE, which reduced TBARS by 57% after 3 days at 4 °C and by 89% after 3 months at -22 °C, maintaining antioxidant protection up to 6 months. Chitosan-malic acid without extract most effectively limited proteolysis, while chitosan-acetic acid with 20% WTE provided the highest antimicrobial effect against Enterobacteriaceae and mesophilic aerobes. Higher WTE levels (20%) tended to be less effective for oxidation control and occasionally showed pro-oxidant behavior, highlighting the importance of optimizing both acid type and extract concentration. Overall, chitosan-WTE coatings, particularly the malic acid-10% WTE formulation, offer a promising bio-based, low-cost tool to extend sardine shelf-life by simultaneously mitigating oxidative, enzymatic and microbial spoilage during chilled and frozen storage, and represent a viable alternative to synthetic preservatives for seafood products.



Graphical abstract

P09 Application of an olive by-product in hamburgers to increase their shelf life and nutritional value

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Lipid and protein oxidation in meat products is the second most important cause of their deterioration after microbial contamination, leading to a loss of meat quality and reduced nutritional value. The objective of this work is to evaluate an olive by-product rich in phenolic compounds, the olive pulp after extracting the oil, as an antioxidant ingredient to fortify hamburgers and extend their shelf life. To study the absorption of the incorporated compounds in the matrix, three fortification methods were evaluated: kneading, pipetting (onto a sponge in a tray), and spraying (on the entire package). Subsequently, the hamburgers were frozen at different times (0h, 1 day, and 5 days) and analyzed by the Foling-Ciocalteu method to determine the total phenolic content (TPC). Results show that when the ingredient is incorporated by spraying and maintained for 5 days, it reaches the highest phenolic content (21.11 ± 3.25 mg GAE/100g). Besides, the phenolic profile of the fortified products obtained by LC-MS/MS showed high amounts of oleuropein and hydroxytyrosol, with relevant increases in rutin and caffeic, p-coumaric, and protocatechuic acids. In conclusion, olive pulp could be a suitable ingredient to replace part of the synthetic antioxidants in meat products to prevent lipid and protein oxidation. Next steps are to figure out the quantity of the required olive pulp to show an efficient antioxidant action compared to synthetic antioxidants, without resulting in alterations of the organoleptic characteristics of the meat.

Keywords: natural antioxidants; olive pulp by-product, lipid and protein oxidation; fortification methods, meat-based products

The research leading to these results was supported by MICINN for supporting the Ramón y Cajal's grant for Paz Otero (RYC2022-036690- I), by Xunta de Galicia for supporting the program Excelencia-ED431F 2024/22 and GRC-ED431C 2022/25. Pengren Zou is grateful for the financial support provided by the Program of China Scholarship Council.

P10 Extract rich in phenolic compounds obtained from olive pulp by Supercritical Fluid Extraction for food fortification and shelf-life improvement

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The food industry is seeking natural ingredients that improve the nutritional quality of foods and extend their shelf life. In this context, olive pulp after oil extraction (PBF) represents a promising by-product rich in phenolic compounds. This study aimed to evaluate the stability of PBF after supercritical fluid extraction (SCFE) during storage and to assess its application in the fortification of sweet bars and cookies. Three post-SCFE PBF samples, corresponding to different batches collected in 2021, 2022, and 2023, were analysed before and after five months of storage at −20 °C by the Folin-Ciocalteu method to determine the total phenolic content (TPC). In addition, the phenolic profile of fortified sweet bars (1–8% PBF) and cookies (2.6% PBF) was characterized by LC-MS/MS and compared with that of their respective non-fortified controls. Results show that the storage of PBF at −20 °C for five months preserved the TPC fraction, showing 1376.75 μg GAE/100 mg (PBF from 2023) while modifying their phenolic profile. The incorporation of PBF resulted in phenolic enrichment in both sweet bars and cookies. In sweet bars, hydroxytyrosol reached 71.38 ± 3.17 μg/g at 8% PBF, whereas in cookies it increased to 18.48 ± 0.74 μg/g. In conclusion, PBF retained a high phenolic content during storage and showed a phenolic enrichment in food matrices such as sweet bars and cookies. These results support its valorisation as a functional ingredient and suggest its potential to contribute to the stability and, potentially, the shelf life of final products.

Keywords: olive pulp by-product, phenolic compounds, functional ingredient, stability, food fortification.

The research leading to these results was supported by MICINN for supporting the Ramón y Cajal's grant for Paz Otero (RYC2022-036690- I), by Xunta de Galicia for supporting the program Excelencia-ED431F 2024/22 and GRC-ED431C 2022/25.

P11 Project CardAPium: Exploring Cardoon (Cynara cardunculus L.) by-products to obtain cutting-edge Active Packaging for food applications

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The project "Exploring Cardoon (Cynara cardunculus L.) by-products to obtain cutting-edge Active Packaging for food applications", with the acronym CardAPium, is a Portuguese exploratory research project (PEX) financed by Fundação para a Ciência e a Tecnologia (FCT). The project will be developed at the National Institute of Health Doutor Ricardo Jorge (INSA), from February 2025 until February 2027. The CardAPium Project aims to develop a biodegradable and edible active film, based on whey protein, a major dairy industry by-product, to improve cheese preservation and extend its shelf life. This film will incorporate, as its active component, ethanolic extracts from cardoon leaves, the main by-product of cardoon application in the cheese/dairy industry. To obtain these bioactive extracts, various extraction techniques will be explored, including conventional solid-liquid solvent extraction and ultrasound-assisted extraction (UAE) using different solvents, to recover compounds such as luteolin and chlorogenic acid. The primary goal is to create a safe and sustainable solution for cheese preservation, that reduces the use of harmful preservatives and promotes circular economy. To achieve this, the Project is divided into six main tasks, with more specific goals, including the complete characterization of the cardoon leaves and their extracts; the optimization of a whey protein-based active coating with several percentages of the cardoon leaf extract; the physical and chemical characterization of the active coatings; and the evaluation of the lipid oxidation and microbiological status of the packed/coated cheese. Project CardAPium involves a multidisciplinary team composed of members from INSA, Faculty of Pharmacy of the University of Coimbra, (FFUC), and NOVA School of Science and Technology (FCT-UNL), with extensive expertise in areas such as materials engineering, innovative food packaging using biodegradable polymers, and food technology, and will work closely together towards the main goal.

This work was developed within the scope of the CardAPium Project (2023.15813.PEX) financed by Portuguese national funds FCT/MECI (https://doi.org/10.54499/2023.15813.PEX). This work was supported by Portuguese national funds FCT/MECI through the MEtRICs research unit (UID/04077/2025, https://doi.org/10.54499/UID/04077/2025) and through UIDB/00211/2025.

P12 Functional Edible Films Based on Sodium Caseinate Incorporating Lactobacillus casei: Toward Bioactive Food Packaging

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Edible films incorporating probiotics represent a promising strategy for the development of functional food packaging with health-promoting properties. Sodium caseinate (SC) is a protein-based biopolymer widely studied for its excellent film-forming ability, biodegradability, and favorable mechanical performance, while Lactobacillus casei (LC) is a well-established probiotic strain commonly used in functional food applications. This study aimed to develop SC-based edible films enriched with LC at two concentrations (10^9 and 10^{10} CFU/mL) and to evaluate their structural, thermal, mechanical, and functional properties.

SC and SC/LC films were prepared by solvent casting using glycerol as a plasticizer and dried under controlled conditions (37 °C for 72 h). Structural interactions between SC and LC were investigated by ATR-FTIR spectroscopy, while thermal stability was assessed through TGA and DSC analyses. Mechanical properties were evaluated according to ASTM D882. Colour parameters (L*, a*, b*, ΔE, WI) and swelling behaviour were determined to assess optical properties and moisture sensitivity. Probiotic viability was monitored throughout the film formation process.

ATR-FTIR analysis indicated good compatibility between SC and LC, with minor spectral shifts suggesting interactions within the protein matrix. Thermal analyses showed that probiotic incorporation did not significantly affect film stability. Mechanical testing revealed a slight reduction in tensile strength and elongation at break; however, films maintained adequate flexibility and structural integrity. Swelling behaviour indicated controlled water uptake, supporting potential application in bioactive release systems. Colour measurements showed minimal changes, confirming acceptable visual properties. Importantly, both probiotic concentrations maintained high viability, demonstrating effective entrapment and protection within the SC matrix.

Overall, SC-based edible films successfully combined structural functionality with probiotic viability, highlighting their potential as active food packaging systems. From an applicative perspective, these materials may contribute to extending the shelf life of perishable foods while simultaneously delivering functional microorganisms capable of promoting consumer health. The simplicity of the production process and the use of biodegradable, food-grade materials further support their potential scalability and translational value toward industrial applications and technology transfer in sustainable functional packaging systems.

Keywords: Sodium caseinate; Lactobacillus casei; Edible films; Probiotic viability; Active packaging; Functional food; Shelf life

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P13 Functionality, Safety, and Challenges of Bioactive Extracts for Active Packaging

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Plant extracts and extracts from industrial agro by-products are increasingly explored for the development of active packaging, due to their natural origin and bioactive properties. These extracts can originate from diverse sources, including different plant species, varieties, and anatomical parts (e.g., leaves, peels, seeds), which significantly influence their final composition and activity.

Several factors affect the effectiveness of these extracts, such as the extraction method, number of extraction steps, solvent type, sample-to-solvent ratio, and the presence or absence of concentration steps. In recent years, environmentally friendly extraction techniques have gained attention, including microwave-assisted extraction (MAE), pressurized liquid extraction (PLE), ultrasound-assisted extraction (UAE), supercritical fluid extraction (SFE), and the use of natural deep eutectic solvents (NADES).

The biological activities of these extracts are highly variable and may include antioxidant, antibacterial, antifungal, and antiviral properties. To properly assess antioxidant capacity, it is essential to use multiple complementary assays, such as DPPH (2,2-diphenyl-1-picrylhydrazyl) radical, FRAP (Ferric Reducing Antioxidant Power), and β-carotene bleaching methods, since each test is based on different mechanisms. Also important is the characterization of the antioxidant compound profile to identify the main molecules responsible for the observed activity. However, plant extracts are complex mixtures where synergistic or antagonistic interactions may occur, meaning that the overall activity cannot be accurately predicted from the sum of individual components.

Safety is another critical aspect, as extracts may contain contaminants such as heavy metals, pesticide residues, mycotoxins, or naturally occurring toxic compounds like alkaloids.

This presentation will address the high potential and challenges of the extracts obatined from plants and agro by-products used to prepare active packaging. These challenges include the standardization to ensure consistent efficacy, thorough safety assessment, strategies to improve stability (e.g., encapsulation), and regulatory hurdles, as approval processes can be complex and time-consuming in some countries.

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P14 Smart Monitoring of Fresh-Cut Melon Quality: Integration of a Multi-Component pH-Sensitive Film for Shelf-Life Prediction

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Melons have secured a dominant global market share due to their exceptional nutritional profile and high vitamin content. However, as a minimally processed product, fresh-cut melons face significant challenges regarding shelf-life stability and real-time quality monitoring. Degradation typically follows a predictable pattern of tissue disintegration, translucency, and the formation of undesirable off-flavors caused by microbial metabolic activity. This research aims to develop a novel, non-destructive colorimetric spoilage indicator capable of tracking the deterioration of fresh-cut melons through distinct visible color variations, providing a reliable tool for food safety management. The study involved three phases: aseptic preparation of fresh-cut melons; a 10-day monitoring of physicochemical and microbiological quality (pH, CO2, firmness, and microbial growth) at 4 ± 2 °C and 12 ± 2 °C; and the fabrication of a halochromic indicator by embedding a methyl red, thymol blue, and bromothymol blue dye mixture into a polyvinyl alcohol (PVA) film. Sensor sensitivity was validated via colorimetric testing across a broad pH spectrum. Experimental data confirmed a strong correlation between microbial proliferation, head-space atmospheric shifts, and the sensor's distinct color transitions. The PVA-based film demonstrated high sensitivity to volatile basic compounds and organic acids evolved during melon senescence. Significant, perceptible color transitions were observed as the melons transitioned from fresh to spoiled states, particularly under the 12 ± 2 °C condition. These shifts effectively mirrored real-time changes in firmness and CO2 levels, validating the sensor's accuracy as a quality proxy. The developed multi-dye spoilage indicator provides a dependable, low-cost solution for visual freshness monitoring. By enabling real-time assessment of food safety without opening the package, this technology offers significant potential for the intelligent packaging industry to reduce food waste and enhance consumer confidence in the fresh-cut produce sector.

P15 From Citrus Waste to Active Packaging: Whey Protein Films as a Circular Economy Strategy to Extend Salmon Shelf Life

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The valorization of agro-industrial by-products and the reduction of food waste have emerged as key priorities in the transition towards more sustainable food systems. Active packaging, enriched with fruit-derived antioxidants, simultaneously combats food spoilage and promotes the utilization of agro-industrial by-products. This work explores the use of ethanolic extracts from lemon by-products incorporated into whey protein concentrate (WPC) films to delay lipid oxidation in refrigerated fresh salmon.

WPC-based films were formulated with lemon by-product extract at 1%, 2%, and 4% (w/v). Phenolic profiling by UHPLC-ToF-MS [1] identified 9 migrating compounds including flavanones (eriocitrin, hesperidin) and phenolic acids, with total migration increasing with extract concentration (151 to 347 μg/dm^2). Salmon samples were stored at 4 °C for 10 days, with lipid oxidation assessed at days 0, 3, 6, 8, and 10 via the TBARS assay [2].

All active films significantly reduced malondialdehyde (MDA) compared to the control, keeping values below the consumer sensory rejection threshold of 1 mg MDA/kg until day 10, while the control exceeded this limit by day 6. The 4% film provided the strongest early-stage protection, while the 2% formulation achieved the most sustained effect, with a 76% MDA reduction at day 10. This concentration-dependent pattern suggests a dual role of phenolics: effective radical scavengers at moderate levels, with potential pro-oxidant activity at higher concentrations. The 2% film also preserved adequate mechanical integrity, with tensile strength comparable to the control film.

These findings establish lemon by-product extracts as effective functional ingredients for WPC active films, extending fresh salmon shelf life while supporting a circular economy strategy.

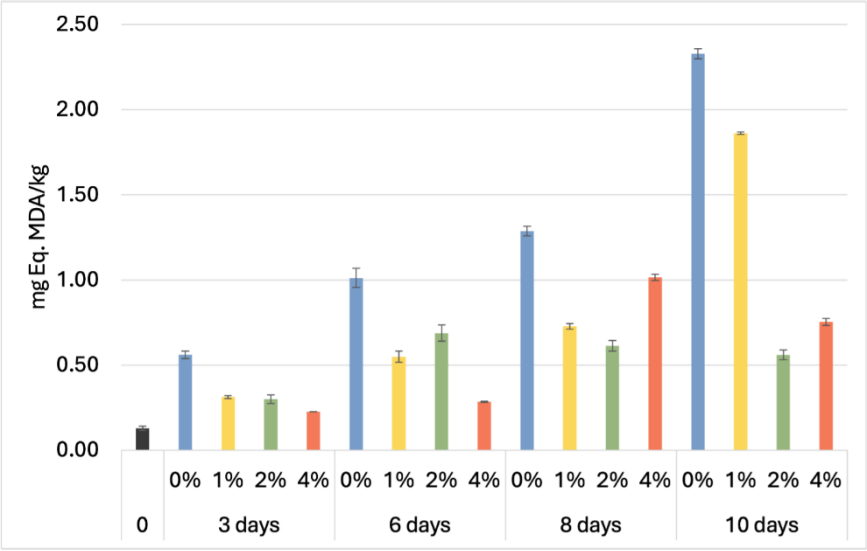

Figure 1: TBARS assay results for salmon packaged with whey protein-based films containing lemon by-product extract at 1%, 2%, and 4% (w/v), and unwrapped control, after 0, 3, 6, 8, and 10 days of storage at 4 °C

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P16 Reducing Postharvest Mechanical Damage in Apples During Transport: A Statistical Evaluation of Packaging Configurations Under Simulated Transportation Vibration

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Mechanical bruising during postharvest handling and transportation is a major source of economic loss in the apple industry, reducing fruit quality, marketability, and shelf life. This study evaluated how packaging design influences vibration-induced bruising in two apple cultivars (Jonagold and Fuji) under simulated transport conditions. A factorial experimental design was used to assess the effects of package type (corrugated fiberboard vs. plastic crates), cushioning (none, bottom-only, or top-and-bottom), motion limiters (dividers, trays, or polyethylene bags), fruit arrangement (single vs. double rows; vertical vs. horizontal orientation), and vibration exposure (0.5–0.7 Grms; 2–4 h) representative of truck transport. Bruise incidence and severity were measured after vibration and evaluated after 5 and 7 days using caliper measurements, bruise area calculations, and pitting assessments. Data were analyzed using descriptive statistics, correlation analysis, and ANOVA. Jonagold apples were more susceptible to bruising (20.0% bruised) than Fuji (10.3%). Corrugated packaging and top-and-bottom cushioning reduced bruising by up to 23% compared with plastic crates and no cushioning, while longer vibration exposure increased bruising by up to threefold. ANOVA identified vibration intensity, vibration duration, cultivar, and row count as dominant factors ($p < 0.001$). Overall, the results provide practical guidance for packaging optimization, with the potential to reduce postharvest losses by 15–30% and improve fresh-produce distribution performance.

Figure 1: Selected Apple Packages: (a): P2-C1-L1&P2-C2-L1, (b): P2-C1-L3&P2-C2-L1, (c): P1-C1-L1&P1-C2-L1, (d): P2-C1-L3&P1-C2-L3

Apple packed in 8 different packaging configuration

Keyhan, S., Shirzad, K., Almenar, E., & Joodaky, A. (2024). Transportation Vibration Effects on Apple Bruising. Packaging Technology and Science, 37(11), 1065-1071.

This work was supported by the Michigan Apple Committee (MAC24-04) and Project GREEEN (GR23-079). The authors appreciate the in-kind support, including packaging materials provided by Riveridge Produce and apple samples provided by the MSU Clarksville Research Center.

P17 Biodegradation behaviour of PLA-starch blends in a simulated Pelagic marine environment

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The development of biodegradable materials for specific uses is a promising alternative for mitigating the plastic pollution problem. However, it is essential to study the biodegradation behavior of these materials under a wide range of environmental conditions to ensure their environmental safety and sustainability.

The aim of the present study was to study the biodegradation and disintegration behavior of amorphous PLA-Starch blend films under laboratory conditions simulating the marine pelagic zone, analyzing the effect of the starch ratio on the degradation rate. Films were prepared by melt-blending and compression molding. Thermoplastic starch (TPS) was first prepared by mixing corn starch and glycerol (30 g/100 g of starch), then PLA-starch blends were prepared in various proportions (PLA-S: 100:0, 80:20, 50:50, and 20:80). Biodegradation was monitored using a respirometry method to quantify CO_2 production in accordance with ISO 23977-1 standard. In parallel, film disintegration was evaluated by measuring weight-loss and by analyzing the changes in microstructure, thermal properties, molecular weight distribution, and FTIR spectra at different exposure times. PLA-starch blend films showed improved biodegradation and disintegration rates (Figure 1) due to the hydrophilic nature of thermoplastic starch and its high sensitivity to water uptake and microbial enzymes. The degradation and solubilization of starch in the aqueous medium created internal pores in the blend films, increasing their internal surface area and allowing water and microorganisms better access to the PLA phase. This promoted the hydrolysis and degradation of the PLA, as evidenced by the more porous structure and lower thermal stability of the residual PLA in the blended films. Nevertheless, starch degradation was delayed by polymer retrogradation/recrystallisation and by the encapsulating effect of PLA, which prevented this polymer from being exposed to the aqueous medium and microbial action. PLA 80 film (80% PLA - 20% starch) represented an interesting alternative for promoting PLA biodegradation in marine environments.

Biodegradation curve and (B) Biodegradation rate of films for PLA, TPS films in different proportions (100:0, 80:20, 50:50, and 20:80), and the control (Microcrystalline Cellulose).

none

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P18 Safety assessment of chitin as a sustainable food packaging material using an integrated in vitro genotoxicity and mutagenicity approach

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The development of sustainable food packaging materials is a key strategy to improve food shelf life and reduce environmental impact. Among the emerging bio-based candidates, chitin has gained attention due to its abundance, biodegradability, and potential functional properties in food preservation systems. However, its safety as a food contact material must be ensured prior to industrial application. In this context, the present study aimed to assess the genotoxic and mutagenic potential of chitin using an integrated in vitro testing strategy according to the recommendations of the European Food Safety Authority (EFSA).

Genotoxicity was assessed using the in vitro mammalian cell micronucleus test (MN, OECD 487), while mutagenicity was evaluated through the mouse lymphoma assay (MLA, OECD 490). Both assays were conducted using L5178Y $TK^{+}/^{-}$ cells. Chitin was tested at concentrations up to 200 µg/mL under short-term exposure times (6h, with and without metabolic activation using S9) and long-term exposure times (24h, without S9). Cytotoxicity, solvent and positive controls were included to validate the performance of the assays.

Chitin did not induce a statistically significant increase in MN frequency under any of the tested conditions, indicating the absence of clastogenic or aneugenic effects. Similarly, MLA results showed no increase in mutation frequency at any concentration or any treatment conditions. All results fulfilled the validity criteria established for both OECD protocols.

These results support the absence of genotoxic and mutagenic effects of chitin in vitro, reinforcing its potential as a safe and sustainable material for food packaging applications. This safety profile is particularly relevant for its incorporation into systems designed to extend food shelf life. Nevertheless, further studies are recommended to complete its toxicological profile and support regulatory decision-making.

Keywords: chitin, food contact material, in vitro, genotoxicity, mutagenicity, L5178Y TK+/-

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P19 Tentative identification of non-volatile migrants from two biodegradable food packaging materials: polybutylene succinate (PBS) and poly(butylene succinate-co-adipate) (PBSA)

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Biodegradable polymers such as poly(butylene succinate) (PBS) and poly(butylene succinate-co-adipate) (PBSA) are increasingly used in food contact materials due to their favorable environmental profile. However, the potential migration of non-intentionally added substances (NIAS), including oligomers, remains insufficiently characterized. In this study, the migration profiles of PBS and PBSA pellets were investigated using different food simulants: ethanol 10% (v/v), acetic acid 3% (v/v), and ethanol 95% (v/v).

Non-volatile migrants were analyzed by ultra-high-performance liquid chromatography coupled to high-resolution mass spectrometry (UHPLC-Q Exactive). For the structural elucidation of selected compounds, targeted-MS2 experiments were conducted. Compound identification was based on precise mass measurements and fragmentation patterns, supported by a homemade database derived from known starting substances, including succinic acid, adipic acid, and 1,3-butanediol.

More than 50 oligomers with molecular weights below 1000 Da were tentatively identified in the migration extracts. These included both linear and cyclic oligomers, the latter being the most intense peaks observed in the chromatograms of both polymers. Migration experiments revealed a higher number of compounds in the lipophilic food simulant (ethanol 95%), indicating a greater affinity of these migrants for fatty food matrices.

Given the lack of analytical standards, toxicological data, and established migration limits for these oligomers, an initial estimate of their potential risk was performed using Cramer's decision tree. This approach enabled the classification of the identified substances into three different toxicity levels, resulting in oligomers of low, medium, and high toxicological concern. These findings contribute to a better understanding of NIAS present in biodegradable polymers and highlight the need for a more comprehensive toxicological assessment.

Keywords: PBS, PBSA, migration, oligomers, NIAS

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P20 Zein–pectin nanoparticles as carriers for carvacrol in active PVA biocomposite films

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The environmental impact of non-biodegradable plastic waste from food packaging has increased the demand for sustainable materials capable of preserving food quality and safety. In this context, biodegradable polymers combined with active compounds represent a promising strategy for the development of next-generation packaging systems. Polyvinyl alcohol (PVA) is widely used due to its excellent film-forming ability, good mechanical properties, and thermal stability. Despite these advantages, the absence of intrinsic antimicrobial activity significantly limits its potential for active packaging applications. Carvacrol (CRV), a natural phenolic compound found in oregano and thyme essential oils, is known for its strong antimicrobial activity against a broad range of foodborne microorganisms and is classified as Generally Recognized As Safe (GRAS). Nevertheless, its high volatility and hydrophobic character result in rapid loss and poor stability when directly incorporated into polymer matrices. To address these limitations, carvacrol-loaded zein/pectin composite nanoparticles (CRV-Z/P NPs) were developed and optimized in this study using an antisolvent precipitation method. The optimized nanoparticles achieved high encapsulation efficiency (~90%) and exhibited a core–shell spherical morphology with an average particle size of approximately 300 nm. FTIR analysis suggested that hydrogen bonding, electrostatic interactions, and hydrophobic effects were the main forces driving nanoparticle formation. CRV-loaded nanoparticles were subsequently incorporated into PVA films at different concentrations (1, 3, and 5 wt%) via solvent-casting method. The resulting films displayed homogeneous nanoparticle dispersion and improved functional properties. In particular, encapsulation enabled a more controlled release of CRV and enhanced antimicrobial activity compared to non-encapsulated systems.These results demonstrate that zein/pectin nanoparticles can serve as effective carriers for volatile bioactive compounds, offering a simple and sustainable approach for the development of active, biodegradable packaging materials.

Keywords: PVA, Zein–Pectin nanoparticles, Carvacrol encapsulation, Antimicrobial films, Biodegradable packaging

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P21 Toward Sustainable Food Ingredient Development: Zein–Pectin-Based Delivery Systems for Citrus By-Product Extract

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Rising demand for healthier foods has driven the development of functional ingredients enriched with phenolic compounds, known for their antioxidant and health-promoting properties. However, their low stability and bioaccessibility require encapsulation strategies1,2. This study valorises lime by-products by developing zein–pectin microparticles via spray-drying to stabilise phenolic-rich extracts for food applications.

First, ultrasound assisted extraction and agitation were used to obtain phenolic-rich extract yielded from lime by-products. Zein and pectin were employed to encapsulate lime extract through antisolvent precipitation. Further drying using mini-spray drying provided the final microparticles at a 33% concentration of each material. Particles were characterized in terms of morphology, thermal stability at 160 °C and 200 °C, antioxidant capacity, phenolic content, as well as it was determined the bioaccessibility of each phenolic compounds after performing an in vitro digestion.

Lime microparticles of 0.7 μm have shown an encapsulation efficiency of ~80% and an encapsulation yield of ~94%, with a phenolic content increase of ~46% (19 mg GAE/g particles) comparing to non-loaded microparticles, highlighting phenolic compounds such as eriocitrin (5.3 mg/g particles) or hesperidin (6.5 mg/g particles). Encapsulation significantly improved thermal resistance: after 20 min at 160 °C, degradation was 53% in the free extract versus 9% in encapsulated particles, while at 200 °C free extracts lost up to 92% within 10 min, compared to 52% polyphenols retention in encapsulated systems. After in vitro digestion, encapsulation improved both the bioaccessibility and recovery of all compounds by at least 10%, resulting in values exceeding 80% for bioaccessibility and 95% for recovery.

In conclusion, microparticles were successfully developed, demonstrating high phenolic content and maintained bioaccessibility after in vitro digestion. Mini spray-drying proved effective for producing stable, health-promoting ingredients for bakery products, highlighting the potential of these particles to valorise lime by-products within a circular economy framework.

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P22 INVESTIGATION OF POTENTIAL MIGRANTS IN POLYLACTIC ACID (PLA) DRINKING STRAWS

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Polylactic acid (PLA) is one of the most commonly used biopolymers, with applications in single-use food contact articles due to its bio-based nature and environmental advantages. Nonetheless, despite their growing industrial use, relatively little is known about the volatile profile of PLA-based materials for food contact. From a food safety perspective, identifying such chemicals and evaluating the migration is important for risk assessment and compliance with food contact material regulations.

The objective of this study was to investigate the volatile compounds present in PLA drinking straws from different suppliers through a non-targeted methodology, and estimate the toxicity of the detected compounds using an in silico tool.

Volatile compounds were extracted using a purge and trap system (P&T) under the following conditions 80°C and 30 min and then analyzed by gas chromatography mass spectrometry (GC-MS).

The volatile compounds tentatively identified in PLA-based materials were mainly aliphatic hydrocarbons, esters, organic acids and reactive carbonyl compounds. The Toxtree software was used to estimate the toxicity of the detected compounds. Most of the substances belong to Cramer class I, and only a few compounds belong to class II and III, implying a low overall toxicological risk. Interestingly, a large number of the compounds were not listed in Regulation (EU) No 10/2011; and several of them were considered non-intentionally added substances (NIAS) resulting from processing or degradation.

Keywords: PLA, bioplastics, volatile compounds, NIAS, non-targeted approach.

European Union. (2011). Regulation (EU) No. 10/2011. Official Journal of the European Union, L12, 1–89.

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P23 Pectin-based aerogels loaded with natural bioactive compounds for sustainable packaging

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One key approach for the development of sustainable food packaging is the implementation of circular economy strategies, including shelf-life extension, safety enhancement, waste reduction, and the design of eco-friendly absorbent materials. Biodegradable polysaccharides derived from the food industry by-products have demonstrated low toxicity and significant environmental benefits, representing promising candidates for the development of active delivery systems. Their formulation into aerogels confers on them exceptional swelling capacity and ultralight weight (1,2).

In this work, pectin-based aerogels were synthesized by $CaCl_2$ ionic crosslinking followed by solvent exchange (ethanol) and supercritical CO_2 drying. Their morphological and physicochemical properties were characterized using dynamic image analysis, scanning electron microscopy, helium pycnometry, and nitrogen adsorption–desorption analysis to determine surface area and pore size distribution. Eugenol, a natural phenolic compound derived from clove bud, was incorporated via supercritical CO_2 impregnation to provide the pectin matrix with antioxidant activity. Eugenol was quantified by gas chromatography equipped with a headspace sampler and coupled to mass spectrometry HS-GCMS, spiking the own matrix with standard solutions of different concentrations to determine the loaded content.

For the safety assessment of the aerogels for food packaging purposes, a non-target screening method was applied after submitting the samples/matrix/pellets of pectin to 80 ºC for 20 min using Purge and Trap technique coupled to Gas Chromatography and Mass Spectrometry (P&T-GC-MS) to identify volatile compounds that could be present in the sample.

Both non-impregnated and eugenol-impregnated aerogels demonstrated porosity values and pore sizes within typical aerogel range, and eugenol loading was found to be ~30 μg/mg of aerogel, confirming a successful supercritical fluid impregnation. Most of the substances identified were linear and branched saturated hydrocarbons such as decane and heptane, 2,4-dimethyl or octane,4-methyl, with low toxicity according to the Cramer's decision tree

Overall, the pectin aerogels showed the characteristic properties that define this class of materials, along with the potential of incorporate antioxidant capacity, supporting their suitability as materials for food packaging applications.

Keywords: polysaccharides, aerogels, antioxidants, food packaging

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P24 Starch aerogels reprocessing: A circular and sustainable strategy for advanced food shelf-life applications

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1. Introduction: An extension of food shelf-life while reducing environmental impact remains a major challenge for current food systems due to poor packaging waste management and low material sustainability1. Aerogels based on biopolymers, such as starch, have attracted attention in food packaging innovations owing to their outstanding high porosity, low density, lack of toxicity, and tunable physicochemical properties2. However, their broader implementation is hindered by limited strategies for reuse and end-of-life management. In this context, this work aims to develop and evaluate environmentally friendly strategies for the reprocessing of starch-based aerogels with potential application in food packaging, while preserving or improving their functional properties3.

2. Materials and methods: Reprocessed starch-based aerogels were produced from: (i) new aerogels, (ii) xerogels, and (iii) new aerogels mixed with native corn starch. All methodologies employed mild conditions and reagents, such as water and ethanol, and avoided energy-intensive or chemically aggressive treatments. In all cases, aerogels were fabricated via supercritical drying using CO2 at 39ºC and 120 bar. The resulting materials were characterized in terms of physicochemical and mechanical properties.

3. Results: The different reprocessing strategies successfully yielded starch aerogels with preserved structural characteristics. Besides, the amylose content among different reprocessing strategies and samples was maintained, indicating the absence of chemical modifications during the processes. Thermal analysis showed similar degradation behaviors, and mechanical performance was improved after reprocessing in some cases.

4. Conclusion: These findings demonstrate the feasibility of reprocessing starch aerogels without losing functionality and supporting their integration into circular material production schemes. From a shelf-life perspective, the ability to reuse such materials while keeping relevant properties positions them as promising candidates for sustainable food packaging and preservation systems.

5. Keywords: Starch, aerogels, reprocessing, circular economy, sustainability, shelf-life.

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P25 Cellulose-Based Compostable Films (NatureFlex™) as Sustainable Packaging for Organic Strawberries (Fragaria ananassa): Effects on Quality Preservation during Refrigerated Storage

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The reduction of postharvest losses in highly perishable commodities, alongside the replacement of fossil-based plastics, is a key challenge for sustainable food packaging. This study evaluated the effectiveness of a novel biodegradable cellulose-based film, NatureFlex™ (N), used alone or in combination with an active film (N+A), in maintaining the quality of flow-packed strawberries (Fragaria ananassa), in comparison with conventional microperforated polypropylene (mPP). In the N+A system, an alginate-based film enriched with lemon essential oil was placed at the bottom of the package. Strawberry transpiration and respiration rates at 4°C were quantified, and the film permeability coefficients (KPO_2 and $KPCO_2$) required to achieve a headspace gas composition of 2.5% O_2 and 16% CO_2 were estimated. Quality changes during 14 days of storage were monitored using weight loss and water mass balance measurements, changes in headspace gas composition, visual assessments, colorimetric, texture, and microbiological analysis. The estimated permeability values ($KPO_2 = 5\times10^{-4}$ and $KPCO_2 = 6.4\times10^{-4}$ cc·m·24 h^{-1}·m^{-2}·Pa^{-1}) were consistent with NatureFlex™ specifications ($KPO_2 \approx 6\times10^{-4}$), confirming its suitability for strawberry packaging. Compared with mPP, NatureFlex™ packaging better preserved fruit quality, reducing total weight loss to about 9% compared to 14% in mPP-packed samples, delaying browning of the strawberries, and containing microbial proliferation. Yeast and mold count at the end of storage were lower in N samples than in mPP samples (4.54 vs 5.46 log CFU/g, respectively), in agreement with visual observations showing a lower incidence of fungal decay in fruit packed in N and N+A films. However, headspace gas measurements revealed a 20% seal failure rate which limited the establishment of the target modified atmosphere. Overall, the results support the potential of cellulose-based compostable films as sustainable packaging materials for fresh produce, combining improved shelf-life performance with reduced reliance on conventional petrochemical plastics.

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P26 Methodologies for the contamination of LDPE films with benzophenone for diffusion studies

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Highly additivated plastic materials with model migrants are needed to carry out diffusion studies. The distribution of migrants in the polymer should be as uniform as possible. In the present study two contamination methods, specifically polymer wax contamination method [1] and highly concentrated solution immersion method [2] were investigated.

Benzophenone (BZP), a common plastic additive widely used as a photoinitiator for inks, was selected as model migrant because of its low-molecular weight and physico-chemical properties [2].

The wax-method was carried out by placing several LDPE films in close contact with a polyethylene wax additivated with BZP, the system was incubated at 60°C. The second method involved the immersion of LDPE films in a highly concentrated ethanolic solution of BZP, and it was stored at 60°C. To check the concentration of BZP in the additivated films an HPLC-DAD method was applied. Both methods recorded a benzophenone uniform concentration on the contaminated material. The wax method provided better results in terms of final concentration.

Then, the additivated films prepared by both methods were used to perform a kinetic migration study of BZP into the food simulant 20% ethanol (v/v). In both cases, a diffusion coefficient at the order of 10-8 was obtained.

To assess the possibility of swelling in the immersion method, two solvent absorption tests were performed on the LPDE film in H2O and EtOH, and a weight increase was recorded after 24 hours in both cases.

Considering the results obtained, the wax method was evaluated more suitable for this contamination assay, prospects are to test contamination in other materials.

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P27 Overview on membranes for permeability assays after in vitro gastrointestinal digestion of biobased packaging chemicals

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Introduction: Biobased food contact materials designed for packaging can transfer low molecular-weight compounds, like contaminants, that can be harmful for human health. Risk assessments on chemicals from food packaging materials rely primarily on migration studies from the packaging to the food (1). However, these approaches fail to consider the gastrointestinal digestion process, the release of contaminants from the food matrix and their subsequent absorption and bioavailability at the intestinal epithelium. In vitro protocols to evaluate the bioaccessibility of chemical contaminants from food samples are considered suitable tools for food safety and replace animal models (2). Numerous methods (tissue-based, cell-based and non-biological based models) exist to assess the bioavailability across the human gastrointestinal wall by mimicking intestinal absorption and permeability (3). Some of these methods use artificial membranes since they are a reliable tool to study passive permeation.

Objective: This work aims to evaluate the current state-of-the-art regarding membrane permeability assays and their application for the bioaccessibility of contaminants from biobased food contact materials.

Material and methods: A systematic bibliographic search was conducted using relevant databases, focusing on keywords such as "membrane permeability", "biobased packaging" and "in vitro models".

Results: The analysis identifies diverse artificial membrane models including regenerated cellulosic dialysis membranes, hollow fiber membranes and biomimetic membranes. Despite varying physical properties such as pore size and thickness, artificial membranes have been primarily developed and validated in pharmaceutical and nutritional fields but not in food safety. These models offer the advantage to closely mimic the in vivo situation from anatomical, biochemical and structural perspectives.

Conclusion: Although membranes are currently underutilized in food safety, they have a significant potential as a standardized tool for assessing the bioaccessibility of contaminants migrating from biobased food packaging, thus, allowing a more accurate exposure estimation.

Key words: artificial membranes, bioaccessibility, in vitro permeability, food safety.

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BioAccessibility of Emerging Chemical Contaminants in Foods from Biobased Food Packaging: Implications for Dietary Human Exposure Assessment (BioACCEx) Project (PID2024-161082NB-I00) funded by Spanish Ministry of Science MICIU/AEI/10.13039/501100011033 and FEDER, UE.

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P28 ANTIBACTERIAL EXTRACTS FROM TIGER NUT MILK PROCESSING WASTE TO DEVELOP BIODEGRADABLE ACTIVE FILMS

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INTRODUCTION: The valorization of agro-industrial waste as a source of bioactive compounds represents a promising strategy for developing active packaging materials aimed to extend the food shelf-life, while adding value to such by-products. In this study, subcritical water extraction (SWE) was employed to obtain phenolic-rich extracts from the residue generated during the tiger nut milk ('horchata') processing, following starch extraction. The extracts were incorporated into biodegradable hydrophilic and hydrophobic polymeric matrices to develop films with antimicrobial properties.

MATERIALS AND METHODS: Extracts were obtained by SWE at 170 and 180 °C (8 and 11 bar, respectively) for 30 min, using a 1:15 (w/v) solid:liquid ratio. Antibacterial activity against Escherichia coli and Listeria innocua was evaluated through minimum inhibitory concentration. Active films incorporating 6 g/100 g extract were produced using poly(3-hydroxibutirate-co-3-hydroxyvalerate) (PHBV) or thermoplastic starch (0.3 g glycerol/g starch) via melt blending and compression moulding. Antimicrobial performance was assessed through challenge tests at 10 °C for 6 days in TSA agar, pumpkin and salmon matrices, followed by microbial enumeration (log CFU/g).

RESULTS: Extraction conditions significantly affected antibacterial extract activity, with higher efficacy at 180 °C. PHBV-based films exhibited superior antimicrobial performance than starch-based films, particularly in TSA and pumpkin matrices. The highest inhibition was observed in PHBV films with extracts obtained at 180 °C, achieving reductions up to 1.4 log CFU/g for E. coli in pumpkin. Limited effects were observed in salmon, highlighting the strong influence of the food matrix composition.

CONCLUSION: Horchata processing waste is a valuable source of bioactive compounds for PHBV and starch active packaging. SWE at 180 °C provided the extracts with higher antibacterial activity, and their incorporation at 6% into PHBV films showed promising results. Further studies should explore higher extract concentrations to improve antimicrobial performance.

KEYWORDS: PHBV, starch, MIC, challenge essay, subcritical water extraction

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P29 Evaluation of Triacetin as an Eco-Friendly Plasticizer for Polylactic Acid (PLA) Films: A Comparative Study on Functional Properties

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In the food packaging sector, Polylactic Acid (PLA) is a prominent biopolymer recognized for its biodegradability and for its potential for developing compostable packaging. However, its inherent brittleness and limited mechanical strength restrict its application primarily to rigid disposable packaging, limiting its broader industrial utility. To mitigate these drawbacks, plasticization is a common strategy employed to enhance flexibility and chain mobility.

This study explores the potential of Triacetin (TA) as an alternative, eco-friendly, low-molecular-weight plasticizer to improve the mechanical performance of PLA films obtained via the solvent casting technique. For comparison, Polyethylene Glycol (PEG), a well-established plasticizer, was also evaluated. A Design of Experiments (DoE) was implemented, investigating three PLA concentrations (2.5%, 5%, and 7.5% w/v) and three plasticizer levels (10%, 20%, and 30% w/w). Chloroform-based film-forming solutions were cast and characterized after 24 hours of controlled drying. The resulting films were subjected to comprehensive testing, including mechanical properties, barrier and optical properties.

The research aimed to identify the optimal polymer-to-plasticizer ratio that maximizes film flexibility without significantly compromising structural integrity or moisture barrier properties. Despite the slight increase of permeability, the tailored formulations demonstrate a significant improvement in elongation at break, a phenomenon linked to the efficient intercalation of TA molecules within the polyester chains. Ultimately, this study provides valuable insights into the viability of Triacetin as an effective plasticizer for PLA. These findings offer a pathway toward the development of functional, biodegradable, and sustainable alternatives to conventional petrochemical-based packaging, expanding the potential of PLA for flexible food packaging applications.

Keywords: DoE, Mechanical Properties, Polylactic Acid, Triacetin.

P30 Effects of chemical crosslinking and cold plasma surface treatment on the properties of carboxymethyl cellulose-based films for food packaging applications

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Carboxymethyl cellulose (CMC) is widely used in the development of biodegradable films. However, it possesses certain drawbacks, such as limited barrier properties, high moisture sensitivity, and poor mechanical strength. To overcome these limitations, advanced techniques such as cold plasma and chemical crosslinking are employed. The present study explores the effects of calcium ions (Ca^{2+}) as a crosslinking agent and cold atmospheric plasma (CAPP) treatment. CMC-based films were modified with Ca^{2+} at different concentrations (0 to 2%) and exposed to cold atmospheric plasma for designated periods of time (0, 5, or 10 minutes). Plasma treatment improved film morphology by reducing surface agglomeration. FTIR analysis indicated that Ca^{2+} caused an attenuation of major bands, such as O-H, while the combined modifications increased the films' hydrophilicity. Young's modulus decreased with the addition of Ca^{2+} (from 3121 ± 673 MPa at 0% Ca^{2+} to 962 ± 92 MPa at 2% Ca^{2+}). Conversely, water barrier properties were improved, as the water vapor permeability decreased from 0.89 ± 0.12 g·mm/(h·m²·kPa) for control films to 0.19 ± 0.02 g·mm/(h·m²·kPa) for films treated with 2% Ca^{2+} and 10 minutes of CAPP. This study indicates that combining Ca^{2+} and CAPP treatment can enhance the physicochemical properties of CMC films. The resulting material is suitable for use as a packaging material, benefiting from the synergistic effect of crosslinking and reactive surface species generated by cold plasma.

Keywords: Modified cellulose films, Cold plasma treatment, Crosslinking agent, Physicochemical characterization

P31 Bio-based shellac coatings to improve barrier properties of kraft paper for compostable food packaging envision its use in insect-based foods

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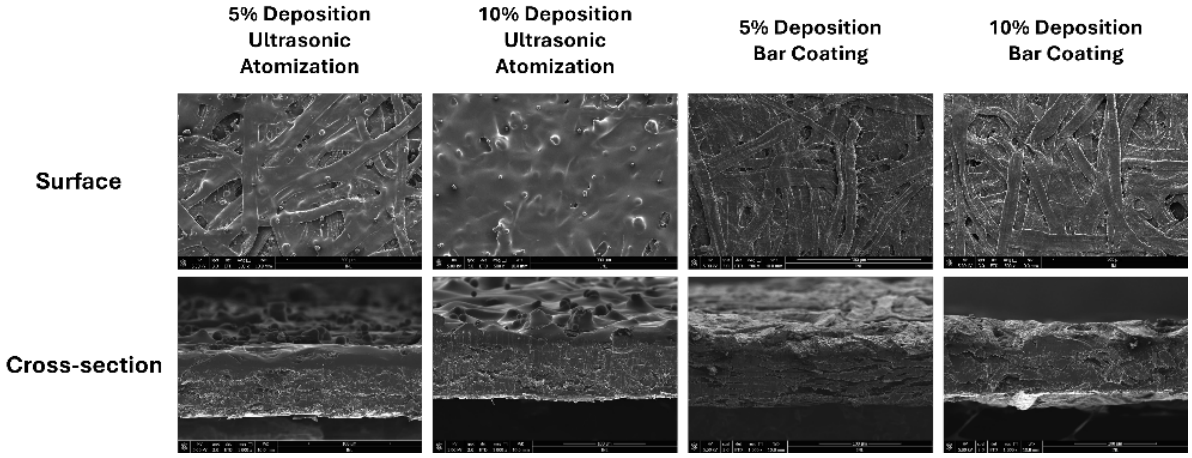
Replacing conventional plastic packaging with bio-based and compostable materials requires developing paper-based structures with improved barrier properties while maintaining recyclability and compostability. [1,2] This work aimed to develop shellac-based coatings for kraft paper and compare ultrasonic spray and bar coating as application techniques for food packaging. In the end, these packaging materials are expected to be used to pack insect-based foods.

Shellac coatings were applied at target depositions of 5% and 10% of the final material mass using two techniques. In ultrasonic atomization, a 10% (w/v) shellac solution was used, yielding depositions of approximately 4 and 8 g/m² under optimised conditions. In bar coating, 15% and 30% (w/v) shellac solutions were used to obtain the same target deposition levels. The developed materials were characterised by scanning electron microscopy (SEM), Cobb, water contact angle, grease resistance, water vapour permeability (WVP) over 24h, and disintegration under composting conditions.

Shellac-coated papers showed mass loss above 90% during disintegration tests, confirming their suitability for compostable applications at coating levels ≤10% of total mass. SEM images (Figure 1) revealed that increasing shellac deposition by ultrasonic atomization produced more homogeneous and less porous surfaces, while bar-coated samples displayed smoother but less differentiated morphologies between deposition levels. The 10% bar-coated sample showed the most relevant barrier improvement, reaching a Cobb value of 8.35±0.99 g/m², whereas the remaining samples stayed above 10 g/m². All samples presented hydrophobic behaviour (contact angles >70°), particularly for bar-coated papers. Grease resistance was low for all formulations (kit value <1). The lowest WVP values were obtained for the 10% bar-coated structure, confirming its superior resistance to water vapour transfer.

These results demonstrate that shellac is an effective bio-based coating for improving kraft paper barrier performance while preserving compostability, with bar coating at 10% deposition providing the most promising overall performance for sustainable food-packaging applications.



SEM images of the surface and cross-section of kraft paper coated with 5% and 10% shellac depositions by ultrasonic atomization and by bar coating.

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2. Poddar D.; Srivastava R. K.; Pattanayek S.K.; Goel G. Int. J. Biol. Macromol. 2025, 310, 143172.

This work was carried out within the framework of the VIIAFOOD Agenda – Platform for Valorisation, Industrialisation and Innovation for the Agri-Food Sector (C644929456-00000040), funded by the Portuguese Recovery and Resilience Plan (PRR) under the European Union's Recovery and Resilience Facility, and by NextGenerationEU funds through the scope of the Agenda for Business Innovation "InsectERA" (Project no. 20 with the application C644917393-00000032).

P32 High-barrier cellulose-based coatings produced by ultrasonic spray coating for insect flour preservation

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Plastic is widely used in food packaging due to its functional properties, extending shelf life and reducing food waste. Polyethylene (PE) is the most common plastic in food applications, including packaging for emerging protein sources such as plant based and insect based foods. However, PE has limited barrier performance, particularly against gases and moisture. To overcome these limitations, synthetic materials are often incorporated into multilayer films, improving resistance and barrier properties. Ethylene vinyl alcohol copolymer is one of the most widely used materials to provide strong oxygen barriers. Despite their advantages, multilayer films pose major recycling challenges because different polymers are difficult to separate after use. Developing bio based coatings applied directly onto film surfaces offers a promising strategy to enhance barrier properties while reducing the need for multilayer structures and improving recyclability. This work aimed to develop cellulose based coatings with oxygen and carbon dioxide barrier properties and apply them to pure PE films using ultrasonic spray coating. Cellulose nanocrystals (CNC) were selected as coating materials, testing two grammages (2 and 4 g/m^2). Coating morphology was analysed by scanning electron microscopy (SEM), and optical and barrier properties were evaluated. SEM images showed that coatings became more uniform and smoother when surface treatment and primer were applied. Optical results indicated that PE control films had haze values between 3–6%, while CNC coatings without treatment exhibited much higher haze (≈30% and 50% for 2 and 4 g/m^2). Applying treatment and primer significantly reduced haze, bringing values close to those of the PE control. Regarding barrier performance, coated PE films showed lower oxygen and carbon dioxide permeability compared with uncoated PE. The combination of treatment and primer further improved gas barrier properties due to enhanced coating uniformity and adhesion. These results demonstrate the potential of recyclable PE based packaging with improved barrier functionality for food applications.

This work was carried out within the framework of the VIIAFOOD Agenda – Platform for Valorisation, Industrialisation and Innovation for the Agri-Food Sector (C644929456-00000040), funded by the Portuguese Recovery and Resilience Plan (PRR) under the European Union's Recovery and Resilience Facility, and by NextGenerationEU funds through the scope of the Agenda for Business Innovation "InsectERA" (Project no. 20 with the application C644917393-00000032).

P33 Bioaccessibility and in vitro digestion in food contact materials: a tool for risk assessment

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The safety of food packaging materials is a key priority within EU food safety policy, supported by regulations based on scientific evidence and risk management principles. Traditional risk assessments for food contact materials (FCMs) focus on chemical composition, migration potential and toxicity (1), but often assume complete absorption of migrated substances, which can lead to overestimated exposure (2). In addition, physiological factors, such as variations in gastric pH, can influence the transformation or degradation of ingested substances (3), yet these aspects regarding the gastrointestinal fate of chemicals remain insufficiently addressed.

This work proposes the application of in vitro digestion methods as tools to improve exposure estimation of substances migrating from FCMs, by incorporating bioaccessibility as a parameter for more adequate risk assessment. Within the framework of the ACHED project, this comprehensive literature review examines the state of the art in the application of in vitro digestion protocols to food packaging, summarizing methodological adaptations, extraction procedures, and analytical approaches used for the identification and quantification of substances of interest.

Following filtering and relevance screening, 40 articles were identified as directly addressing the topic. This study retrieved that the most applied in vitro digestion models include three gastrointestinal compartments, although different levels of complexity were assessed. The substances investigated mainly were nanoparticles, nano and microplastics, bisphenols and phthalates. Among the identified studies, RIVM, UBM or INFOGEST protocols were the most applied.

Overall, this work highlights a knowledge gap in the application of bioaccessibility assays in the context of food safety. It also demonstrates their potential to enhance dietary exposure to substances present in FCMs by integrating chemical properties, physiological variability, dietary patterns and consumer variability, supporting more accurate risk assessment and public health recommendations.

Key concepts in bioaccessibility assessment of chemicals from packaging materials

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2. Brandon et al., 2006, Regul. Toxicol. Pharmacol. 44, 161-71
3. Abuhelwa et al., 2016, AAPS J, 18(5), 1309–1321

In vitro oral bioAccessibility of Chemicals from food contact materials to estimate Human Exposure through the Diet (ACHED) (CNS2022-135887) funded by Spanish Ministry of Science (10.13039/50110001103) and European UnionNextGenerationEU/PRTR.

L. Pazos-Soto is grateful for her grant "Programa de axudas á etapa predoutoral" da Xunta de Galicia.

P34 Meat preservation using PLA/PVA laminates containing almond shell extracts obtained by subcritical water extraction.

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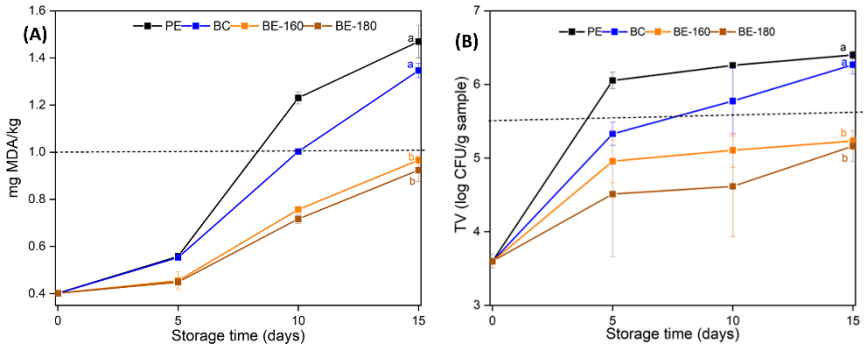
The development of sustainable materials for food packaging is a key strategy to minimise the environmental impact of conventional plastics and reduce food waste by extending their shelf life. In this study, bioactive extracts from almond shells were obtained by subcritical water extraction 1 at 160 °C (E-160) and 180 °C (E-180) and subsequently integrated (15.4 wt.%) into biodegradable PVA-PLA double-layer laminates, by melt blending with PVA and subsequent lamination of PVA and PLA layers by thermocompression 2. These extracts showed highphenolic content (4.24 and 16.7 g GAE/g dry extract, respectively), DPPH radical scavenging capacity (EC50: 4.4 and 1.5 mg extract/mg DPPH, respectively), and significant antimicrobial activity against Escherichia coli and Listeria innocua, with the E-180 extract showing the highest efficacy. The laminated films with and without active extracts exhibited high water vapour and oxygen barrier capacity, intrinsic to the double-layer design 2, while extracts provide the laminates with reddish-brown colour and UV blocking effect. The food preservation capacity of the laminates was evaluated by packaging pork meat and storing it at 5 °C, monitoring quality parameters for 15 days. The films containing extracts effectively reduced the biochemical and microbiological degradation of the meat compared to the control samples. Specifically, active packaging resulted in a slower increase in pH, a significant reduction in lipid oxidation, maintaining levels below sensory rejection thresholds throughout storage, and a marked growth inhibition of total viable bacteria (Figure 1). Consequently, the incorporation of E-160 and E-180 extracts into the films significantly extended the shelf life of the meat, demonstrating that these biodegradable and bioactive laminates are a sustainable alternative for packaging of foods sensitive to oxidation and microbial growth.



Development of TBARS index (A) and Total Viable counts (TV) (B) of cold stored meat samples packaged with different films: polyethylene (PE), PLA/PVA bilayer without active compounds (BC), and PLA/PVA bilayer containing extracts obtained at 160 °C (BE-160) and 180 °C (BE-180).

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2. *Andrade, J., González-Martínez, C., & Chiralt, A. (2022). Antimicrobial PLA-PVA multilayer films containing phenolic compounds. Food Chemistry, 375, 131861.*

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P35 Water-based bioactive coatings applied to compostable PLA packaging to extend blueberry shelf life

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Biodegradable and compostable packaging made from polylactic acid (PLA) represents a sustainable alternative to conventional plastics for the preservation of fresh fruit. However, its limited barrier performance and lack of antimicrobial activity restrict its effectiveness for highly perishable products such as blueberries. In this context, the development of active coatings incorporated onto PLA substrates emerges as a promising strategy to extend postharvest shelf life.

This study investigates the development of bilayer systems consisting of a commercial PLA film coated with an aqueous polymer dispersion. Stable blends of incompatible polymers were prepared in aqueous media using an emulsification–evaporation method, enabling the development of coatings with different polymer ratios. Four formulations were evaluated: two based on amorphous polylactic acid (PL) combined with chitosan (CS) at different concentrations, and other two based on PL and polyvinyl alcohol (PVOH). Methyl anthranilate (Ma), a naturally occurring ester recognized as GRAS and known by its antifungal properties, was added to these coatings in order to provide them with antimicrobial activity.

The effect of formulation composition on the physical properties and the active compound release behavior of developed bilayer systems, in addition to their ability to reduce surface fungal proliferation, were investigated. Results indicated that coatings improved PLA barrier properties and developed active bilayer systems effectively delayed firmness loss and reduced fungal growth of packaged blueberries. These findings highlight the potential of these active and compostable PLA-based packaging materials as sustainable solutions for improving the postharvest quality and extending the shelf life of fresh berries.

Keywords

Polymeric dispersion

Polylactic acid

Chitosan

Polyvinyl alcohol

Coatings

P36 USE OF ALMOND SKIN BY-PRODUCTS TO DEVELOP BIODEGRADABLE ACTIVE BILAYERS BASED ON STARCH AND POLIHYDROXIBUTIRATE

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[1] Universitat Politecnica de Valencia

Currently, multilayer food packaging materials made from petroleum-based plastics pose an environmental problem due to their difficulty in recycling. As an alternative, the development of fully biodegradable multilayer materials is proposed. This study addresses the development and characterization of biodegradable bilayers consisting of a hydrophilic monolayer of cassava starch and a hydrophobic monolayer of polyhydroxybutyrate (PHB). Taking a circular economy approach, defatted almond skin (DAS) and its polyphenol-rich extracts obtained by subcritical water extraction at 160 and 180ºC were integrated to obtain active packaging materials for food preservation. These composite materials were obtained by melt blending and thermocompression and characterized in terms of their microstructure, mechanical, optical, and barrier properties.

The control bilayers exhibited high mechanical stiffness values (430-540 MPa), low extensibility, and water vapor and oxygen permeability values intermediate between the two monolayers. The addition of DAS reduced the extensibility of the material, while the incorporation of the extracts led to a plasticizing effect. This effect is likely due to the partial hydrolysis of PHB polymer during the thermoadhesion process, which was promoted by the phenolic acids (Ordoñez et al., (2021). The water vapor and oxygen barrier capacity was maintained or decreased compared to the control when the extracts and DAS were incorporated, due to an increment in the tortuosity factor that limits molecular diffusion through the polymer matrix.

The incorporation of DAS and extracts resulted in materials that were opaquer and had a marked brownish-red appearance in comparison with the control. These changes are attributable to the natural pigments in the active agents and to the Maillard reaction products that appeared during the thermal processing of biocomposites. These color changes gave the bilayers a high UV light barrier capacity, which, combined with their reduced oxygen permeability, resulted in materials potentially suitable for packaging foods sensitive to oxidative processes.

Keywords: active packaging, bilayers, mechanical, barrier properties.

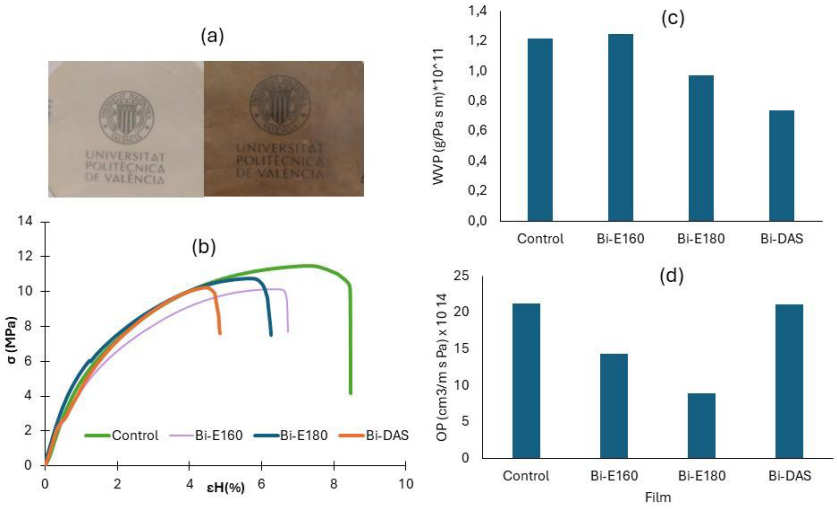

Figure 1. Visual appearance of control and bilayer with E-180 (a), tensile strength vs deformation at break and water vapor and oxygen permeability values of control bilayers and bilayers incorporating almond skin extracts (E) obtained at 160 and 180ºC and defatted almond skin (DAS).

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P37 Next-Generation Biopolymer Coatings for Sustainable Paper-Based Food Packaging

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Introduction: The replacement of petroleum-based plastic coatings with sustainable alternatives has become a central objective in food packaging research. Although paper substrates are renewable and recyclable, their inherent porosity and hydrophilicity limit their barrier performance. Biopolymer coatings have emerged as promising solutions to enhance the barrier and functional properties of paper-based packaging while improving environmental compatibility.

Materials and Methods: A comprehensive analysis of peer-reviewed studies published between 2005 and 2025 was conducted, focusing on biopolymer-coated paper substrates for food-contact applications. Barrier metrics such as water vapor transmission rate (WVTR) and oxygen transmission rate (OTR), interfacial adhesion strategies, and functional additive integration were comparatively evaluated.

Results: Although polysaccharide-based coatings are abundant and provide strong oxygen barrier properties, they remain sensitive to moisture. Biodegradable polyesters, such as PLA, PBS, and PBAT, offer improved hydrophobicity but require enhanced adhesion to cellulose substrates. Hybrid coating systems incorporating nanocellulose or mineral nanofillers create tortuous diffusion pathways, thereby improving barrier performance. Furthermore, the incorporation of bioactive agents enables antimicrobial, antioxidant, and ethylene-scavenging functions, transforming paper packaging from passive protection to active systems.

Conclusion: Biopolymer coatings represent a promising approach for achieving sustainable and multifunctional paper-based packaging. Future research should focus on improving humidity stability, interfacial engineering, and industrial processing compatibility to facilitate large-scale adoption.

Keywords: Biopolymer coatings; Paper-based food packaging; Barrier properties; Active packaging; Sustainable materials

P38 CHEMICAL SAFETY OF BIODEGRADABLE FOOD CONTACT MATERIALS: SCREENING OF VOLATILE COMPOUNDS USING P&T-GC-MS

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Biodegradable polymers are being increasingly used in food packaging applications to replace petroleum-based plastics as a sustainable packaging solution.

Bioplastics, like other food contact materials, must comply with the requirements set out in Article 3 of Regulation 1935/2004 [1], so that they must not release components into food in quantities that could endanger human health.

In the present work, the volatile low-molecular weight compounds present in two biodegradable polymers, specifically poly (butylene succinate-co-adipate) (PBSA) and poly (butylene adipate-co-terephthalate) (PBAT), were analyzed. For that purpose, a non-targeted screening method with Purge and Trap coupled to Gas Chromatography and Mass Spectrometry (P&T-GC-MS) was applied.

Samples were extracted at 80 ºC for 30 min and using the chromatographic conditions reported by Vázquez-Loureiro et al. (2025) [2].

The identification of the detected compounds was obtained by comparison with the spectral libraries NIST/EPA/NIH 11 (version 2.0) and Wiley RegistryTM 8th edition.

More than 40 volatile compounds were tentatively identified in PBSA and PBAT, mainly belonging to hydrocarbons, aldehydes, esters, alcohols, and ketones, with minor aromatic and halogenated species. Hydrocarbons and aldehydes were the predominant compounds. PBSA showed a higher contribution of esters and long-chain hydrocarbons, whereas PBAT was relatively enriched in short-chain hydrocarbons and oxygenated compounds such as ketones and alcohols. The majority of compounds belong to Cramer Class I (low toxicity) and Class II (intermediate toxicity), although some detected aromatic and chlorinated compounds belong to Class III (high toxicity).

Keywords: PBAT; PBSA; volatile compounds; non-target analysis; food contact materials.

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P39 VALORIZATION OF LOW-STARCH POTATO PEEL TO DEVELOP BIODEGRADABLE LAMINATES

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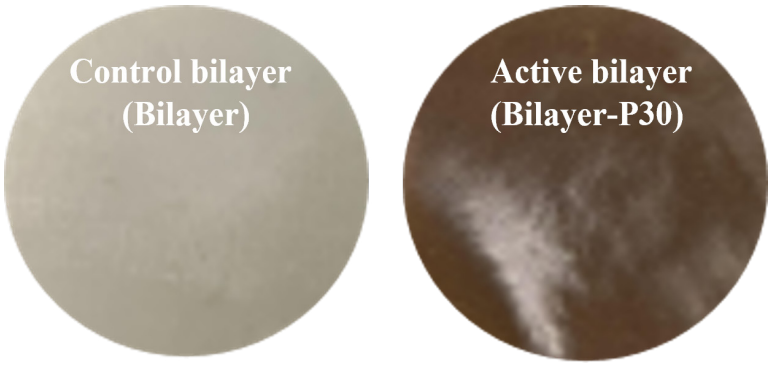
INTRODUCTION: Plastics dominate food packaging but raise environmental concerns. Polyhydroxyalkanoates (PHA) and starch are promising biodegradable alternatives, though limited by high costs and water sensitivity, respectively. Incorporating low cost agro-industrial residues like potato peel (PoP) offers a sustainable strategy for waste valorization and cost reduction, while starch-PHA lamination can improve water barrier properties. This study aims to develop PHA-starch bilayers incorporating PoP as a lignocellulosic filler rich in phenolic compounds.

MATERIALS AND METHODS: Bilayers were produced using modified thermoplastic potato starch (TPSm, 0.3 glycerol/g starch and 0.2 g PHA/g starch) and neat PHA monolayers through melt blending and thermocompression moulding. PoP (0.3 g residue/g film) was incorporated or not into the PHA layer, and bilayers were obtained by thermo-sealing (Bilayer, Bilayer-P30). Materials were characterized as to their microstructure, mechanical, barrier and optical properties, total phenol content and antioxidant capacity. In vivo oxidation tests using sunflower oil were also performed.

RESULTS: TPSm conferred oxygen barrier capacity to the laminates while PHA limited water vapour transfer, which was enhanced by PoP incorporation ($p<0.05$). Incorporation of PoP into PHA improved the oxygen barrier property ($p<0.05$) but slightly increased water vapour permeability due to its hydrophilic nature. Mechanically, bilayers were more extensible but less resistant and stiff than PHA monolayers, with PoP further reducing performance. Opaque PoP-loaded films exhibited effective UV-UVA protection and potential antioxidant activity. Nevertheless, Bilayer-P30 was not suitable for sunflower oil packaging due to oil absorption by PoP particles.

CONCLUSION: Potato peel is an agro-industrial waste with potential to be used as a filler into starch-PHA bilayer films, resulting in materials with good barrier properties, moderate mechanical strength and potential antioxidant activity. Further studies to validate the antioxidant capacity of the bilayers incorporating PoP in other food products sensitive to oxidative reactions will be carried out.

KEYWORDS: polyhydroxyalcanoates, starch, active packaging



Aspect of laminates

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P40 Safety Assessment of Recyclable Coffee Packaging: Screening Non-/Intentionally Added Substances and Quantifying Primary Aromatic Amines in Multilayer Polyolefin-Based Materials

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The transition towards recyclable flexible packaging is driving the replacement of aluminum layers with polyolefin-based multilayer structures. While these solutions improve recyclability, the absence of inorganic barriers may increase interactions between food and packaging materials, raising food safety concerns. So, the potential migration of additives used in packaging manufacture (IAS) and harmful non-intentionally added substances (NIAS), like primary aromatic amines (PAAs), must be carefully evaluated.

This study investigates migration phenomena in multilayer laminates intended for coffee powder packaging. Polyolefin-based structures differing in layer compositions and barriers were examined. First, the materials were characterized by mechanical testing and FT-IR analysis. A screening approach was then applied to identify volatile and semi-volatile IAS and NIAS using headspace solid-phase microextraction coupled to gas chromatography–mass spectrometry (HS-SPME-GC-MS). Detected compounds were identified by library matching and evaluated for toxicological concern. In parallel, the migration of PAAs was assessed through targeted analysis using ultra-performance liquid chromatography coupled with high-resolution mass spectrometry (UPLC/HR-MS). Migration tests were performed under worst-case conditions using food simulant B, in accordance with EU legislation for long-term food contact materials. Quantification was carried out using individual PAAs standards following Joint Research Centre guidelines.

The proposed combination of screening IAS/NIAS and targeted PAAs analysis allowed discrimination between different laminate structures and barrier solutions. In this way, combining broad screenings with targeted approaches provides a robust strategy to identify potential safety concerns and support informed decisions in material selection and packaging design.

Keywords: Recyclable packaging; NIAS; primary aromatic amines; polyolefin multilayers; coffee packaging

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P41 Effects of cold adaptation on Listeria monocytogenes growth in challenge tests of ready-to-eat (RTE) meat products

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Challenge test has been used to validate the safety of RTE products against L. monocytogenes (Lm). Cold adaptation of the bacterial cultures is recommended for refrigerated products (EURL 2021). However, effects of cold adaptation on various Lm strains were poorly understood. This study was to compare growth parameters (growth rate μ, lag time λ, time to 1-log outgrowth TTG1) of cold and non-cold adapted Lm cocktails in a refrigerated ham.

Three chicken hams were prepared: T1 – Control, T2 – 0.7% vinegar powder and T3 – 0.8% cultured sugar. Five Lm cultures grown overnight at 37oC were cold adapted in BHI at 7oC for 7 days. They were combined in equal volumes to create adapted and non-adapted cocktails. The grounded ham was inoculated with each cocktail (3 log cfu/g), vacuum packed and stored at 7oC for 110 days. Triplicate samples were randomly drawn and enumerated for Listeria (ALOA) and anaerobic plate count (BHI). Parameters (μ, λ, TTG1) were calculated from growth curves and compared statistically (α=0.05). Non-inoculated samples were also prepared in a similar manner.

The adapted Lm cocktail showed significantly shorter λ (0.10 – 0.59 days) than non-adapted one (1.99 – 9.78 days) across all recipes. The μ values of the two cocktails were not significantly different except in T3, whereby the adapted cocktail had significantly lower μ (0.108 d-1 vs. 0.202 d-1). Consequently, TTG1 of adapted cultures was 20% - 50% shorter than non-adapted ones depending on antimicrobial ingredients. No growth was detected in non-inoculated samples except T1 where anaerobic plate count reached log8 by day 35.

Cold adaptation shortened significantly the observed lag times and TTG1 of Lm. Growth rates were not affected by the adaption but reduced significantly with antimicrobial ingredients. In conclusion, cold adaptation is a critical step in Lm challenge test of refrigerated RTE products.

European Union Reference Laboratory for Listeria monocytogenes (EURL Lm) (2021). EURL Lm Technical Guidance Document on challenge tests and durability studies for assessing shelf-life of ready-to-eat foods related to Listeria monocytogenes (Version 4). Zenodo. https://doi.org/10.5281/zenodo.7760700

P42 Reducing Natamycin Dependence in Cheese Through Whey Protein-Based Coatings Incorporated with Cardoon Leaf Extract

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In response to the increasing consumer demand for foods with less synthetic additives, research has focused on developing biodegradable active packaging systems incorporating bioactive compounds from sustainable sources. Agro-industrial by-products such as cardoon (Cynara cardunculus L.) leaves, often discarded despite their richness in antimicrobial and antioxidant compounds, and whey protein, widely used for biodegradable film production, represent promising alternatives in the cheese industry. Cheese, a highly perishable product prone to microbial contamination, is commonly preserved with natamycin, however, concerns regarding its excessive use have driven the search for safer and natural preservation strategies.

In this sense, this study aimed to evaluate the potential of whey protein-based coatings incorporated with cardoon leaf extract (2.0% w/v and combined with 50% natamycin) to extend cheese shelf life and assess their potential to reduce natamycin use. Cheeses were dipped in the active coatings and stored at 5 ± 2 °C for 45 days. Samples were analysed for microbial growth (total viable counts, moulds and yeasts, Enterobacteriaceae) and lipid oxidation (Thiobarbituric Acid Reactive Substances (TBARS) assay).

Results indicate that active coatings delayed microbial growth in both rind and interior, with values comparable to those of natamycin alone. Cheese with 2.0% of cardoon leaf extract and 50% of natamycin presented the lowest counts of total viable microorganisms (5.96 ± 0.14 Log CFU/g), moulds and yeasts (4.21 ± 0.05 Log CFU/g), and Enterobacteriaceae (5.04 ± 0.09 Log CFU/g) compared to control samples and coating with only 2.0% of cardoon leaf extract. Lipid oxidation remained at low levels (0.12 mg MDA / Kg cheese), with no significant difference between both active coatings.

Overall, the incorporation of cardoon extracts into whey protein-based coatings demonstrated antimicrobial and antioxidant properties, improving cheese preservation during refrigerated storage. This sustainable approach reduces reliance on synthetic preservatives while valorising agro-industrial by-products.

Keywords: Cynara cardunculus L.; Active Coatings; Shelf-Life Extension; Antimicrobial Properties; Antioxidant Properties

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P43 Valorisation of Lime By-Products in Gluten-Free Vegan Pancakes: Functional, Sensory, and Bioaccessibility Assessment

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The goals of the circular economy and the demand for healthier foods are driving the use of fruit by-products as ingredients, enabling the development of zero-waste foods while improving their nutritional quality1. This study aimed to valorise lime by-products from a zero-waste perspective, through the direct and complete use as a functional ingredient in gluten-free vegan pancake formulations.

Control pancakes and lime flour-enriched formulation ranging from 2.5% to 10% (P2.5%, P5%, P7.5% and P10%), were analysed for their rheological properties, batter density, morphology, colour, water activity, texture, and proximate composition. In addition, an in vitro digestion was performed following the standardised INFOGEST protocol on lime flour and pancake samples to evaluate the bioaccessibility of phenolic compounds in the enriched formulations, as well as the protective effect of the food matrix. Finally, considering the consumer as the ultimate target of these products, a hedonic sensory analysis and a CATA (Check-All-That-Apply) test were conducted.

The results showed that fortification improved batter consistency and enhanced the nutritional profile of the pancakes by increasing fibre and phenolic compound content while reducing sugar levels. All fortified samples exhibited lower spread indices, and approximately 50% of the total phenolic compounds remained bioaccessible after in vitro digestion. Hesperidin and eriocitrin were identified as the dominant phenolic compounds, showing moderate bioaccessibility (40–60%) and an overall recovery above 80%. Sensory evaluation revealed that the P2.5% and P5% samples achieved the highest overall acceptance, which was associated with a sweet taste, soft texture, and uniform colour, whereas higher fortification levels resulted in bitterness, astringency, and lower preference.

Overall, P2.5% and P5% emerged as the most promising formulations, demonstrating that flour derived from lime by-products can be effectively used as a functional, sustainable ingredient in bakery products. Its incorporation contributes to enhanced nutritional value and enables the development of fibre-rich, lower-sugar bakery goods, while maintaining acceptable sensory quality and aligning with zero-waste and circular economy principles.

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P44 Postharvest quality of peaches under an ionizing atmosphere

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Postharvest conservation of peaches is essential to maintain quality during storage and distribution. Emerging technologies, such as ionizing atmosphere, may influence fruit physiology and quality attributes. This study aimed to evaluate the effects of storage time and atmosphere (normal vs ionizing) on the physicochemical properties of peaches, including firmness, weight loss, total soluble solids (TSS), and titratable acidity.

Peaches were stored under two atmospheric conditions (normal and ionizing) at 1°C and 95% humidity. Fruit quality was monitored over time (7 and 14 days), with additional exposure to room temperature (+3 days). Measurements included weight and colour, firmness, TSS and titratable acidity. Data were analysed using two-way ANOVA followed by multiple comparison tests ($p < 0.05$).

Storage time significantly affected all parameters ($p < 0.01$). Firmness decreased progressively, with no significant effect of atmosphere storage treatment, although additional exposure to room temperature (3 days of shelf-life period) significantly accelerated softening ($p < 0.0001$). Weight loss increased with storage duration and was influenced by atmosphere storage treatment in a time-dependent manner ($p < 0.0001$), with significantly higher losses under ionizing conditions at 7+3 and 14+3 days. TSS was affected by storage time and showed a significant interaction with atmosphere storage treatment ($p = 0.0077$), with higher values under ionizing conditions observed at 14+3 days. Titratable acidity decreased significantly during storage, particularly at 14 days, with no effect from the atmosphere storage treatment.

Storage time and post-storage handling conditions were the main factors affecting peach quality. Exposure to room temperature significantly accelerated quality degradation.

Keywords: Peach; Postharvest; Storage atmosphere; Quality; Shelf-life

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P45 Impact of Germination on Volatile Compounds in White and Verdina Beans from Galicia

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Alubia is a variety of the common bean (Phaseolus vulgaris) that grows in Galicia and Asturias in Spain. When harvested while still immature (green) and dried in the shade, it is known as Alubia verdina (AV), appearing small and green, and when dried on the plant it is known as White Alubia (AB), being twice as large and white in color. Beans are nutritionally rich in proteins, fiber, phenolic compounds among others, and the germination can improve its nutritional value (like proteins and phenolic compounds) and sensory characteristics and decreases others undesired compounds like taninns [1]. Among all legumes, the verdina beans are the most appreciated by top chefs due to their smooth texture and delicate flavor. Therefore, this study aims to analyze the volatile profile of verdina and white beans before and after germination (72h) to evaluate the impact on their flavor.

Samples were acquired from family farmers at a local market in Santiago de Compostela, Spain. Purge and trap coupled with gas chromatography and mass spectrometry (P&T-GC/MS) was used to analyze bean samples. Before being injected into the GC-MS instrument, each sample were submitted to a thermal desorption at 80°C for 30 min for VOC extraction and concentration. Spectral matching with mass spectral libraries were used to identify compounds.

No differences were found among green and mature alubias in terms of volatile compounds detected. However, compounds namely alcohols such as 1-Butanol; 1-Butanol, 3-methyl-; 1-hexanol; 3-Hexen-1-ol or 2,3-Butanediol were found after germination in comparison with harvested before germination [2]. Alcohols presence resulted from the oxidation of lipids due to the presence of dehydrogenase. Besides them, 2-Butanone, 3-hydroxy-, acetic acid and butanoic acid were the compounds with higher presence in both green and mature germinated samples, which could be related from free amino or fatty acid degradation [3].

The results obtained indicate that the germination influences in the composition of volatile compounds, while the stage of maturation and the type of drying (matured directly in the plant or in the shade) of the beans showed no significant differences. The absence of compounds such as isobutyric acid or pentanoic acid in Verdina Alubia, associated to rancid, butter, cheese and burnt odor, respectively, confirm and highlight the delicate flavor claimed for this food product.

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P46 Germination and thermal processing as strategies for modulating the nutitional and technology profile of creole corn flour

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Creole corn represents an important genetic and cultural heritage, especially in traditional agricultural systems, and is fundamental for food security and the sovereignty of local communities. This study evaluated the effects of germination using two dehydration methods (forced-air oven at 55 °C/12 h - GCFT1 and conventional oven at 180 °C/2 h - GCFT2) on the mineral profile of creole corn flours from the traditional community called Quilombo Caraíbas, Ibitiara, Bahia, Brazil. A control flour without germination (CCF) and two germinated flours (GCFT1 and GCFT2) were characterized for proximate composition, particle size distribution, water absorption index (WAI), water solubility index (WSI) and oil absorption index (OAI). Germination and thermal processing significantly reduced ($p<0,05$) moisture content (3.19 to 6,25%). No significant differences ($p>0,05$) were observed between the samples for protein content (11.07 to 11.59%) and ash content (0.95 to 1.04%). However, lipid and carbohydrate content were significantly higher ($p<0,05$) in the sprouted flours (GCFT1 - 3.12 and 81.55% and GCFT2 - 2.96 and 79.24%), when compared to CCF (1.32 and 76.41%), respectively. The passing mass of the flours varied from 70.12 to 81.19%, with a statistically significant difference between the samples ($p<0.05$). There was no significant difference ($p>0,0$) for WAI (2.16 to 2.33 g/g) and OAI (3.31 to 3.46 g/g); WSI was higher in GCFT2 (20.71%). These variations are influenced by several factors such as variety, environmental conditions, germination, drying method and thermal intensity, reinforcing the importance of processing control to obtain products with specific nutritional and technological characteristics. The results showed that germination under different thermal processes influenced nutritional profile of creole corn flours, highlighting their potential for use in food products and for valorizing traditional food systems. The use of creole corn in the human diet will stimulate the production of sustainable food and family farming.

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P47 Volatile fingerprint of feijoa (Acca sellowiana) cultivated in Galicia.

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Introduction: "Feijoa" (Acca sellowiana) is a tropical fruit native to South America that is increasingly cultivated in temperate regions such as Galicia due to it charecteristic aroma. This distinctive aroma arises from a complex mixture of volatile compounds, including esters, terpenes, aldehydes, and alcohols (1). This study aims to analyze feijoa fruits grown in different areas of Galicia, contributing to their chemical characterization and potential valorization.

Material & Methods: Purge-and-trap gas chromatography-mass spectrometry (P&T-GC/MS) was used to analyze Feijoa samples grown in Galicia. Before being injected into the GC-MS instrument, 200 mg portions of each sample underwent thermal desorption and a 30-minute purge at 80°C for volatile organic compounds (VOCs) extraction and concentration. Spectral matching and fragmentation pattern comparisons against commercial mass spectral libraries, supported by retention index data, were used to identify compounds.

Results: Preliminary results revealed a complex volatile profile in "feijoa", comprising numerous compounds from the classes of esters, terpenes, alcohols, and aldehydes and ketones. VOCs such as 3-hexen-1-ol, ocimene, octan-3-one, and linalool contributed most to the fruit's characteristic aroma imparting green, citrus-tropical, herbal, and floral notes, respectively. This composition aligns with previous reports of "feijoa" in Latin America. However, differences in the terpene fraction allowed to distinguish the samples; specifically, some fruit samples were characterized by the presence of α-gurjunene, copaene, and trans-calamenene, while others exhibited distinct profiles containing cis-calamenene, globulol, or aromadendren, bringing woody, sweet, and floral notes to the overall aroma profile, according to the Galician geographical region of growth.

Conclusion: This study provides a qualitative description of the volatile composition of "feijoa", (Acca sellowiana) grown in different parts of Galicia. The results highlight significant compounds that define its sensory qualities and confirm a complex fragrance profile dominated by esters, terpenes and alcohols.

Keywords: Acca sellowiana, volatile compounds, feijoa fruit, flavor, P&T-GC-MS.

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P48 Differentiation of Brazilian Hop (Humulus lupulus L.) based on α/β-bitter acids: Effect cultivars and geographic origins.

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Introduction: Hops (Humulus lupulus L.) are a dioecious rhizomatous climbing plant belonging to the Cannabaceae family. It is mainly cultivated in central Europe and across the American continent, including Brazil and is widely recognized for its essential role in the brewing industry, where it provides bitterness, aroma, and preservative properties. In addition, there is growing interest in its high content of bioactive compounds, particularly bitter acids, which may offer additional benefits beyond traditional brewing applications (1). This study aims to compare Brazilian and imported hop from eight cultivars (MittelfrühMIT), Nugget-NUG, Cascade-CAS, Centenial-CEN, Columbus-COL, Comet-COM, Magnum-MAG and SAAZ-SAA) to evaluate differences in bioactive compounds profiles.

Material & Methods: Hop pellet samples from Brazilian (N) and imported (IM) were analyzed. The bitter acids α (cohumulone, adhumulone) and β (colupulone, adlupulone) were extracted with absolute ethanol using ultrasound-assisted extraction and quantified by HPLC-DAD.

Results: Among the eight cultivars studied, five Brazilian varieties exhibited high levels of bitter acids, with the highest value observed in the NUG-N cultivar (1.70 mg/g) and the lowest in SAA-IM (0.55 mg/g). The α/β acid ratio showed marked variability across both origins and varieties. COL-IM exhibited the highest ratio (3.75), indicating a hop variety well suited for bittering and offering greater stability. In contrast, of the eight cultivars produced in Brazil showed a lower α/β acid ratio, reflecting a primary contribution to aroma rather than bitterness.

Conclusion: The results of this study reveal significant differences in hop chemical composition driven by origin and cultivar. Brazilian hops primarily exhibit an aromatic, softer sensory profile, whereas imported cultivars confer greater bitterness, constituting a key criterion for cultivar selection in the brewing industry and beer flavor optimization.

Keywords: hop, bitter acids, α-acids, β-acids, HPLC-DAD.

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P49 Stability of Red Beet (Beta vulgaris) Juice as a Natural Colorant in Flavored Yogurt Under Different Storage Conditions

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Natural colorants derived from red beet (Beta vulgaris) are widely used in dairy products due to clean-label applications. However, betalains, the primary pigments in red beet juice, are highly sensitive to light, temperature, and pH variations. Betalains are classified into two main groups: betacyanins (red-purple) and betaxanthins (yellow-orange). These pigments are particularly susceptible to oxidative degradation, heat, and pH fluctuations, which limit their applications in food products (Antigo et al., 2018). This study evaluates the color stability of beetroot juice in flavored yogurt under different storage conditions. Yogurt samples were stored at 4°C and 20°C, both in light and dark environments, for three weeks. pH and color (L*, a*, b*) changes were monitored weekly using pH meter and a Hunter Lab colorimeter. The results demonstrated that yogurt stored at 4°C in the dark exhibited the least color change. However, in samples stored at 4°C under light exposure, a decrease in the +a* value indicated the loss of pink color, while an increase in the +b* value was observed. In contrast, at 20°C, where acidity also increased over time, both light-exposed and non-exposed samples experienced color degradation. The color change at 20°C was characterized by a decrease in the +a* value and a more pronounced increase in the +b* value compared to the 4°C samples. These findings indicate that storage at 20°C, combined with a decrease in pH, shifts the product's color spectrum from red to yellow, while light exposure accelerates the degradation of red pigments. Overall, the study suggests that maintaining low storage temperatures and protecting products from light significantly enhances the color stability of beet-derived pigments.

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P50 Active films based on PBS and rice straw and citrus pruning waste extracts obtained by subcritical water extraction

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In the context of agri-food waste valorization, subcritical water extraction at 180 °C was used to obtain phenol-rich extracts from rice straw and citrus pruning waste. The extracts were characterized for their total phenolic content, antioxidant activity, and ability to inhibit the growth of Listeria innocua and Escherichia coli, which were chosen as representatives of Gram-positive and Gram-negative bacteria, respectively. The bioactive extracts were incorporated into PBS films at 5% and 10% to develop active films with antioxidant and antimicrobial activity.

The extracts exhibited high phenolic content (9.6–9.8 g GAE/100 g extract), antioxidant activity and a strong ability to inhibit bacterial growth. The developed films were analyzed for their ability to inhibit bacterial growth and for their overall migration and phenol migration in different food simulants.

P51 Winery Residues as a Source of Bioactive Compounds for Smart Packaging: Development and Validation of a Fish Freshness Indicator

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Smart packaging systems are important tools for monitoring the cold chain and reducing food waste. This study describes the development and testing of a colorimetric freshness indicator based on a starch-polyvinyl alcohol matrix. The active component consists of an anthocyanin extract (~339 mg/L) recovered from winery residues, which serves as a natural pH-sensitive pigment. The smart indicators were prepared by incorporating the winery extract into the biopolymer matrix. The films were first characterized for their microstructural and physical properties. Sensitivity of the films to pH buffers, ammonia, trimethylamine (TMA), and dimethylamine (DMA) was evaluated. Furthermore, a stability study was conducted over a 45-day period under different temperatures (5, 15, and 25°C) and relative humidity levels (from 33% to 98%). Finally, the indicators were applied to the packaging of gilthead sea bream (Sparus aurata) fillets stored under both constant and fluctuating temperatureconditions to validate their performance against microbiological and physicochemical spoilage indices.

Characterization through infrared spectra and microstructure analysis showed that the anthocyanins improved the miscibility of the polymers. The films demonstrated high sensitivity to volatile amines, with total color difference (ΔE) values exceeding 50. The stability tests revealed that high temperature and relative humidity could compromise the functional properties of the films. During the fish storage trials, the indicators exhibited a clear color transition from pinkish-red to pale green-blue. This shift correlated accurately with the increase in volatile basic nitrogen levels (TVB-N) and microbial growth (specifically Pseudomonas spp. and Enterobacteriaceae). These results indicate that the labels are capable of reflecting spoilage levels and thermal fluctuations, providing a practical bio-based solution for real-time quality monitoring in the seafood industry.

P052 Development of a Sustainable Pomegranate-Based pH-Indicator for Real-Time Fish Freshness Monitoring: A Green Approach Integrated with AI

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Reducing food waste and enhancing consumer safety are primary objectives in the development of smart packaging. This study focuses on the design of a sustainable freshness indicator using a starch–polyvinyl alcohol matrix. Pomegranate juice was selected as a natural and cost-effective source of anthocyanins to act as the pH- sensitive component.

To prioritize sustainability, the pomegranate juice was incorporated directly into the biopolymer carrier, avoiding energy-intensive extraction and organic solvents. The indicators were characterized for their microstructure, water affinity, and color response to pH variations and volatile amines. The efficacy of the films was then validated using fish fillets stored at 2.8°C for nine days. To ensure an objective evaluation of the colorimetric results, an artificial intelligence (AI) tool was implemented to classify the visual changes during the storage period.

Microstructural analysis confirmed high integrity and excellent compatibility between the juice and the biopolymer matrix. The films exhibited high sensitivity to pH changes and volatile amines (specifically ammonia), showing a distinct colorimetric shift from red to purple-green. During the fish packaging trials, a perceptible color change was observed between days 4 and 5, a phenomenon linked to changes in the headspace gas composition and the progression of microbiological and chemical spoilage. Even though the incorporation of the juice increased the hydrophilicity of the membranes, the indicators maintained satisfactory structural stability and functional performance throughout the storage test.

These findings demonstrate that the combination of pomegranate juice and a starch- PVA matrix provides a green and reliable tool for real-time freshness monitoring. The integration of AI-based classification eliminates subjective interpretation, offering a scalable and high-fidelity solution for quality control within the intelligent packaging industry and the cold chain.

PO53 Performance evaluation of novel bio-based films for active packaging of refrigerated fish fillets

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Interest in sustainable food packaging has driven the demand for biodegradable biopolymers, such as polylactic acid (PLA) and polyhydroxybutyrate (PHB)[1,2]. Their blends are particularly promising as they offer enhanced mechanical and thermal properties [3,4]. This study aimed to develop and characterize active PLA/PHB films incorporating eugenol, a GRAS-certified compound with potent antimicrobial properties[5], to optimize their functional performance for fresh fish packaging.

Active films were produced using the solvent casting method, based on a previously optimized formulation of 80/20 PLA/PHB ratio plasticized with 10% (w/w) glycerol monolaurate (GML). Eugenol was incorporated at concentrations ranging from 0 to 1.0% (v/v). Characterization included mechanical profiling (ASTM D882-02), optical (color) and UV-barrier analysis, water vapor permeability (WVP), and surface hydrophobicity via water contact angle measurements. Film surface structure and chemistry were assessed through SEM and FTIR, respectively. Finally, antioxidant activity (DPPH, ABTS) was measured, and antimicrobial efficacy was evaluated in vitro against a range of foodborne pathogens and spoilage bacteria, followed by shelf-life storage trials on refrigerated (2 °C) gilthead seabream fillets.

Increasing eugenol concentrations led to enhanced flexibility (higher elongation at break), even tough tensile strength and elastic modulus followed a decreasing trend. Surface hydrophobicity improved, with contact angle values increasing from 65.30° (control) to 80.33° for the 1.0% eugenol films. While WVP increased slightly with eugenol addition, the films demonstrated superior UV-barrier properties, minimal color change and opacity values similar to the control. The films exhibited strong antioxidant properties, while antimicrobial assays revealed a concentration-dependent inhibition of all tested bacteria. Furthermore, storage trials using the 0.5% and 1% eugenol formulations successfully extended the shelf life of the fish by 2 days compared to the control.

Eugenol-loaded PLA/PHB/GML blends provide a sustainable, high-performance alternative for active seafood packaging, effectively balancing environmental goals with food safety requirements.

Keywords: Active packaging, PLA/PHB blends, Biopolymers, Eugenol, Fish preservation

P054 Enhancing Shelf Life and Marketability of 'Kim Ju' Guava Using Argon-Based Active Modified Atmosphere Packaging

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Guava (Psidium guajava L.) cv. Kim Ju is a widely cultivated and highly favored variety in Thailand for both domestic consumption and export. As a climacteric and highly perishable fruit, it ripens rapidly after harvest, leading to rapid quality deterioration and spoilage. This work evaluated the effectiveness of two active modified atmosphere packaging (MAP) systems; 99.99% argon (ArMAP) and a gas mixture of 90% argon + 10% carbon dioxide (Ar+CO_2 MAP) in comparison with an unsealed control, for extending shelf life and maintaining postharvest quality of guava stored at 10±1°C and 80–85% relative humidity (RH) for 28 days. The results showed that both active MAP treatments (ArMAP and Ar+CO_2 MAP) significantly ($p < 0.05$) maintained postharvest quality and delayed senescence compared with the control throughout storage. Among the treatments, Ar+CO_2 MAP was the most effective, extending shelf life up to 24 days, compared with 20 days under ArMAP and 12 days in the control. The Ar+CO_2 MAP treatment showed similar weight loss to the ArMAP treatment, which outperformed the control at 8 days of storage. Furthermore, Ar+CO_2 MAP significantly ($p < 0.05$) maintained fruit firmness, delayed color change, particularly by preserving green color (a* value) and reducing chlorophyll degradation, minimized total color difference (ΔE), and suppressed respiration rate, thereby delaying ripening more effectively than ArMAP and the control. Visual quality scores of 'Kim Ju' guava treated with Ar+CO_2 MAP and ArMAP were higher than those of untreated fruit after 16 days of storage. Overall, the use of active MAP with an Ar+CO_2 gas mixture represents a promising approach for maintaining postharvest quality and extending the marketability of 'Kim Ju' guava, thereby enhancing its commercial potential.

Keyword: carbon dioxide; inert gas; postharvest quality; Psidium guajava; respiration

PO55 Oxidative shelf-life stability of Hermetia illucens oil for food applications: a preliminary literature review

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The growing interest in sustainable agri-food systems has encouraged the search for alternative lipid sources from unconventional biological matrices. In this context, edible insects are increasingly considered not only as protein sources, but also as valuable lipid fractions. Among them, black soldier fly larvae (Hermetia illucens) represent a promising matrix due to their ability to convert low-value organic substrates into protein- and lipid-rich biomass. BSFL oil is generally characterised by lauric, palmitic, oleic and linoleic acids, a composition that may support its use as a food lipid ingredient but also raises questions about oxidative stability, rancidity development and quality preservation during storage and processing.

Recent studies have described the composition, extraction and oxidative behaviour of BSFL oil and other edible insect oils, highlighting the influence of processing conditions, lipid profile and temperature on oil quality. However, available information remains fragmented, and results from other insect oils, such as Tenebrio molitor oil, cannot be directly transferred to H. illucens oil because of species-specific lipid composition and oxidation pathways.

This review aims to identify and organise the main quality identifiers reported for the evaluation of oxidative deterioration in H. illucens oil and other edible insect lipid fractions, providing a literature-based baseline for future shelf-life studies. The literature will be compared according to insect species, lipid abundance, fatty-acid distribution, processing conditions and analytical markers. Particular attention will be given to indicators of primary oxidation, secondary oxidation, hydrolytic rancidity, fatty-acid profile changes and volatile off-flavour formation.

The expected outcome is a structured set of quality identifiers suitable for future BSFL oil shelf-life assessment, including peroxide value, p-anisidine value, TBARS/MDA, free fatty acids or acid value, Totox, fatty-acid profiling and volatile markers such as hexanal, nonanal and 2-pentylfuran. This framework will support future studies on BSFL oil deterioration and preliminary kinetic modelling of lipid stability.

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