ABSTRACT PROCEEDINGS

II Conference FoodWaStop

CA22134

Sustainable Network for agrofood loss and waste prevention, management, quantification and valorisation

March 4-5th 2025

Rectorate of the University of Córdoba, Spain

REDSICURA ONEHEALTH4FOOD
UNIVERSIDAD DE CÓRDOBA
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FoodWaStop COST OVERVIEW

The **FoodWaStop COST**, is a scientific cooperation network, "CA22134 – Sustainable Network for agrofood loss and waste prevention (FLW), management, quantification and valorisation » funded by COST ACTION programme that addresses the following challenges and aims to: (i) build an interdisciplinary and multi-actor European Network that will also connect with non-EU Mediterranean countries, to promote knowledge on FLW beyond the state of the art; (ii) determine incidence of FLW in the critical points of the fruit and vegetable value chain; (iii) foster technological innovations and sustainable management strategies to reduce and prevent FLW; and (iv) valorise agrofood waste to promote a circular bio-economy.

The experience of the Coordinators and Participants gained from other related projects (e.g., PRIMA, H2020), the background from diverse EU and extra-EU countries, and the involvement of stakeholders and industry partners will contribute to increase awareness of this problem, to determine its incidence, to seek strategies for its management through exploitation of the potential of innovative technologies, and to define good practices to prevent FLW.

The **FoodWaStop** Network will provide benefits to various stakeholders and end-users, including all actors in the agrofood value chain, from farmers (Farm) to consumers (Fork). Moreover, **FoodWaStop** will create a knowledge platform that will promote innovation, deliver guidelines, and favour dialogue with policymakers, to focus their attention on the social and economic implications of FLW.

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OPENING SPEECH

COST Action "Sustainable Network for agrofood loss and waste prevention, management, quantification and valorisation, FoodWaStop"

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Food loss and waste (FLW) is a global challenge recognised by international governments and organisations. Reducing FLW is key to sustainably ensure nutritional food security for an increasing world population. It is a target of the Sustainable Development Goals of the United Nations, and the Farm to Fork Strategy of the European Green Deal. The FoodWaStop COST project addresses these challenges and aims to: (i) build an interdisciplinary and multi-actor European Network that is also connected with non-EU Mediterranean countries, to promote knowledge on FLW beyond the state of the art; (ii) determine incidence of FLW in the critical points of the fruit and vegetable value chain; (iii) foster technological innovations and sustainable management strategies to reduce and prevent FLW; and (iv) valorise agrofood waste to promote a circular bio-economy. The experience of the Coordinators and Participants gained from other related projects (e.g., PRIMA, H2020, HE, other COST Actions), the background from diverse EU and extra-EU countries, and the involvement of stakeholders and industry partners contribute to increase awareness of this problem, to determine its incidence, to seek strategies for its management through exploitation of the potential of innovative technologies, and to define good practices to prevent FLW. The FoodWaStop Network provide benefits to various stakeholders and end-users, including all actors in the agrofood value chain, from farmers (Farm) to consumers (Fork). FoodWaStop COST CA22134 Action started on 21 September 2023 and currently involves over 700 working group (WG) members from 59 countries (Figure 1), joining one or more of the 6 WGs. Interested people are welcome to contribute sharing their knowledge applying for WGs at the link FoodWaStop. The first plenary meeting was hold in Ancona on 24-25 January 2024 (see https://stopmedwaste.net/#postharvestancona2024) and opportunity for young students were planned, with 39 short term scientific missions (STSM), a Training school on quantification of food loss and waste organized in Cranfield on 9-11 July, and further activities thanks to the contribution of WG members. All information is mainly published on Facebook FoodWaStop page (https://www.facebook.com/profile.php?id=61551787798541), as well as on X (https://twitter.com/CostFoodwastop) and Instagram (https://www.instagram.com/foodwastopcostaction2023/) accounts, and on

LinkedIn profile (https://www.linkedin.com/company/foodwastop-cost-action-ca22134/?viewAsMember=true&success=true). The videos of the first plenary meeting are available on the YouTube channel (https://www.youtube.com/channel/UCZ8PLeRL_OK9PYMVv1Dou_A). Any contribution is welcome, and the FoodWaStop COST Action aims to create a knowledge platform that will promote innovation, deliver guidelines, and favor dialogue with policymakers, to focus their attention on the social and economic implications of FLW.

Keywords: Agrofood waste; Euro-Mediterranean knowledge hub; Sustainable food management; Circular bio-economy; Socio economic empowerment of smallholders

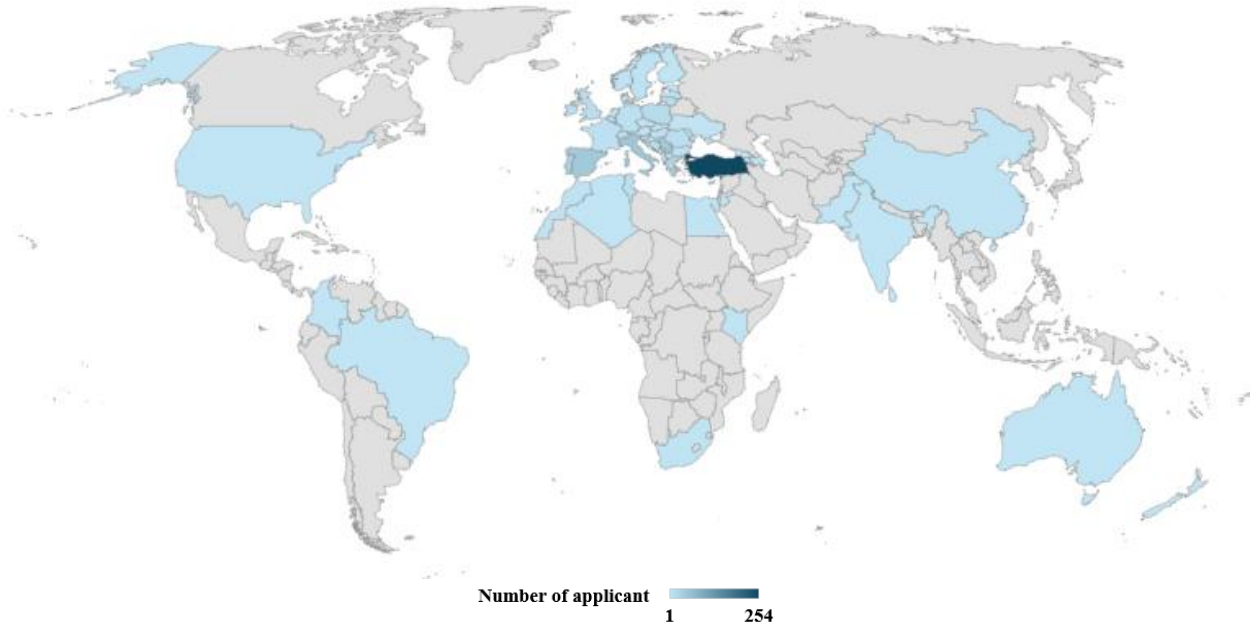

Figure 1: Number of working

ORAL PRESENTATIONS

WG1. Prevention of food loss and food waste

O1.1. Impact of *Xylella fastidiosa* on Mediterranean Area: Searching for New Management Strategies

O1.2. Is food packaging part of the solution or part of the problem?

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Food packaging plays an important role in the reduction of food waste, since it protects the food, among others, from light, humidity, mechanical influences and microbial contamination. However, it can become a source of food contamination itself. The transfer of various substances from the food contact materials (FCMs) into the food can bring about unacceptable changes in its composition, not only deteriorating its organoleptic properties, but also and most importantly posing toxicity threats to the consumers. Therefore, such chemical migration phenomena should be evaluated and controlled. The complex mixture of substances comprising an FCM indicates the difficulty associated with their characterization. At the same time, next to conventional FCMs that have been intensively investigated, new materials and materials of a more complex nature, such as recycled paper and plastic, are entering the food processing streams and require immediate safety assessment. In the frame of this contribution, we will discuss the issue of chemical migration, address the difficulties associated with the comprehensive characterization of FCM migrants and present the analytical workflows developed in our lab, facilitating the identification and semi-/quantification of both intentionally and non-intentionally added substances (IAS & NIAS) migrating from FCMs into their content and compromising food safety.

Keywords: food contact materials, chemical migration, safety assessment

O1.3. Measuring and Mitigating Food Loss and Waste: A Comprehensive Review on Quantification Methods and Preventative Strategies

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Food loss and waste (FLW) pose significant global challenges with economic, environmental, and social impacts, affecting food security, sustainability, and climate change efforts. This review examines current methods for quantifying FLW across the food supply chain, from production to consumption, and strategies to mitigate these losses. It outlines definitions and frameworks guiding FLW studies, distinguishing between food loss and waste, and various measurement approaches. Major quantification methodologies discussed include direct measurement, surveys, modeling, and technological applications like IoT and machine learning, highlighting their strengths and limitations. Key drivers of FLW, such as inefficiencies in production, supply chains, consumer behavior, and policy gaps, are explored. Preventative and mitigation strategies, including policy interventions, technological innovations, improved logistics, and consumer education, aimed at reducing FLW at all stages, are analyzed. Challenges in implementing FLW mitigation strategies, including economic barriers, regulatory inconsistencies, technological limitations, and cultural factors, are discussed. Our findings suggest that integrated efforts combining accurate quantification, innovative strategies, and supportive policies are essential to effectively address FLW, concluding with future research directions for robust quantification methods and integrating FLW mitigation into sustainability policies.

Keywords: Food loss and waste, Quantification methods, Prevention strategies, Sustainability, Food supply chain

O1.4. Leveraging Citizen Science to Unchain Food Waste from GDP and Population Growth through Ecolabel Innovations in Food Packaging Industry

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Food waste poses significant environmental and economic challenges, exacerbated by growing populations and increasing GDP levels. Food literacy, encompassing knowledge and practices for informed food choices, offers a pathway to mitigate waste and promote sustainability. This study investigates the intersection of food waste and food literacy by analyzing official datasets from sources such as Eurostat, UN Statistics Division, FAOSTAT, and WHO. It further evaluates the foundational principles of ecolabels within the food packaging industry to identify gaps and opportunities for enhancing consumer engagement. The analysis explores how digitalizing ecolabels—through technologies like QR codes, blockchain, and augmented reality—can transform their effectiveness. Digital platforms enable interactive consumer education, real-time product traceability, and enhanced transparency, fostering stronger links between consumer behavior and sustainable practices. By integrating digital solutions, ecolabels can address current limitations, such as low consumer awareness or trust, and empower consumers to make informed decisions. This research concludes with recommendations to bridge the existing gaps in ecolabel standards and implementation, leveraging digital tools to create a robust, transparent, and consumer-centric approach in the fight against food waste.

Keywords: Food literacy, Digital solutions, Consumer behavior, Sustainable food choices

O1.5. Chitosan-graft-Pomegranate Extract Hydrogel As An Antibacterial and Antioxidant Pad for Shelf Life Extension in Food Packaging

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In the preservation of water-rich foods, especially meat, spoilage can occur due to bacterial contamination and oxidative degradation. This study aimed to determine the structural characteristics and synthesis of the chitosan-graft-pomegranate extract hydrogel using a cost-effective and biobased method to develop antibacterial and antioxidant pads. Pomegranate extract is utilized to create covalently and noncovalently linked chitosan hydrogel networks. Various characterization techniques, including Fourier transform infrared spectroscopy, thermogravimetric analysis, field emission scanning electron microscopy, atomic force microscopy, and rheological analysis, validated the successful fabrication of the hydrogel. The freeze-dried hydrogel exhibited swelling ratios of 373%, 614%, and 508.5% at pH levels of 5, 7.4, and 10, respectively. Electron microscopy images revealed the porous hydrogel, thus validating the cross-linking procedure. The use of pomegranate extract enhanced the phenolic content, yielding a radical scavenging efficacy of 50.20%. The hydrogel exhibited notable antibacterial activity, with inhibition zones against Escherichia coli and Staphylococcus aureus measuring 18 ± 1 mm and 12 ± 1 mm, respectively. The hydrogel is essential for moisture absorption in water-rich foods like meat, owing to its significant swelling capacity, and may serve as an antibacterial absorption pad.

Keywords: food packaging, chitosan, antibacterial, antioxidant, pomegranate extract

O1.6. The molecular basis of superficial scald development in apple fruit using a multi-omics and functional approaches

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Superficial scald is a significant physiological disorder affecting apple (*Malus domestica* Borkh.) fruit, characterized by skin browning following extended cold storage at early ripening stages. However, the molecular processes driving SS development remain poorly understood. To investigate the mechanisms underlying SS occurrence, 'Granny Smith' apples were harvested at two maturity stages (early and late) and stored at low temperature (0°C for 3 months), followed by exposure to room temperature (24°C) for shelf life. Phenotypic and physiological analysis revealed that early-harvested apples showed reduced ethylene-dependent ripening and an increase in SS symptoms. A comprehensive multi-omic approach, including RNA sequencing, whole genome bisulfite sequencing, proteomic and metabolic analysis of apple skin tissue, identified potential genes, proteins and metabolites associated with scald (early harvest) and non-scald (late harvest) phenotypes at both the pre-symptomatic (during cold storage) and symptomatic (ripening) stages. Furthermore, *in silico* protein modification analysis indicated that

protein post-translational modifications, particularly oxidation events, contribute to SS development. Current data also highlight the roles of a-farnesene synthase (MdAFS) and polyphenol oxidases (MdPPO), two genes historically associated with scald development. Notably, overexpression or suppression of MdAFS1 and MdPPO16 in apple skin tissue using RNA interference (RNAi) and CRISPR-Cas9 approaches during cold storage and post-cold ripening resulted in non-scald phenotypes. This combination of large-scale omics and functional studies may offer valuable insights into the molecular mechanisms underlying scald development, contributing to future breeding strategies aimed at improving post-harvest life in apples.

Key words: Apple, superficial scald, epigenetic, multi-omic, RNA interference, CRISPR-Cas9, a-farnesene synthase, polyphenol oxidase

Acknowledge: The present study was funded by the Hellenic Foundation of Research and Innovation (HFRI) through "1st Call for H.F.R.I's Research Projects to Support Faculty Members & Researchers and Procure High-Value Research Equipment" (project number HFRI-FM17-633; GERASKO).

WG2. Agrofood loss and waste management

O2.1. Utilization of By-products from the Cereal Milling Industry for Dietary Supplement Production

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Due to their high energy density and valuable nutrient content, cereal grains serve as a primary raw material for food production. However, the mechanical processing of grains, such as dehulling and grinding, generates numerous by-products, including bran, husk, and kernels. Globally, the grain milling industry produces approximately 525 million tons of by-products annually, with the European Union accounting for around 42 million tons per year. These by-products are rich in bioactive components, such as dietary fibre, phenolic compounds, phytoestrogens, avenanthramides, phytosterols, carotenoids, tocopherols, tocotrienols, inositol phosphate, glutathione, and melatonin. In recent years, a global increase in cereal cultivation led to growth in cereal processing, and consequently, an increase in by-products, particularly husk, broken grains, and bran. The high concentration of health-promoting compounds in grain by-products has prompted discussions on their optimal utilization. Currently, it is estimated that 90% of total bran is used as animal feed. However, the substantial nutrient and bioactive content of these by-products presents opportunities for their application not only as functional additives in food products but also in the production of dietary supplements. Therefore, to extract specific bioactive compounds with high concentration from various cereal by-products, both conventional and non-conventional extraction methods are employed.

Keywords: cereal by-products, physical extraction method, bioactive compounds.

O2.2. The Characterization of Wastewaters Generated in Serbian Medium-Sized Wineries

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Winery wastewater originates from various cleaning and rinsing operations implemented in different stages of winemaking. Due to the seasonal nature of wine production, not enough data about winery wastewater composition and volume is currently available, which is a problem for the selection of appropriate treatment. This study aims to investigate the composition and volume of wastewater from different stages of white, rose, and red wine production in selected Serbian wineries. The effluents, obtained from medium-sized wineries were collected in three consecutive years during the washing of the crusher, press, and tanks after clarification of must, wine fermentation, and the first racking. The samples were analyzed in terms of pH, dry matter, total suspended solids, COD, BOD5, total phenols, reducing substances, total and assimilable nitrogen, total phosphorus, TDS, Na, K, Ca and Mg. Obtained results indicate that wastewaters from wine production possess a high organic and inorganic load, while volume determination data evidence substantial flow variations. Analyzed effluents are not suitable for discharge into surface water and public sewage systems without proper treatment. The waste waters from wine industry are convenient raw material for biotechnological production, which is a sustainable and low-cost solution for the winery waste management.

Keywords: winery wastewater, qualitative characterization, composition analysis, sustainable development

O2.3. Management of Postharvest Fruit Rot by Cold Storage Combined with Biological Antifungal Compounds

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Proper postharvest storage is essential to preserve the quality and flavor of the fruit and avoid economic losses. Maintaining the cold chain is essential to slow down fruit ripening, reducing symptoms of senescence and wiping out fungal rot. Experiments were conducted on two orange cultivars 'Maltaise' and 'Valencia Late' having early and late harvesting seasons respectively. The fruits from each cultivar were tested at the time of harvest by storing them at 5 °C after being treated with chitosan, clove essential oil, ammonium bicarbonate salt or no treatment. Two controls were considered, one positive control (distilled water) and one negative control (Fludioxonil). A loss index was established which includes the percentage of weight loss, incidence (%) and severity of fungal infection (%). Fruits were conserved during cold storage and shelf life for 42 days (cv. Maltaise) and for 82 days (cv. Valencia Late). The results showed that the cv. Maltaise' was stored with minimal deterioration when not treated in any way or treated with chitosan. The cv. 'Valencia Late' was best preserved, successively in order of effectiveness, when it was not treated or treated with clove essential oil, chitosan or ammonium bicarbonate salt. These results showed that treatments with biological compounds represents a promising tool for citrus disease management, while limiting the need to synthetic fungicide. However, a careful sorting prior to fruit storage is needed.

This work was conducted within the framework of the PRIMA StopMedWaste project, which is funded by PRIMA, a programme supported by the European Union.

Keywords: citrus fruit, postharvest decay, fungi, zero treatment.

O2.4. Experience of the Tunisian partner in the PRIMA 'STOP MED WASTE' project

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The STOP MED WASTE project (2020-2024) comprises eight research units in the Mediterranean region working collectively to extend the shelf life of fresh fruit, vegetables and aromatic plants through the application of physical methods, natural compounds and biocontrol agents. The project has been devised with three specific objectives. Firstly, it seeks to reduce food waste from 30% to 15%. Secondly, it aims to reduce the amount of discarded fruit by 20%. Thirdly, it intends to reduce the application of post-harvest pesticides by 20%. The antifungal activity of thirty essential oils (Eos) was evaluated with a view to controlling the three main pathogenic fungi responsible for postharvest fruit rot. Essential oils of cinnamon bark and of clove flower bud were the best in reducing in vitro the mycelial growth of these fungi at 500 ppm. Evaluation of the two Eos under semi-commercial conditions and within the packaging house demonstrated that their efficacy was reliant on the storage temperature. Clove EO was effective in reducing fruit rot in cold storage (superior to fludioxonil), while cinnamon EO was effective at room temperature (similar to fludioxonil). Concurrently, it was proved that the most effective method for prolonging the shelf life of fruit stored at low temperatures is to refrain from any form of treatment, provided that the fruit is correctly sorted prior to storage. Additionally, effectiveness of several GRAS salts was assessed against fungal rot of fruit after harvest, and phytotoxicity of sodium metabisufite (SMB) in treated fruit was investigated. Treatment of healthy orange and apple with SMB at a non-phytotoxic dose did not improve the pathological and physicochemical characteristics of these fruits after long cold storage compared with the untreated control. This result indicates that it is possible to dispense with treatments for healthy fruit intended for cold storage. However, it should be noted that the storability of the fruit depends on the cultivar, the length of storage and the degree of fruit ripening. Thus, well-sorted but untreated red apples showed the longest storage period, followed by yellow apples and 'Maltaise' oranges. If these results are confirmed and applied on a larger scale, it is likely that they will have a positive impact on the reduction of pesticides and food losses. This work was conducted within the framework of the PRIMA StopMedWaste project, which is funded by PRIMA, a programme supported by the European Union.

Keywords: biological treatment, cold preservation, postharvest, shelf life, Tunisia

WG3. Quantification of food loss and food waste

O3.1. Understanding Household Food Waste: A Global Survey on Perceptions, Quantification, and Key Drivers

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Food waste remains a pressing global challenge, with severe environmental, economic, and social repercussions (FAO, 2021). Households contribute significantly to global food waste yet accurately measuring waste generation and understanding the behavioral and socio-cultural factors behind it remains a challenge (Hebrok & Boks, 2019; Reynolds et al., 2022).

This study aims to investigate household food waste through a large-scale global survey, exploring individual perceptions, self-reported waste behaviors, and key socio-economic drivers. The survey collected responses from 900 individuals across 59 countries and five continents. Although the sample is not representative in statistical terms, its broad distribution provides valuable cross-cultural insights into the main behavioral patterns and waste-generation mechanisms.

The findings reveal that food waste is strongly influenced by socio-demographic variables, lifestyle habits, and food purchasing behaviors (Seconda et al., 2021; Principato et al., 2022). Key drivers include misinterpretation of expiration labels (Wilson et al., 2023), poor meal planning (Romani et al., 2022), and limited awareness of food waste reduction strategies (Filimonau et al., 2022). Additionally, regional differences highlight how cultural attitudes, household size, and income levels shape food management practices and waste behaviors (Hartmann et al., 2021).

The study contributes to the global discourse on food sustainability by providing empirical evidence to support policy-making and intervention strategies (UNEP, 2021). Findings emphasize the need for targeted educational campaigns, technological innovations, and policy incentives to drive behavioral change and encourage more efficient food resource management (Roodhuyzen et al., 2021). These insights align with Sustainable Development Goal 12.3, which aims to halve global food waste by 2030 (UN, 2023).

Keywords: *NA*

O3.2. Food Waste in Czech Households: How to Change Consumer Behavior?

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Households are the largest contributors to food waste within the food chain in European countries, accounting for more than 50% of total food waste, according to EU estimates. This presentation showcases the findings of a three-year project that analyzed mixed municipal waste from 900 Czech households. The study provides precise and unique data on the volume of food wasted by households, with waste weight measured in each season to capture the impact of seasonality across three different housing types.

As part of the project, two types of intervention campaigns were tested to reduce food waste in households. The presentation highlights the key pillars of these communication campaigns. Results showed that thanks to the interventions, households reduced food waste by up to 11%.

Keywords: *NA*

WG4. Valorisation of agrofood waste and a circular bio-economy

O4.1. Grape Pomace Valorisation: Development of a holistic biorefining approach

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Grape pomace (GP) exhibits an unavoidable waste stream of the vinification process, consisting of oil, phenolics, lignocellulose and free sugars that could be valorised via bioprocessing. This work elaborates on the design of a biorefining process to utilise grape pomace towards the production of a multitude of end-products within the bioeconomy concept.

An aqueous extraction step was employed to obtain free sugars as a nutrient feedstock, that was assessed as supplement in fungal bioconversions to produce mycelial biomass, intracellular and extracellular polysaccharides. The medicinal mushrooms *Ganoderma lucidum* and *Trametes versicolor* were evaluated in controlled submerged fermentations. The crude polysaccharides were assessed for their bioactive properties (e.g. antioxidant activity) intended for the development of functional food components. The lignocellulose fraction after the aqueous extraction could be evaluated for the production of nanocellulose fibers via chemical processing to be directed used for sustainable packaging formulations. Phenolics and oil were also extracted via solvent-liquid extraction as value-added products. Ongoing studies target the secretion of crude enzymes from *T. versicolor*, using the lignocellulose fraction as substrate in solid state fermentation. Overall, the aim of this collaborative work is to develop a cascade bioprocessing concept of GP that complies with the pillars of circular economy.

Keywords: grape pomace; fungal fermentation; added-value products; nanocellulose.

Acknowledgements: This work was supported by the FoodWaStop COST CA22134 Action. Part of the experiments was performed under STSM entitled "*Nanocellulose production from grape pomace to develop a holistic valorization scheme*"

O4.2. Properties of Oleogels from Upcycled Oils and Extra Virgin Olive Oil

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With growing interest in sustainable food innovations, this study explores the use of upcycled oils - pumpkin seed oil (PSO), rice bran oil (RBO), and grapeseed oil (GSO) - sourced from food by-products, compared to extra virgin olive oil (EVOO), to formulate novel oleogels, aiming to address the growing demand for sustainable fat alternatives in food applications. Carnauba wax at various concentrations (7%, 9%, and 11%) was used as the structuring agent. The physicochemical and rheological properties of the oleogels were comprehensively evaluated. Results showed that EVOO had the highest monounsaturated fatty acid content and GSO exhibited the greatest polyunsaturated fatty acids. The 11% EVOO oleogels were the lightest and most yellow, The 7% PSO oleogels appeared the reddest, and the 11% GSO oleogels showed greener hues. Wax concentration significantly influenced textural and viscoelastic characteristics. Notably, GSO oleogels demonstrated superior gel network integrity. Thermal analysis showed that all oleogels had similar melting points of around 70°C. This study highlights the potential of upcycled oils to create functional oleogels, offering a sustainable alternative to traditional solid fats for various food applications, while contributing to the valorization of food by-products.

Keywords: Carnauba wax; Upcycled oils; Oleogels; Fat alternatives; Food by-products

O4.3. From Waste to Wellness: Investigating Kiwiberry Leaves as a Nutraceutical Ingredient through *In Vitro* and *In Vivo* Studies

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The 2030 Agenda for Sustainable Development emphasizes the importance of reducing agro-food residues to enhance environmental sustainability and economic efficiency. Valorizing these residues, such as kiwiberry (Actinidia arguta) leaves, offers a promising solution for waste reduction and resource optimization, with applications across various industries. This study investigates the nutraceutical potential of a kiwiberry leaf extract obtained through ultrasound-assisted extraction, using both in vitro (intestinal co-culture model) and in vivo (Wistar rats) approaches. In vitro intestinal permeability studies revealed that coumaroyl quinic acid achieved the highest permeation (25%), followed by rutin and chlorogenic acid. The extract's efficacy was further validated in vivo, where young male Wistar rats treated with the extract (50 and 75 mg/kg body weight) for seven days showed increased antioxidant enzyme activity (superoxide dismutase, catalase, and glutathione peroxidase) in liver and kidney tissues, alongside decreased triglyceride levels and reduced lipid peroxidation. These findings suggest that kiwiberry leaf extract is a sustainable and potent nutraceutical ingredient with notable antioxidant properties.

Keywords: *Actinidia arguta* leaves; phenolic compounds; antioxidant effects; nutraceutical ingredient.

O4.4. Valorization of the Viticulture Waste to Obtain Polyphenol-Rich Extracts that Modulate Gut Cardiovascular Dysbiosis

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Cultivating vines for wine production is a longstanding and significant agricultural pursuit on a global scale. The wine-making industry produces annually 2 to 5 tonnes/hectare of grapevine cane waste, but only in the last years has its valorization received considerable attention as they are rich in bioactive compounds, especially polyphenols (stilbenes, gallotannins, and proanthocyanidins). Therefore, our study focused on evaluating the in vitro modulation effect on cardiovascular (CV) microbiota using 3 polyphenol-rich cane extracts obtained from different grapevine varieties, to understand their potential to positively influence dysbiosis. The extract from the Feteasca Alba grapevine variety showed the highest value of total phenolic content (69.97 ± 0.47 mg/g su), gallotannins (50.43±0.01 mval tannic acid/g su), and antioxidant activity (DPPH method) and was obtained by enzymatic pre-treatment and fluidized bed extraction. The microbiological and qPCR analysis proved that the total microbial load increased up to 2 log, a higher population of the beneficial bacteria Lactobacillus sp. and Bifidobacterium sp., and the 1.3 log decrease of opportunistic pathogen E. coli contributing to CV pathogenesis. These results were correlated with the metabolic profile determined by HPLC. This preliminary work suggests the potential of viticulture waste to be valorized by the nutraceutical industry.

Keywords: waste valorization, grapevine cane extract, polyphenols, cardiovascular microbiota modulation, nutraceuticals

O4.5. Valorization of Hemp Seed Meal: Nutritional Characterization and Application in Breadmaking

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Hemp seed processing produces by-products such as press cake or meal, which have significant potential for food applications. Hemp seed meal is recognized as a valuable source of nutrients that can be recycled into functional food products, thereby reducing costs by replacing expensive raw materials with by-products. However, ensuring food safety is crucial due to the potential for microbiological and chemical contamination, as well as the presence of naturally occurring toxins. This study focused on the fractionation of hemp meal through sieving and its subsequent nutritional and antinutritional characterization to explore its potential for reuse in breadmaking.

Cotyledon-containing fractions (<180 μm and >180 μm) were found to be rich in proteins (up to 44.4%), lipids (18.6%), and sugars, while hull fractions (>250 μm and >350 μm) had a higher fiber content. Bioactive compounds, including phenolics such as cannabisin B and catechin, were unevenly distributed among the fractions, providing insights into their targeted utilization. Antinutritional factors were primarily concentrated in the cotyledon fractions. The incorporation of hemp flour into bread formulations (up to 20%) enhanced nutritional value without significantly affecting dough rheological properties at lower substitution levels. These findings highlight the potential of hemp meal in developing functional, nutrient-enriched food products, while underscoring the importance of processing conditions to ensure product safety and quality.

Keywords: hemp seed meal, breadmaking, antinutrients distribution, nutritional profile

O4.6. Valorization of Grape Pomace: Novel and Sustainable Anthocyanin Extraction Techniques for the Development of Active Packaging Systems.

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Grapes are the world's largest fruit crop, with a production of almost 75 million tons in the 2022 campaign (FAOSTAT, 2024). Approximately 75% of the global grape production is allocated to the winemaking industry, which generates large quantities of byproducts (about 25% of grapes used for wine production) known as grace pomace (GP) (Georgieva et al., 2023). GP is a valuable source of bioactive compounds, particularly phenolics like anthocyanins. These compounds are of great interest in the food industry not only because of its antioxidant capacity, but also its halochromic condition in response to changes in pH, which can potentially be used in the food packaging industry for the development of dual (active and smart) packaging systems. However, traditional methods for extracting anthocyanins from food matrices often face challenges. The use of conventional organic solvents and extraction techniques can lead to low extraction yield, reduced sustainability and compromised stability of anthocyanins, reducing their bioactivity and hindering the valorization of GP. The aim of this work focuses on the development of anthocyanin extraction systems from GP using Deep Eutectic Solvents (DES) as sustainable alternative to conventional organic solvents. By improving extraction efficiency and preserving anthocyanin bioactivity during storage, this approach seeks to enhance the potential for incorporating these compounds into dual packaging systems.

Keywords: Valorization, Grape pomace, Anthocyanins & DES

Gorgieva, S., Jančič, U., Cepec, E., & Trček, J. (2023). Production efficiency and properties of bacterial cellulose membranes in a novel grape pomace hydrolysate by Komagataeibacter melomenusus AV436T and

Komagataeibacter xylinus LMG 1518. International Journal Of Biological Macromolecules, 244, 125368. https://doi.org/10.1016/j.ijbiomac.2023.125368

FAOSTAT. (2024). https://www.fao.org/faostat/en/#data/QCL

O4.7. Exploring High-Value Applications of Solid-State Fermented Olive Leaves

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This study investigated the effects of solid-state fermentation (SSF) using various microbial strains - *Aspergillus niger, A. oryzae, Candida utilis,* and *Lactobacillus acidophilus* - on the chemical composition of olive leaves (OL). The primary goal was to assess the potential of SSF-treated olive leaves for high-value applications. The research centered on key bioactive compounds, including oleuropein (OLE), hydroxytyrosol (HT), elenolic acid (EA) derivatives, and the triterpenic acids maslinic (MA) and oleanolic (OA). Additionally, the study analyzed other chemical constituents relevant to nutritional and antinutritional properties for feed applications, as well as specific mineral content.

The findings showed a gradual reduction in OLE and elenolic acid EA derivatives, which were eventually completely degraded, while HT levels initially rose before decreasing to low levels. MA and OA levels, however, remained stable throughout the process. Among the microbial strains tested, *A. niger* produced the highest HT concentration (1 mg/g dry weight) and resulted in the smallest decrease in the antioxidant potential of olive leaves (13.8% after 72 hours). The fermentation process also contributed to variable protein levels, reaching up to 187 mg/g, potentially enhancing the nutritional value of olive leaves.

Overall, SSF significantly altered the phenolic composition of OL, notably affecting OLE and HT levels, while maintaining the stability of triterpenic acids like. Despite a decrease in certain phenolic compounds, the fermented OL demonstrated an enhanced nutritional profile, particularly in protein content and antioxidant capacity. These findings suggest that fermented OL holds potential for valuable industrial applications, such as inclusion in animal feed.

Keywords: Agriculture waste, food waste, bioconversion, co-culture.

O4.8. Upcycled Pomegranate By-Products for Juice Bioactive Enrichment: A Green Extraction Approach

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A substantial proportion (40-50%) of the by-products (peel, pulp, seeds) generated during pomegranate processing are rich in bioactive components (tannins, phenolic acids, anthocyanins), offering a potential avenue for upcycling. Nevertheless, the extraction of high molecular weight and/or bound to plant matrix phenolics by innovative methods is required in order to achieve greater efficiency and economy. This study aimed to extract the by-products by solvent (S), homogenizer assisted (H), total liquefaction (T) and enzymatic (E) extractions or their combination (ES, TS, ESH) and upcycling of pomegranate juice (PJ) with the rich phenolics extract. The physicochemical and sensorial changes in enriched juice were analyzed throughout storage (4-25°C, 60 days). The highest yield, total phenolic content and DPPH antioxidant activity were observed in the extracts that underwent an enzymatic treatment. The highest total phenolic, total flavonoid and hydrolysable tannin contents and antioxidant activity were observed in the SPJ sample, which exhibited a greater addition of S extract. The ESPJ sample demonstrated the highest sensorial scores. The bioactive contents and sensorial properties of the juices were observed to decline with the increase in storage time and temperature. It can therefore be concluded that the upcycled juices, which are rich in bioactive components, have an acceptable sensorial profile and can be stored at low temperatures.

Keywords: Pomegranate by-product, Phenolics, Extraction, Upcycle, Storage

O4.9. Stone and Berry Fruits as Alternative Sources of Pectin

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Pectins are present in the cell walls of higher plants, but the amount and type of pectin varies greatly depending on the source. These economically important polysaccharides are extracted mainly from citrus fruits and apples. However, significant amounts of pectin are also contained in berries, such as strawberries, raspberries and black currants, and stone fruits - plums, cherries and peaches. Information on the properties of pectin extracted from these sources is very limited and selective. Based on the conducted research, it was found that pectin fractions isolated from stone and berry fruits show differences in chemical composition and supramolecular structure. The highest galacturonic acid content, which determines pectin gelation, was found in cherries, plums, peaches and strawberries containing similar amounts. The degree of methylation of GalA also changed significantly depending on the type of fruit and the pectin fraction. AFM analysis showed structural differences between pectin fractions Cherries may have a special technological potential, in which water-soluble fraction consists mainly of linear, low-esterified homogalacturonan. Strong aggregation of the DASP raspberry fraction may be associated with rhamnose content three times higher than in other fractions. Stone and berry fruit can find new applications as a source of pectins and specific monosaccharides.

Keywords: pectin, berries, stone fruits, polysaccharides

O4.10. Application of sustainable extraction and formulation principles in development of tomato waste derived nutraceuticals (ExtracTom-App)

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Tomato processing waste (TPW), a byproduct of the tomato processing industry, is produced in large quantities worldwide, posing a challenge for sustainable waste management. Traditionally, TPW has been used as animal feed or fertilizer, but its potential as a valuable raw material is increasingly recognized due to its high levels of bioactive compounds, including carotenoids, polyphenols, and pectin. These compounds offer significant health benefits and are in rising demand within the pharmaceutical and cosmetic industries. Despite this promise, the broader industrial use of TPW remains limited. The ExtracTom-App scientific project aims to develop sustainable processes for creating innovative nutraceuticals using tomato waste as a secondary raw material rich in carotenoids, polyphenols, and pectin. The project's objectives align with global guidelines for transitioning to resource-efficient production and consumption. As part of this effort, green extraction methods for carotenoids, polyphenols, and pectin will be developed using a novel combination of mechanochemical and microwave extraction (MCE/MAE) techniques, which are at an advanced stage of technological readiness. By fostering the development of sustainable processes and identifying renewable raw materials that do not compete with other production chains, the project will contribute to improving the sustainability of food production systems.

Keywords: tomato processing waste; carotenoids; polyphenols; pectin; sustainability; circular economy

WG5. Cross-cutting strategies and smart systems for food management

O5.1. Reduction of Fruit Losses by Sensing Technology for Early Detection of Postharvest Alterations and Quality

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Horticultural produce are sustainable food, if compared to animal products, with high nutritional value but very perishable. Therefore reducing postharvest losses of fruits and vegetables is of paramount importance to ensure food security for the world population. Early detection of physiological alterations during postharvest storage and distribution is essential to reduce postharvest losses (of both whole and minimally processed fresh products) and to design product shelf life, improving postharvest chain sustainability. Among the primary causes of postharvest losses, physiological disorders related to wrong time/temperature combination, during storage play a major role, together with decay incidence and quality at harvest. Recent studies on the potentiality of NIR and hyperspectral imaging (VIS-NIR and NIR) will be discussed, with regard to the quality assessment, the storage potential and freshness of raw material before and after minimally processing, the discrimination of horticultural crops, based on pre-harvest factors, as genotype, time of harvest and growing practices and the early detection of decay and physiological disorder as chilling injury.

Keywords: hyperspectral, NIR, chilling injury, postharvest losses

O5.2. Electronic Nose for Monitoring Volatile Organic Compounds

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Electronic noses (E-noses) are useful for monitoring of volatile organic compounds (VOCs) derived from, for example, food products. In many reported wearable sensing devices, there is link between food condition and the released VOCs. Our group have been developing functional sensor arrays or e-nose specifically targeting a wide range of VOCs. By integrating different kinds of functionalized materials such as gold nanoparticles, conducting polymers, etc., the e-noses are able to discriminate VOCs as well as a mixture of VOCs with satisfactory sensitivity and a low detection limit. These results presage a new type of smart sensing device, with a desirable performance in monitoring food products and furtherly avoiding food wastes.

Keywords: e-nose, VOC, food waste

O5.3. Assessing the Potential of Digital Twins in Food Supply Chains to Reduce Food Loss and Waste

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The use of digital twins in the food supply chain offers an innovative solution to reduce Food Loss and Waste (FLW) by digitally monitoring and optimizing every stage from production to consumption. Reducing food loss and waste is a very important issue both in terms of sustainability goals and economic efficiency. Digital twins are a virtual representation of a physical system or process and continuously reflect the system by updating it with real-time data. In this way, it provides the opportunity for detailed monitoring and analysis at every stage of the supply chain. Thanks to real-time monitoring, data analytics and forecasting capabilities, it is possible to prevent waste and increase efficiency at every stage of the supply chain. The aim of the current study is to investigate the possible potentials of these and more advantages of digital twin technology in the food supply chain. As a result of comprehensive literature research and expert interviews, it is aimed to examine the potentials determined as a result of the variability in their importance levels with the GRA-DEMATEL method, which is one of the Multi-Criteria Decision Making methods. By assessing possible potentials, it is expected that the impact of digital twin technology will be shown to each employee in the food chain.

Keywords: Food supply chain, digital twins, FLW, Multi-Criteria Decision Making method

O5.4. Applying Systems Thinking on Reduction of Food Loss and Waste

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Over-production and over-supply are a contributing cause of waste, yet they also provide resilience in the form of redundancy. This paper examines systems thinking as a mean to minimise food waste. We find that there are strong synergistic elements and interventions that support short- and long-term resilience. The complexity of food systems requires a more holistic and coordinated approach. Many food system challenges are complex problems whose solutions are contested and which transcend disciplinary, divisional, and institutional boundaries. In increasingly complex food systems, these challenges result from interactions across different scales and levels. They require integrated actions taken by all stakeholders at local, national, regional, and global levels, by both public and private actors, and across multiple fronts- not only in agriculture, but also in trade, policy, health, environment, gender norms, education, transport and infrastructure, and so on. It requires a synergetic merging rather than a destructive clashing of the ideas emerging from these various angles. To explore the food loss and waste dynamics, this paper addresses the limitations of many traditional approaches, which tend to be sectoral with either a narrowly defined focus that leads to technical fixes, which are subjected to the scope of one ministry or public agency, or which use systemic thinking to tackle objectives but are limited to sub-systems. This paper also encouraging development practitioners and policymakers to see the bigger picture will also help facilitate multi-stakeholder collaboration and policy coordination at different levels to promote a more balanced relationship and jointly address future challenges. While there will clearly be trade-offs to be made, there will also be opportunities to simultaneously accomplish multiple objectives. A food systems approach can help identify such synergies, as well as facilitate the coordination needed to achieve them.

Keywords: Food system, systems thinking, system dynamics, value chain.

WG6. Networking and dissemination, communication and transfer of knowledge

O6.1. Innovative Strategies for Agrofood Loss and Waste Reduction: Insights from PRIMA Agrofood Funded Projects (2018–2024)

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The escalating challenge of food loss and waste (FLW) across the agrifood value chain calls for integrated, interdisciplinary solutions that not only mitigate losses but also valorise by-products in support of a circular bio-economy. Over the past seven years, the PRIMA Programme has strategically supported a portfolio of agrifood projects (2018–2024) that have advanced research and innovation in FLW prevention, management, quantification, and valorisation. This body of work has fostered collaborations among academia, industry, and policy stakeholders—spanning EU and Mediterranean countries—to address critical points along the fruit and vegetable value chains and beyond.

Our collective initiatives have applied cutting-edge technologies, including precision agriculture, IoT-based monitoring systems, predictive modelling, and digital platforms, to identify and quantify FLW hotspots. Concurrently, several projects have piloted innovative valorisation pathways, converting waste streams into value-added products such as bio-based materials, renewable energy, and high-quality nutritional ingredients. These efforts underscore the transformative potential of smart systems and cross-cutting strategies in reshaping traditional food supply chains toward sustainability and resilience. Key outcomes include:

• Enhanced FLW Quantification: Development of robust methodologies to accurately assess FLW across diverse agrifood sectors.

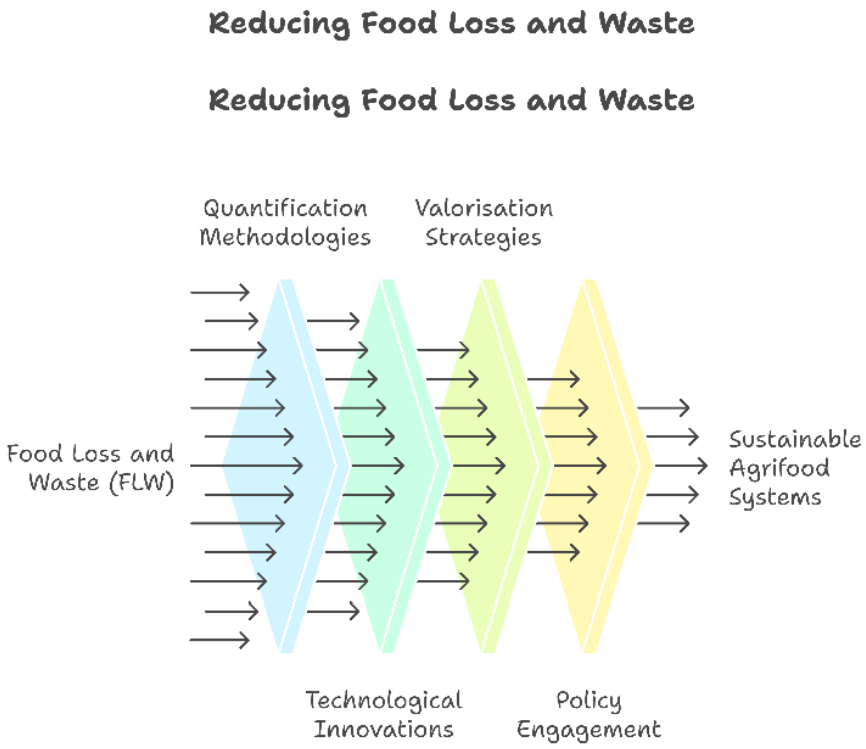
• Technological Innovations: Implementation of advanced sensor networks and AI-driven analytics to monitor and predict FLW, enabling timely interventions.

• Valorisation Strategies: Successful demonstration of circular bio-economy principles through the conversion of agrifood by-products into commercially viable and environmentally friendly outputs.

• Policy & Stakeholder Engagement: Establishment of multi-actor networks that translate scientific insights into actionable guidelines for policymakers, industry, and end-users from farm to fork.

This presentation will discuss the synthesis of lessons learned from PRIMA-funded projects, highlighting their contributions to sustainable FLW management. By showcasing evidence-based practices and innovative technological solutions, we aim to inspire further collaboration within the FoodWaStop Network and stimulate policy dialogue on the socio-economic and environmental imperatives of reducing FLW. Our collective experiences affirm that integrated, multi-disciplinary approaches are vital to achieving resilient and sustainable agrifood systems in the face of global challenges.

Keywords (e.g., Food Loss, Food Waste, Circular Bioeconomy, Agrofood Systems, PRIMA Projects)



O6.2. Foodwaste Discourse-Current Stage and Future Perspectives

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POSTER PRESENTATIONS

WG1. Prevention of food loss and food waste

P1.1. Understanding Food Waste Management Practices and Consumer Perspectives in Albania

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Food waste is an important global issue with environmental, economic, and social implications. This study used an online survey of 150 participants to explore food waste management practices, habits, and people's knowledge of the problem. This survey investigates key factors responsible for food waste, purchasing habits, and storage practices, as well as checking the attitudes of consumers regarding healthy and organic foods.

The findings give an insight into the level of awareness about food waste and its consequences to the environment; while most respondents are concerned, they do not have substantial ways of reducing such waste. Consumer preference for healthy and organic foods is presented by cost and accessibility as some of the possible barriers to making such purchases.

Furthermore, this study provides comprehensive knowledge on the food waste management practices of an urban Albanian context, and it outlines a clear demand for targeted educational interventions that result in sustainable consumption habits. These are glimpses into the development of bases on which policymakers, educators, and sustainability advocates may base the design of effective interventions which will reduce food waste and enhance environmental stewardship in Albania.

Keywords: food waste, purchasing habits, organic food, consumer attitudes.

P1.2. Potentiometry with Ion-Selective Electrodes as a Cheap and Useful Analytical Technique for Food Quality Control

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One way to reduce food waste is to produce high quality food. The quality and composition of many foodstuffs can be successfully tested by potentiometry using ion-selective electrodes. This technique allows to directly determine free ion concentration in various samples. The main advantages of this technique are low costs, speed which samples can be analyzed with, device portability, no sample destruction and the requirement of minimum sample preparation. Among the various types of ISEs, those with solid contact are becoming increasingly popular. In recent years our team successfully developed ion-selective electrodes with solid contact sensitive to potassium, copper, nitrate and chloride ions. These electrodes exhibited very good analytical parameters and among the various potential applications, they are suitable for the determination of particular ions in food samples. In this paper we demonstrate results of determination of potassium and nitrate ions in fresh vegetabes, fruits and juices. Food products were collected from local markets. They were analyzed after minimum sample preparation without mineralization. The reliability of the obtained results was assessed by recovery study. In each case satisfactory agreement of the results was obtained, which confirms the analytical usefulness of the constructed electrodes in food quality control.

Keywords: potentiometry, ion-selective electrodes, food quality monitoring

P1.3. Determination of trace amounts of titanium in nettle as a plant food material as food quality monitoring

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To avoid food loss and waste, an important aspect is to control the quality of food. For this, procedures are needed that allow simple, fast and inexpensive determination of various components in food. One method for determining metal ions in food samples characterized by simplicity of execution, low cost of analysis and at the same time low limit of detection is striping voltammetry. In the method described in this report, the goal was to develop a voltammetric procedure for the determination of titanium in nettle extracts. Nettle is not just a common plant that causes unpleasant sensations when you come into contact with its leaves. It turns out that eating nettle can bring many health benefits, as it is rich in nutrients and is known in folk medicine for its antibacterial properties. Nettle can be used to prepare a strengthening soup or is consumed as a tea. Nettle contains high amounts of vitamin C, folic acid, calcium, silicon and iron. In addition, this plant also has a high titanium content as it readily accumulates it. Therefore there is a need for simple and low-cost procedures to enable the determination of titanium in plant materials including nettle.

Keywords: food quality monitoring, nettle, titanium, determination

P1.4. Functional properties and antifungal activity of wild radish (*Raphanus raphanistrum* L.)

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Pathogenic fungi, including mycotoxin-producing species, contribute significantly to food loss in agriculture by infecting crops and reducing both yield and quality. In this context, natural compounds such as raphanin, found in the leaves and roots of *Raphanus raphanistrum*, may help inhibit fungal pathogenesis. This study aims to evaluate the antioxidant activity of raphanin and its potential to mitigate the impact of mycotoxic *Fusarium* species. The highest levels of total polyphenols (35.9 mg GAE/g) and total flavonoids (23.5 mg CatE/g) were found in the root and leaf extracts, respectively. The root extract demonstrated the strongest free radical scavenging activity, with an IC50 value of 0.93 mg/ml in the DPPH assay. For ferric reducing ability (FRAP), the root extract was more effective than the leaf extract, with an EC50 value of 0.35 mg/ml. The antifungal efficacy of ethanolic extracts at a concentration of 10 mg/ml was tested against *Fusarium culmorum* and *Fusarium verticilloides*. The results revealed significant antifungal activity, with leaf and root extracts showing inhibition rates of approximately 38% and 52%, respectively. Overall, this study demonstrates that *Raphanus raphanistrum* extracts possess promising antioxidant and antifungal activities, suggesting their potential as natural alternatives for controlling fungal contamination in agricultural crops.

Keywords: Phenolic compounds, antifungal activity, Raphanus raphanistrum, Brassicacea, Fusarium

P1.5. Impacts of Food losses on the Nutrition of the Population

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Reducing food loss and waste is a key part of Sustainable Development Goal (SDG) 12 on Responsible Consumption and Production. Food loss refers to any food removed from the supply chain between maturity and sale, including inedible parts as these are integral to the marketed product. Our main hypothesis is that increased food loss results in a decreased food supply per person, subsequently reducing the ability to feed the population. We evaluated population nutrition using two indicators: average dietary energy supply adequacy and prevalence of undernourishment. The data comes from the Food and Agriculture Organization (FAO). To analyze these relationships and process the data, we used a simultaneous equations model (SEM). After evaluating the SEM, we obtained the following results: losses of vegetal products do not have a direct or indirect influence on the two dependent variables. However, losses of animal products directly and indirectly affect the prevalence of undernourishment. In conclusion, there is a positive relationship between the loss of animal products and mediator variables. Greater losses lead to greater per capita supply. Additionally, there is a negative relationship between per capita supply and the prevalence of undernourishment. A larger per capita supply leads to a smaller prevalence of undernourishment.

Keywords: Food losses; FAO; Simultaneous equations model; Mediator variables; Population nutrition.

P1.6. Evaluation of soil solarization on fungal soilborne pathogens' populations, lettuce plant growth and the soil bacterial community

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The intensive cropping system makes lettuce crop susceptible to many soilborne pathogens that cause significant yield and quality losses. In this study, the impact of several soil disinfestation methods were evaluated. The populations of the soilborne pathogens *Rhizoctonia solani*, *Pythium ultimum*, *Fusarium oxysporum* and *F. equiseti* were measured with qPCR before and after the implementation of disinfestation methods. Although all the tested methods significantly reduced the four soilborne pathogens, soil solarization was the most effective. In addition, solarization reduced the number of lettuce plants affected by the pathogens *R. solani* and *F. equiseti*, influencing significantly at the same time the growth of lettuce plants. Amplicon sequence analysis of 16S rRNA encoding genes used to study the soil bacterial community structure showed that Firmicutes, Proteobacteria, and Actinobacteria were the predominant bacterial phyla in soil samples. Solarization had positive effects on Firmicutes and negative effects on Proteobacteria and Actinobacteria. Fumigation with dazomet increased the relative abundance of Firmicutes and Proteobacteria, and reduced the Actinobacteria, while the biofungicide had no significant effects on the three predominant bacterial phyla. Bacterial community composition and structure varied after soil disinfestation treatments since they imposed changes in the α-and β-diversity levels. Such results are expected to contribute towards the implementation of most effective control method against major soilborne pathogens of lettuce or other leafy vegetables.

Keywords: leafy vegetables, microbiome, next generation sequencing, soilborne disease management

P1.7. Systematic Analysis of Food Waste Drivers in Canteens: Development of a Monitoring System for Leftovers

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Automated food waste measurement in collective restauration is crucial for reducing waste efficiently, as traditional methods like surveys or manual weighing lack precision and are time-consuming. Combining RGB-D image analysis with artificial intelligence, an apparatus was developed to systematically monitor food waste on trays in real-time. A depth camera captures RGB-D images of food remains. Each image is then processed by a deep-learning model that performs a pixel-level classification into food categories (semantic segmentation), accurately recognizing food items using visual and spatial details such as texture, colour, and shape. The volume of leftover food can be calculated using depth information. This automated system achieved high overall precision in waste recognition, with better results for more represented categories. Waste quantification was performed using direct measurements of tray leftovers and calibrated against standards for the five most represented waste categories. Sensitivity analysis confirmed the reliability of the collected data. By enabling accurate and systematic monitoring of food waste, this technology provides the opportunity to identify patterns, track waste drivers, and pinpoint inefficiencies in food consumption. These insights empower collective food services to implement targeted interventions, optimize resource allocation, and ultimately contribute to significant reductions in food waste, aligning with broader sustainability goals.

Keywords: Convolutional Neural Network, RGB-D camera, Segmentation, Waste prevention

P1.8. New Scenarios for the Application of Controlled Atmosphere Storage

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Atmosphere modification surrounding the fresh produce contributes to delay ripening and senescence extending commercial life of commodities. Storage in Controlled Atmosphere (CA) is one of the commercial application of this technology, which consists of the rapid decrease of oxygen levels (through the addition of nitrogen) and the removal of excess carbon dioxide as produced by the fresh product by respiration. Most of the CA storage facilities in the world are dedicated to long-term storage of apples, pears, and kiwifruits. In particular, a good part of the technological evolution of CA storage on the last 30 years has been driven by the attempt of reducing the incidence of scald, an oxidative alterations of apples caused by long-term cold storage. For other products, although benefiting by atmosphere modification, the CA technology has been seldom applied, given their much shorter potential storage life; in these cases the available technology consisted in the Modified-Atmsphere Packaging (MAP) which is somewhat less efficient in maintaining the optimal gas concentration around the products. In the last few years a number of experimental evidences have lighted more attention to the potential application of CO_2-enriched CA storage in prolonging shelf life of a number of fresh products, including figs, strawberries, mushrooms, thanks to the fungistatic activity of carbon dioxide when in concentration higher than 10%. In particular for grapes, pomegranates and cherries, potential storage life obtainable can reach several weeks, up to 14-16 for pomegranates. This possibility opens new scenarios of application to CA technology to a number of products other than apple, pear, and kiwifruit, which might extend commercial seasons, maintain a better quality, and, above all, decreasing the amount of postharvest losses. Some of these applications will be described and discussed in this work.

Keywords: controlled-atmosphere storage, pomegranate, grapes, shelf-life

P1.9. Superomniphobic Coatings for Food Packaging Applications: Minimizing Waste Inside the Food Containers

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Food residue left inside containers poses significant challenges in terms of food wastage and sustainability. Superomniphobic coatings, characterized by their exceptional repellency against both water- and oil-based substances, offer an innovative solution to this problem. In this study, the development of environmentally friendly, durable, and scalable superomniphobic coatings, which were specifically tailored for food packaging applications, were studied. Utilizing plasma enhanced chemical vapor deposition (PECVD) technique, we optimized key process parameters, including temperature, pressure, and precursor flow rates, to achieve uniform, adherent, and high-performance polymeric thin film coatings on the inner surfaces of the food containers including plastic and glass jars and bottles, which would allow for the viscous liquid food to glide off completely, with no residue.

Our results demonstrated that the coated surfaces effectively repelled a wide range of liquid food substances, including ketchup, mayonnaise, and pudding, which significantly reduced the residue inside the corresponding containers. The thin coating acted as a slippery barrier between the inner surface of the container and the viscous liquid food. Additionally, these coatings maintained their functionality under various conditions, including temperature fluctuations and mechanical stress, simulating real-world usage scenarios. This research not only enhances the efficiency and cleanliness of food containers but also contributes to sustainability by reducing food waste and cleaning resource consumption.

Keywords: Superomniphobicity, Chemical vapor deposition, thin film, food packaging

P1.10. Action on post-harvest losses (PHL) reduction in Algeria

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Today, one of the main global challenges is how to ensure food security for a world growing population whilst ensuring long-term sustainable development. According to the FAO, food production will need to grow by 70% to feed world population which will reach 9 billion by 2050. In Algeria, agriculture is considered to be a vital aspect of national economy and rural development. Achieving sustainable agricultural production, generating employment, reducing imports and minimizing post-harvest crops losses are the major challenges for the agriculture sector. In Algeria, the post-harvest handling, storage, sorting and packaging contexts in the value-chain are underdeveloped. The lack of awareness about the importance of post-harvest practices and lack of using modern technology threaten the growth of this sector. Adopting sound post-harvest methods can reduce food losses and wastage in every stage of the food supply chain, and integration of modern techniques, capacity building systems are very important. This brief overview highlights some concepts and problems of PHL in Algeria, and critical factors governing them. Also, some strategies and alternatives ways of preventing and reducing these losses were explored.

Keywords: Food security; Algeria; Post-harvest; Sustainable Agriculture.

P1.11. Valorization of cold stored Tunisian pomegranate as ready-to-eat arils

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Ready-to-eat arils (REA) offer another form of pomegranate fruit in the market, providing innovative methods to prolong the shelf life for pomegranate fruit, and to reduce fruit waste after harvest. The quality of fruit is generally affected by several postharvest treatments and conditions. This study used a combination of storage temperatures (2 °C and 6 °C) for up to 60 days to determine the postharvest quality of arils assessed after shelflife. Results of aril sensory analysis showed that the overall flavor and appearance were highly rated when the fruit was stored for 2 months at 2 °C. Similarly, results of instrumental measurements showed that the fruit could be stored for 2 months at 2°C without significant reduction in anthocyanins and aril color. Storing fruit for 60 days at 6°C led to a reduction in overall quality and changes in aroma profile of REA after shelf life. The outcomes of this study suggest that a storage period of pomegranate for 60 d at 2 °C is recommended for REA consumption to preserve sensory quality and minimize volatile aroma component reductions after shelf life.

Keywords: *Punica granatum*, anthocyanins, freshness, postharvest quality

P1.12. Addressing Food Waste in Serbia: Challenges, Strategies, and Sustainable Solutions

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Serbia faces significant challenges in food waste management, despite cultural traditions of hospitality that encourage abundant food preparation. The country lacks an established system for redistributing surplus food to those in need, resulting in approximately 770,000 tons of annual food waste. In Belgrade alone, an estimated 165,000 tons of food waste contribute to municipal waste, exacerbating environmental and social issues. Current practices, including excessive food purchasing and oversized restaurant portions, further intensify the problem. With about 90% of total waste ending up in landfills, greenhouse gas emissions from food waste are a major concern. Efforts are underway in Belgrade to develop a sustainable food waste management system, including mapping food waste generators and establishing a digital data consolidation platform. These initiatives aim to reduce waste, improve food security for vulnerable populations, and align Serbia with global circular economy trends. The country's regulatory framework, including the Law on Waste Management, provides a basis for addressing these challenges. Adopting structured food waste management practices could significantly benefit marginalized groups and contribute to broader environmental sustainability goals.

Keywords: *Food waste management, Serbia, Sustainable practices.*

P1.13. Investigation of the Antifungal Activity of Natural Compounds Against Botrytis cinerea on Fresh Table Grapes

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To manage postharvest disease, it is necessary to develop alternative effective and safe methods. Bioactive compounds extracted from different fruit and vegetables are good sources of phenolic compounds that can effectively inhibit phytopathogenic fungi responsible for postharvest decay. For this reason, the biological activity of phenolic compounds and their application on controlling gray mold caused by Botrytis cinerea on table grapes was studies. The effectiveness of ashberry, white carrots, beetroot, shadbush and pumpkins extracts, extracted from vegetable waste and a commercial formulation of chitosan were tested against B. cinerea on table grape berries cultivar "Italia". Twenty µl of each substance was applied on artificially wounded berries. Twenty-four h later, wounds were inoculated with twenty µl of a conidial suspension (104 spores per ml) of B. cinerea. The incidence and severity of the disease were analyzed and compared with untreated control. All treatments reduced the disease severity. These findings highlight the potential of the tested substances as a promising natural approach in the prevention of gray mold on table grapes. Further large-scale experiments are needed to confirm the first results.

Keywords: Antifungal activity, valorization of food waste, postharvest decay, phenolics

WG2. Agrofood loss and waste management

P2.1. The Use of Whey for Other products

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Whey is produced as a by-product of cheese and casein manufacture and for many years was regarded as a nuisance, low value material requiring disposal at least cost. Whey is rich in proteins, lactose, and minerals. Using new technologies like membrane separation, has revolutionized the processing of whey into many highly valued products. There are many possible products and manufacturing processes like separation, concentration, fractionation, ultrafiltration, concentration for production of whey protein, mineral powder and lactose (Robinson, R., 2002).

Using yeast like *Saccharomyces cerevisiae* and *Saccharomyces cerevisiase* for alcohol fermentation, the whey from cheese production may be used for production of alcoholic beverages.

Keywords: whey, new technologies, whey products, yeast, alcoholic beverages.

P2.2. Disposal and Utilization of Soybeans of Different Varieties for Biofuel Production and Animal Feeding

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Soy originates from Asia, where it has been cultivated for more than 4.000 years. Its application is diverse, and its utilization is high because both the seed and the stalk are used. Soybeans are one of the main sources of edible oils and proteins for human consumption and for feeding domestic animals. In addition, it can be used for various industrial purposes, provided that it undergoes thermal processing that inactivates unfavorable compounds such as urease and trypsin inhibitors. Since raw soybeans cause indigestion in most consumers, it is necessary to carry out processing, for example by conduction drying. After heat treatment, the soybean seed is further processed for various purposes, while the stalk remains a by-product that needs to be disposed of optimally. The research included nine varieties of soybeans, and thermal processing by conduction drying was carried out at temperatures of 120, 140 and 160 °C. Before and after drying, the nutritional properties of the seeds and the energy properties of the stalk were analyzed. Different soybean varieties showed different results, based on which it is possible to determine which varieties are more suitable for biofuel production or animal feeding, with an emphasis on waste disposal within the circular bioeconomy system.

Keywords: soybeans, disposal, utilization

P2.3. Influence of conduction drying on chemical properties of coffee beans and sustainable disposal of the residues

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The coffee beans develop in cherry-sized berries and are contained in the pulp, from which they draw the nutrients necessary for their growth and development, while the entire fruit is covered by an outer leathery membrane. The coffee fruit itself contains around 68% pulp, 6% parchment skin and 26% pure coffee beans. The protective layers that surround the actual grain and are removed during processing for the market are: outer skin, pulp, parchment skin, silver skin and must be disposed of sustainably. In order to improve the chemical composition and enable long-term use, the coffee beans are refined using the conduction drying process. Two types of coffee were used for the study and their chemical composition was determined. Conduction drying was carried out at 180°C and 200°C. From the results obtained, it can be concluded that the increased drying temperature has no significant effect on the chemical properties of the two coffee varieties and that 84 of the waste (pulp and parchment skin) can be properly disposed of and recycled according to the principle of sustainable bioeconomy.

Keywords: coffee beans, conduction drying, disposal

P2.4. Biochar derived from biological waste disposal enhances arbuscular mycorrhizal fungi (AMF) associations in grapevines

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Biochar, a carbon-rich material derived from the pyrolysis of biological waste, has emerged as a sustainable amendment for improving soil health and plant growth. This study investigates the impact of biochar on the symbiotic relationship between grapevines (Vitis vinifera L.) and arbuscular mycorrhizal fungi (AMF), a crucial mutualistic interaction for nutrient uptake and stress resilience in plants. The application of biochar, produced from agricultural residues, significantly enhanced AMF colonization in grapevine roots under net house conditions. Key findings include improved root colonization rates, increased availability of phosphorus, and better soil structure, creating a favorable environment for AMF activity. Enhanced AMF associations correlated with improved plant growth parameters, including biomass production, shoot elongation, and chlorophyll content, especially under nutrient-limited conditions. Moreover, biochar's porous structure provided microhabitats for microbial communities, further stimulating AMF proliferation. The results suggest that biochar not only supports AMF colonization but also enhances the functional benefits of mycorrhizal interactions, including nutrient acquisition and drought tolerance. This study underscores the potential of biochar as a sustainable agricultural input, promoting soil fertility and vine health while addressing waste management challenges. Future research should explore long-term effects and scalability in vineyard systems.

Keywords: biochar, mycorrhizal fungi, circular economy

P2.5. Valorization of Sunflower Cultivated in Serbia: Enhancing Agrofood Waste Management and Promoting Circular Bioeconomy

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In the context of increasing global awareness regarding sustainability and waste management, research on the valorization of agrofood waste and circular bioeconomy has gained significant importance. This study specifically focuses on the protein content in sunflower cake obtained through cold pressing, a by-product of sunflower oil production. The analysis encompassed 20 different samples of sunflower seeds from the collection of the Institute of Field and Vegetable Crops, cultivated at Rimski Šančevi, Serbia. The by-products generated during sunflower oil production, such as sunflower cake, fall under the category of agrofood waste. The results indicated that the protein content ranged from 20.09% to 30.58% (3.21-4.89% N). These findings highlight the significant potential of sunflower cake as a nutritious product that can be utilized in various industries, including food and animal feed. Sunflower cake can be valorized and utilized in various applications, contributing to waste reduction and promoting sustainable practices within the agroindustry. The valorization of sunflower cake contributes to waste reduction in the agroindustry and promotes sustainable practices through a circular economy. By utilizing by-products such as sunflower cake, it is possible to create added value and reduce the environmental footprint of production. This approach not only enhances the economic sustainability of the sector but also contributes to the development of innovative solutions for managing agrofood waste.

Keywords: sunflower cake, agrofood waste, protein content, circular bioeconomy, waste valorization

P2.6. Yeasts Volatile Organic Compounds (Vocs) as Potential Growth Enhancers and Molds Biocontrol Agents of Mushrooms

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Yeast volatile organic compounds (VOCs) were investigated for their effect against fungal pathogens. VOCs produced by yeasts positively affect crops, acting as antifungals or biostimulants. According to results from in vitro assays, VOCs produced by *Aureobasidium pullulans* and *Metschnikowia pulcherrima* limited green mold without hindering the growth of cultivated mushroom, thus indicating beneficial effects of these VOCs on their growth and biochemical composition. VOCs produced by the yeasts significantly inhibited the growth of *Trichoderma* spp. but did not affect mushroom mycelial growth. Conversely, M. pulcherrima VOCs significantly stimulated *Lentinula edodes* mycelial growth. FT-IR spectroscopy on mushroom mycelia exposed to VOCs allowed us to correlate stimulation of their mycelial growth with an increased protein and lipid content, determining interesting nutraceutical differences. Compounds emitted by yeast strains revealed that the alcohol class dominated the volatilomes, particularly in *A. pullulans*. In contrast, *M. pulcherrima* was the only yeast producing isobutyl acetate, recognized as a plant growth promoter. Using different yeasts to produce a composite volatilome could be advantageous for cultivation of mushroom because a variety of compounds could hinder fungal pathogens present in natural habitats. Further studies will be necessary to understand the application of VOCs in the context of large-scale mushroom cultivation.

Keywords: VOCs, Cultivated mushrooms, Trichoderma spp., BCAs, FT-IR spectroscopy

P2.7. Global Biogas Industry Development: Identifying Key Influencing Factors

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The biogas industry offers significant benefits, including providing clean energy, enabling the harmless and resourceful treatment of organic waste, and supplying organic fertilizers. Notably, a substantial portion of biogas potential originates from agricultural residues, positioning the industry at a critical intersection of energy production and food systems. Despite its 400-year history and technological maturity, only about 5% of global biogas potential has been developed, and many countries experience the abandonment of biogas facilities after a period of operation. This study aims to investigate the reasons behind the substantial disparities in biogas development across different countries, with a focus on the utilization of agricultural waste. Using big data analytics, we established quantitative indicators to assess biogas industry development from 1990 to 2021. Our findings reveal that, while countries like Germany implemented comprehensive biogas subsidy policies after 2004, higher subsidy amounts do not necessarily correlate with faster biogas development. The underlying cause is attributed to differences in resource endowments, particularly in the agricultural sector. Through literature review and data analysis, we identified 15 potential influencing factors. Among these, factors related to agriculture and food—such as Farmer Share, Organic Agriculture Area Percentage, and Agricultural Machinery Rate—and economic indicators like GNI per capita, Average Years of Education, Household and NPISHs Final Consumption Expenditure, High-Technology Exports, and Share of Modern Renewables show significant correlations with biogas industry development. Understanding these factors is crucial for formulating effective policies to promote sustainable biogas utilization globally, especially by maximizing the value of agricultural residues within food production systems.

Keywords: Biogas Industry, Agriculture waste, Sustainable Energy, Big data

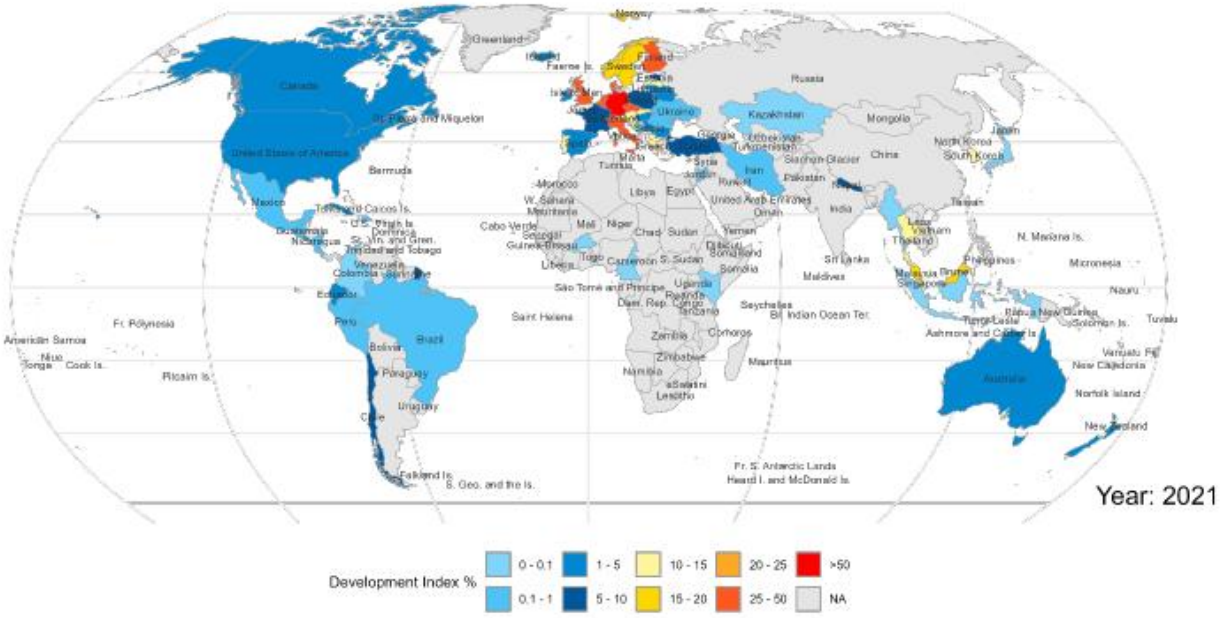

Fig.1 Global biogas industry development index in 2021

P2.8. Identification of a specific mechanism of herbicidal action against parasitic broomrapes on root extracts of lambsquarter (*Chenopodium album*).

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Our work aims to explore the potential of agricultural waste, such as pruning residues and weed biomass, as sources of natural compounds with pesticidal properties. Broomrapes (Orobanche and Phelipanche spp.) are obligate parasitic weeds that infect the crop in a process initiated when broomrape germination is triggered by specific compounds exuded by the same host root that will later provide its nutrition. Broomrape germination in the absence of a host leads to its death, a phenomenon termed suicidal germination. This study investigates the root chemistry of lambsquarter (Chenopodium album) to identify compounds that induce broomrape suicidal germination, with the ultimate goal of developing selective and sustainable herbicides that mitigate crop yield losses.

Lyophilized lambsquarter roots were extracted by maceration with a hydroalcoholic solution. Three different solvents with increasing polarity, i.e. n-hexane, dichloromethane and ethyl acetate, were sequentially used to obtain three organic extracts. The dichloromethane extract induced high levels of suicidal germination in three broomrape species (Orobanche crenata, Orobanche minor and Phelipanche ramosa). Therefore, this extract was fractioned using column chromatography, thin-layer chromatography, and high-performance liquid chromatography. This process resulted in the isolation of two pure compounds with confirmed suicidal germination-inducing properties. Structural characterization of these compounds is currently underway using high-resolution nuclear magnetic resonance (NMR) spectroscopy and mass spectrometry (MS).

The purification of lambsquarter dichloromethane root extract led to the isolation of two distinct compounds with strong germination-inducing activity against root parasitic weeds. These findings provide evidence that allelopathic weeds can themselves be exploited as a source of potential herbicidal compounds.

The sustainability of chemical strategies of crop protection is threatened by the ability of pathogens to evolve resistance to pesticides. This problem is exacerbated by the decreasing number and specificity of authorized pesticides, as well as the slow development of novel modes of pesticide action. Broomrapes cause significant yield losses worldwide and their control remains ineffective or inapplicable in many agricultural systems. This work identified a specific mechanism of herbicidal action against broomrapes from the ubiquitous weed lambsquarter, highlighting the potential of leveraging bioactive compounds derived from agricultural waste for the development of pest management strategies. Unlike conventional herbicides, these suicidal germination inductors offer a target-specific alternative that exploit the sophisticated germination biology of broomrapes against themselves. Repetitive use of herbicides based on suicidal germination strategy will not select for herbicide-resistant broomrape biotypes because once broomrape has germinated in the absence of the host, it will die in few days. Future research should focus on evaluating their efficacy under field conditions, their ecotoxicological profile and the design of efficacy-enhancing formulation techniques for their development as next-generation bioherbicides.

Keywords: *NA*

P2.9. Encapsulation of a Polyphenol Rich Byproduct of Olive Oil

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The main objective of this work was to develop an aqueous olive juice (AOJ) encapsulation protocol in order to protect the polyphenols from the environmental factors and/or the physicochemical processes that could degrade them.

The AOJ was purchased from the enterprise Biosasun S.A. (Allo, Navarre, Spain) using olive grapes of the local variety (Arroniz). The encapsulations were developed with sonication technology and the coating agent used was a synthetic glyceride purchased from the enterprise Gattefosse (France) named Precirol ATO 5. Different concentrations of AOJ and trehalose were used to evaluate their effect on encapsulation particle size and encapsulation morphology. To evaluate the encapsulation efficiency of polyphenols, analyses of total polyphenols (TPC) and Oleuropein content were carried out before and after the creation of the microencapsulations. In addition, particle size measurements were performed with the Mastersizer 3000 equipment. The initial AOJ had a TPC of 120 mg g-1 and 25 mg g-1 of Oleuropein content.The results showed that the concentration of 150 mg AOJ and 1000 mg trehalose resulted in particles with an average particle size of 0.752 µm and ellipsoidal morphology. This research study allowed us to develop an efficient (± 90%) encapsulation protocol for polyphenols coming from a byproduct of the olive oil industry. The results highlight the efficiency of the microencapsulation technique developed to protect the polyphenols present in AOJ, improving their stability, and open a door to future research to optimise the process and explore its benefits. The aqueous olive juice (AOJ) is a byproduct obtained through mechanical processes and cold extraction during the procurement of extra virgin olive oil (EVOO). This procedure involves the use of filtration and natural decantation in order to safeguard the valuable polyphenols present in olive oils. In this context, encapsulation appears as a promising process that shields active ingredients from external factors that could degrade or affect the stability of the polyphenols. The encapsulation of a polyphenol rich byproduct of olive oil allowed us not only the creation of a novel product with diverse applications in food science, but also the reutilization of a byproduct of the olive oil industry.

This study is part of the PROMETEA project, funded by the Government of Navarre (Spain).

P2.10. Influence of Feed Composition on the Characteristics of Sheep's and Goat's Milk

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This research study addresses the influence of the composition of organic feed on the properties of sheep and goat milk. For this purpose, a specific formulation of organic feed was developed that not only meets the nutritional needs of livestock but also reduces waste and promotes circular economy.

Two formulations of organic feed were made, with the aim of creating a more sustainable feed than conventional feed, which in turn would have added value at a nutritional level, using different quantities of the following by-products: Olive stones from the production of olive oil at Biosasun; exhausted malt from Sesma beer; citrus peel, orange peel, resulting from the production of Ekolo's organic juices; cereal and legumes grown among the olive trees at Biosasun. Two Assaff ewes and 2 African Dwarf goats were selected. Feed dispensing was gradually adapted to the animals' needs by incorporating it into their diet in a gradual manner, being supervised and evaluated by a veterinarian. Weekly samples were taken by hand milking and then vacuum packed in plastic bags for the subsequent determination of various physicochemical parameters. Modification of the livestock diet had a significant impact on the ash content of both sheep and goat milk, with a clear reduction when organic feed was incorporated and an increase when the original feed was returned. Significant differences in fat content were observed between ewe's and goat's milk samples. The variability in protein levels can be attributed to the modification in the protein content of the feed. Lactose did not seem to be significantly influenced by the change of feeding. The data showed differences in polyphenol content between ewe's and goat's milk, being higher in ewe's milk. The content of polyphenols was affected by the feed received to a large extent in the case of sheep's milk.

A feeding system based on organic feed affected polyphenol content and ash content to a greater extent. Furthermore, the feed system can be considered as a safe alternative from the point of view of rumen health. Research on the impact of dietary change in sheep and goats is of utmost relevance in the dairy industry and animal production, as it provides crucial information for improving milk quality and composition, as well as optimizing animal health and performance (BIRBIZI project, funded by the Government of Navarre, Spain).

P2.11. Broccoli Byproduct Extracts Attenuate the Expression of UVB-Induced Proinflammatory Cytokines in HaCaT Keratinocytes

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Broccoli byproducts are an important source of bioactive compounds, which provide important benefits for human skin due mainly to their antioxidant and anti-inflammatory properties. The primary target of UVB radiation is the basal layer of cells in the epidermis, with keratinocytes being the most abundant cell population in this layer. Given the wide range of side effects caused by exposure to UVB radiation, reducing the amount of UV light that penetrates the skin and strengthening the protective mechanisms of the skin are interesting strategies for the prevention of skin disorders. This work aims to evaluate the protective mechanisms triggered by broccoli by-products extract (BBE) on HaCaT keratinocytes exposed to UVB radiation as well as the study of the regenerative effect of these extracts on the barrier of skin keratinocytes damaged by superficial wounds as a strategy to revalorize this agricultural waste. The results obtained revealed that the BBE exhibited a high cytoprotective effect on the HaCaT exposed to UVB light, allowing it to effectively reduce the intracellular content of ROS, as well as effectively attenuating the increase in proinflammatory cytokines (IL-1ß, IL-6, IL-78, TNF-a) and COX-2 induced by this type of radiation. Furthermore, the BBE could be an excellent regenerative agent for skin wound repair, accelerating the migration capacity of keratinocytes thus contributing to the valorisation of this byproduct as a valuable ingredient in cosmetic formulations.

P2.12. Recovery of Bioactive Compounds from Red Grape Pomace

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Red grapes pomace contains many bioactive compounds such as polyphenols, flavonoids, minerals and vitamins that have many health benefits. Due to a limited number of studies regarding the reuse of by-products from the vinification of red grapes, the present study brings new opportunities to exploit these biologically active compounds extracted from red grape pomace.

In this study two extraction methods, such as conventional solvent extraction, microwave assisted extraction and enzyme assisted extraction were used. The effects of several extraction parameters on the phytochemical content were investigated to discover which combination of parameters led to the highest concentration of phytochemicals.

The results revealed that the optimal conditions for anthocyanin extraction (1.95±0.04 mg C3G/g DW) by was achieved at 70% ethanol acidified with acetic acid after 60 minutes of extraction at 25 °C. Also, the highest antioxidant activity (321.18±1.15 mM of Trolox/g DW) was obtained with 96% ethanol acidified with glacial citric acid, after 1 hours of extraction at 25 °C.

Therefore, the bioactive compounds from red grape pomace might be available as a source of functional compounds useful in the pharmaceutical and food industry.

P2.13. Polyphenol Release from Wild Thyme Dust Extract in Simulated Gastrointestinal Fluids

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In traditional medicine, wild thyme (*Thymus serpyllum* L.) is a part of various herbal medicines because of the presence of various bioactives, includinh luteolin, apigenin, catechin, rutin, quercetin, and chlorogenic, caffeic, salvianolic, and rosmarinic acids. Plant waste or dust possesses plenty of active compounds that can be applied in various food, functional food, and pharmaceutical products. Due to the dominant per os application of the plant and its formulations, polyphenol release from wild thyme dust extract in simulated gastrointestinal fluids was investigated.

The extract was prepared using wild thyme dust and 50% ethanol with hydrochloric acid in maceration at a solid-to-solvent ratio of 1:30 g/mL, for 60 min. The particle size of the plant material was 0.3 mm, as a result of the intensive comminution of the starting herbal matrix. An in vitro release study was performed using the Franz diffusion cell with two compartments separated by the acetate-cellulose membrane. The study was conducted in simulated gastric fluid (SGF) and simulated intestinal fluid (SIF). SGF contained hydrochloric acid, sodium chloride, and pepsin (pH 1.2), whereas SIF contained potassium phosphate, sodium hydroxide, pancreatin, and bile salts (pH 6.8). The data has shown that the release of polyphenol compounds in SGF continuously rose during 240 min and reached a value of 56.64% of recovered phenolics. Nevertheless, the quantity of polyphenols in the receptor compartment did not reach a plateau after 240 min of the tested period. At the same time, the diffusion of polyphenols from the extract in SIF was slower, and only 20.95% of phenolics were released during 420 min. The steady state in SIF was achieved after 360 min. The presence of pancreatin and bile salts (in SIF) can decrease the polyphenol diffusion from extract through a hydrophilic acetate cellulose membrane of the Franz diffusion cell, thus the percentage of released polyphenolics was significantly lower. Wild thyme extract was prepared at an acidic

pH value allowing the extraction of bioactive compounds soluble in this pH range. Thus, the extracted bioactive compounds showed faster and higher release in gastric conditions.

The polyphenol diffusion from the extract in SIF was slower in comparison to the gastric environment. In addition, the content of released polyphenolics was lower in SIF. The data obtained encourage encapsulation of wild thyme extract polyphenols to protect them from acidic conditions and provide prolonged/controlled diffusion in the intestine.

The study showed a higher polyphenol release from wild thyme dust extract in SGF compared to SIF. Since the release of phenolics in the gastric environment is not desirable, the study confirmed that the protection of sensitive bioactives and their prolonged and controlled release in intestinal conditions using various carriers is necessary.

Keywords: *NA*

P2.14. Protein Extraction from *Daucus carota* L. Root Peel: Optimization of Extraction Solvent and Procedure

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Daucus carota L. (carrot) is used due to its nutraceutical and health benefits, related to the presence of phenolic compounds, carotenoids, and ascorbic acid which possesses antioxidant, anti-aging, anti-inflammatory, and anti-proliferative activities. In addition, the anti-freeze proteins from *D. carota* can be successfully extracted and are more suitable for industrial applications as cryoprotectants. Thus, in the present research, polyphenol and protein extractions from *D. carota* root peel were optimized to obtain polyphenol- and/or protein-rich extracts from waste.

Polyphenol and protein extractions from carrot root peel were performed *via* varying extraction mediums (water, 30% ethanol, and extraction buffer) and extraction techniques (heat- and ultrasound-assisted procedures, HAE and UAE, respectively). The total polyphenol content was in a range of 1.04 to 1.91 mg gallic acid equivalent/g of fresh plant material, achieving the highest values in the following samples: water and UAE>ethanol and HAE. The total protein content values varied in a range of 5.21 to 8.76 mg albumin equivalent/g of fresh plant material, achieving the highest yields in the following extracts: extraction buffer and HAE≥water and HAE≥water and UAE. Since polyphenol and protein extracts can be further used for food products, the choice of solvent was an essential step. In all samples, extraction solvent type significantly affected polyphenol and protein yields. Ethanol carrot extracts showed significantly lower protein content but high polyphenol yield. Water extracts showed high polyphenol and protein contents, while the samples prepared using extraction buffer possessed high protein yield but low polyphenol concentration. On the other hand, only in the case of the extraction buffer, the high temperature provided the extract with a statistically significantly higher protein yield in comparison to the UAE parallel. Namely, the extraction procedure did not have a significant influence on the protein concentration of the water and ethanol extracts, while in the case of extraction buffer, the high temperature provided the extract with a statistically significantly higher protein content compared to the parallel obtained by ultrasound waves. However, the

extraction technique significantly affected the polyphenol content depending on the employed extraction medium.

The highest polyphenol yield was achieved using water and UAE, while the highest protein content was in the sample prepared using extraction buffer and HAE. Future experiments can be focused on the investigation of individual target polyphenols and proteins of *D. carota* peel and their potential implementation in food and functional food products.

The potential application of prepared extracts into food, functional food, or dietary supplements would realize the principle of the circular economy - from waste to bioactive formulation or value-added product.

Keywords: *NA*

P2.15. Harnessing Agri-Food Waste: Plant Leaf Extracts as Natural Agents Against Antibiotic Resistance

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Agri-food waste management could serve as a crucial strategy in developing sustainable and innovative approaches to address global health challenges, such as antibiotic resistance. The presented study highlights the antibiotic resistance-modifying properties of leaf extracts from grape (*Vitis vinifera*), blackcurrant (*Ribes nigrum*), and fig (*Ficus carica*), highlighting the bioactive potential of commonly discarded agricultural by-products. The leaves of these plants, known for their rich antioxidant composition—primarily phenolic compounds—display significant antibacterial and anticancer properties. The hydro-ethanolic extracts of this plant-based material demonstrated the ability to reverse antibiotic resistance in doxorubicin-resistant human cancer cells and enhance the effectiveness of conventional antibiotics like ampicillin and kanamycin. The extracts influenced proton flux and ATPase activity in bacterial cells, likely affecting antibiotic uptake and efflux. Thus, utilizing agricultural waste as a source of natural resistance-modifying agents not only aids in waste reduction but also contributes to developing innovative, sustainable solutions for managing infectious diseases and cancer. This research emphasizes the importance of agri-food waste valorization in addressing both ecological and healthcare needs, advocating for broader applications of natural plant compounds in pharmacology and food chemistry.

Keywords: plant secondary metabolites, membrane-associated properties, natural antibiotics

P2.16. Minimizing Heavy Metal Contamination in Seafood through Aquaponics: A Sustainable Solution for Food Security

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Heavy metals such as lead, cadmium, and arsenic pose significant health risks when they enter the food chain, leading to various health problems. These metals are carcinogenic and mutagenic, and their prolonged consumption is linked to heart, kidney, neurological, and bone diseases. In many Mediterranean countries, seafood consumption, especially fish, plays a significant role in the accumulation of these heavy metals. When fish live in polluted waters, they absorb these toxins, which can then enter the human body. Aquaponics, a system combining fish farming and hydroponic plant cultivation, offers an alternative with minimized risks. In this closed-loop system, water is continuously filtered and balanced, reducing the accumulation of heavy metals in fish. In contrast, wild fish in natural bodies of water may accumulate heavy metals due to pollution, which can build up over time. Thus, aquaponics offers a safer alternative for food production with lower risks of heavy metal contamination. Moreover, it contributes to sustainability and environmental preservation by using less water and reducing the need for soil. Promoting aquaponics can help improve food security while minimizing environmental impact.

Keywords: heavy metals, aquaponics, seafood, food security, environmental impact

WG3. Quantification of food loss and food waste

P3.1. Fresh Produce Waste in Retail: Quantifying Losses and Identifying Drivers

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Food loss and waste constitute a significant global challenge, with profound societal, economic, environmental, and nutritional consequences. The Food and Agriculture Organization (FAO) estimates that approximately one-third of all food produced and nearly half of all fruits and vegetables are either lost or wasted along the food supply chain. This study focused on quantifying food waste and identifying key contributors in a retail setting, with a particular emphasis on fresh produce. By examining daily waste data and conducting microbiological analyses on loose apples, tomatoes, and citrus fruits, we sought to understand the factors influencing product spoilage and shelf life. Our findings revealed that a combination of factors, including seasonal variations, improper handling practices, and consumer behavior, contributed to significant levels of food waste. To mitigate these losses, we propose several recommendations, such as optimizing inventory management, improving display conditions, and enhancing consumer education regarding food storage and preparation. By implementing these strategies, retailers can reduce their environmental footprint, minimize economic losses, and contribute to global efforts to achieve food security.

Keywords: food waste in retail, Hungary, fruit and vegetable loss, microbial contamination

P3.2. Food Waste Assessment in Hungary

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Food waste usually occurs as a result of human carelessness, when food that would otherwise be suitable for human consumption is thrown away. The majority of food waste occurs in households, which is also present in Hungary, despite the fact that the country is one of the less wasteful nations. During our research, we analyzed in detail, using a questionnaire survey, what factors influence the food purchasing and consumption habits of the Hungarian population, as well as the level of awareness in the field of food waste. The questionnaire covered four main topics: examining purchasing habits, questions on the extent of food waste and awareness, and exploring the personal effects of waste. In our research, we present partial results of a 30-question questionnaire with 1,500 responses. The results revealed that environmental awareness is closely related to the level of food waste, and the amount of wasted food decreases with age. The frequency of wasting different food categories varies according to age groups, education, and other socio-demographic factors.

Keywords: food waste, Hungary, household, questionnaire, survey

P3.3. Toward Consistent Food Waste Reporting in the EU: Analyzing Flows Across Food Supply Chain Stages

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The European Commission has provided a common methodology and minimum quality requirements for uniform measurement of food waste (FW) levels and guidance on reporting data on FW and FW prevention. However, the scope of FW measurement is still vague and interpreted differently across the EU. The EC methodology clearly outlines some flows that must be excluded from reporting, e.g. materials that are linked to the food supply chain (FSC) but never enter it as food. It also defines flows that must be reported and flows that can be reported on a voluntary basis. However, the methodology is less clear on the inclusion or exclusion of such flows as by-products. Furthermore, it does not provide clarity on the inclusion or exclusion of the different flows at the level of the FSC. This study aims to provide a distinction between the different flows within and from the FSC that need to be included in national FW measurement and reporting at each FSC stage. As a result, we have clearly identified and listed the flows, economic activities, waste generation sources and waste destinations that need to be considered for each FSC stage in FW reporting.

Keywords: Food waste, Food supply chain, Definition, Measurement, SDG12

P3.4. Antioxidant Activity and Bioactive Compound Content of Bee Bread Waste from Bingöl, Türkiye

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This study investigated the antioxidant activity and bioactive compound content of bee bread waste (BBW). BBW samples were collected from Bingöl, Turkey, and extracted using ethanol, followed by detailed analyses of bioactive compounds. The total phenolic content (TPC) ranged from 11.98 to 12.08 mg Gallic acid equivalents (GAE) per gram, while the total flavonoid content (TFC) ranged from 2.34 to 2.44 mg quercetin equivalents (QE) per gram. Antioxidant activity, evaluated through DPPH and FRAP assays, demonstrated values of 47.97–51.63% inhibition and 6.82–7.95 µmol Trolox equivalents (TE) per gram, respectively. These results suggest that BBW retains significant bioactive properties despite being classified as waste. Future studies will aim to expand the characterization of BBW, including its macronutrient composition, and to explore its incorporation into innovative food products with enhanced nutritional and functional profiles.

Keywords: Bee bread waste, bioactive compounds, antioxidant activity, sustainable food systems, food waste reduction

P3.5. The Food Production, Energy Supply and Environment ecosystems disruption due to the Russian war in Ukraine: challenges and future development scenarios

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The war in Ukraine represents a significant humanitarian crisis, resulting in heightened poverty, disparities in demographics and well-being, energy crisis, severe long-lasting environmental repercussions that affect not only Ukraine but also far beyond its borders. The war has had multiple impacts, including loss of life, global food supply chain disruption, and environmental distortions. And therefore obstructing sustainable development worldwide. Through the mechanism of contagion, the Russian aggression in Ukraine for developed and developing countries vary: from food, fuel, and fertilizer prices growth to increased distress in energy security, which in turn leads to further problems: poverty, hunger, inequalities etc. The food, energy, and environment ecosystem strategy aims to achieve a balanced and sustainable approach to addressing the food, energy, and environment nexus while being mindful of exponential population growth. A more resilient and sustainable development model could be created by studying the synergies and trade-offs between these areas and exploring the far-reaching implications of war in Ukraine on a global scale. The possible short-term, medium term and long term scenarios are envisaged to see the possible future developments.

Keywords: sustainable development, food, energy ecosystems, war in Ukraine

P3.6. Methodology for Food Loss Quantification (FOLOU Project)

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This methodology aims to serve as a foundation for quantifying parts of the food supply chain that are currently excluded from the concept of food waste as proposed by the European Commission, primarily from the pre-harvest and harvest stages, although also from post-harvest, for which there is currently no regulation for measurement, let alone for reduction. This methodology seeks to be adaptable to different food commodities and territories both within and outside the European Union, particularly at two levels: on the farm level as well as at the territorial level (local, regional, and national).

The development of this methodology has been supported by the experience of the partners involved in the European FOLOU project, as well as the review of external experts on food losses and case studies being conducted within the project, specifically in fruits and vegetables in Spain, meat and dairy in Ireland, mussels in Italy, potatoes in Belgium, and salmon in Norway.

A solid version of the methodology is already in place, which presents key aspects for measuring losses, such as What to measure, Where to measure, and How to measure, along with the insights gained from the case studies and the initial figures obtained in most of these food commodities. The testing of the methodology is not only being carried out for different types of food, but also for various production types: conventional, organic, and agroecological.

It has been concluded that a feasible methodological approach exists to quantify stages of the supply chain that were excluded from the food waste definition established by the European Commission, across different food commodities and various territories within and outside the European Union. Furthermore, the figures obtained through the case studies are substantial enough for these stages to be included in future regulations for analysis and subsequent minimization.

This methodology aims to help standardize loss measurement processes not only across Europe but also beyond, enhancing the comparability of results and fostering synergies across various studies. In this way, it seeks to demonstrate that it is also possible to diagnose and, therefore, establish policies at the European Union level for the analysis and minimization of food losses in the pre-harvest stages. Thus, the goal is for future European regulations to encompass policies for the analysis and

reduction of food losses and waste across the entire supply chain, rather than just a part of it.

P3.7. Investigation of reuse possibilities of unconsumed meals in hotel kitchens to prevent food waste

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Food not only meets basic needs, but has also become a source of pleasure, new experiences and entertainment. The new elements brought to food have also brought negative effects. The most important negative effect is seen as waste. In this study, in order to prevent food waste in hotel establishments, applications for transforming leftover food into another meal are given.

In this study, the causes of food waste in the food and beverage sector were first investigated. Then, using qualitative research technique, the most consumed and wasted meals in hotel establishments were identified and the meals were turned into the main ingredients of other meals. Within the scope of the research, using qualitative research technique, 16 hotel managers in the Mediterranean and Aegean regions of Turkey were interviewed, and it was determined which meals were the most wasted meals in hotel kitchens and from which kitchen section they were wasted, and which meals could be used as the main ingredient of another meal. In this way, it is thought that food waste and waste in hotel kitchens, which have a large share in food waste, can be reduced to some extent. Within the scope of the study, it was determined that 1 soup, 2 rice, 7 main meals, 3 desserts and 4 cold appetizers were the most wasted meals. It was observed that these meals could be transformed into 4 main meals, 9 appetizers or snacks, 6 soups and 3 desserts.

In order to reduce food waste, such new meal derivation practices can be implemented regularly in hotels and even new meal types can be derived. Awareness-raising activities can be carried out for guests who are prejudiced against dishes derived from such leftovers. Hotels that use new food derivation practices can encourage other hotels to do so. Workshops can be organized in hotels as an example of how new dishes can be prepared with leftovers to raise awareness of food waste.

The most common food and beverage service technique in hotels operating in Turkey is the all-inclusive system, and the reuse of these unconsumed meals served in the open buffet is important in terms of reducing food waste. The continuation of similar studies and trainings to be given to hotel kitchen staff will contribute positively to sustainability in the food and beverage sector.

WG4. Valorisation of agrofood waste and a circular bio-economy

P4.1. Valorization of Phenolic Compounds Recovered from Olive Oil Byproducts and their Potential Use in Food Model Systems

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The Olive oil industry generates different by-products, such as olive mill wastewater (OMWW) and olive pomace (OP), which have environmental, social, and economic significance. By-products of the olive oil industry are considered low-cost sources containing high-added value and bioactive compounds including polyphenols that show remarkable antioxidant properties. These compounds are known to be associated with beneficial effects on human health and play an important role in food formulation. This study is focused on evaluating the environmental impact of OMWW and on valorization approaches of bioactive compounds recovered from OMWW and OP. The results of the physicochemical analysis showed that samples of OMWW had an acid pH and high levels of organic load compared to allowed effluent discharge limits according to Albanian standards. The high biodegradability index (>3) confirms that OMWW samples are not biodegradable and the total phenolic content was 5.5 -8.42 g/l. OP extracts have high total phenolic content, antioxidant activity, and antioxidant capacity (0.7 - 0.8 g GAE/L, 80-105% AA, and 90-109% TAC, respectively). Based on the obtained results OP and OWWW have antioxidant qualities and may be useful in food formulation.

Keywords: valorisation, olive pomace, olive oil byproducts, food formulation

P4.2. Insects on the plate: Assessing the sustainability of yellow mealworm proteins in food systems

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Efficient resources used to ensure a sustainable food future has driven an interest in entomophagy, a centuries-old practice recently entering the Western market. Aligned with circular economy principles, repurposing agri-food by-products as insect feed can simultaneously serve as a tool to manage low-value organic biomass and provide new sources of valuable proteins, fats, vitamins and minerals. As insect production and industrial applications advance, insect-derived proteins are being incorporated into food products to reduce or replace the use of conventional ingredients, such as cereals. Understanding the sustainability implications of novel ingredients is crucial, and to that end, life cycle sustainability assessment (LCSA), a tool to assess environmental, social and economic impacts enables the assessment of the production of Tenebrio molitor (yellow mealworm) protein and its incorporation as into artisanal cookies production. The production of insect protein highly contributes to the sustainability outcomes related to upstream characteristics of the feedstock (e.g. production and market value) and downstream on the ingredient type and substitution level in the final food product. The findings provide insights into the viability and implications of integrating insect-derived proteins into food systems contributing to better decision-making among the stakeholders involved in the agrifood sector.

Keywords: food products; LCSA; novel ingredients; circular economy; entomophagy.

P4.3. Investigation of the sugar profile of samples generated during in vitro digestion simulation of dietary carbohydrates using the HILIC-RID method

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Postprandial blood glucose elevation is a risk factor for type 2 diabetes, influenced by the quality of ingested carbohydrates and other foods affecting starch digestion kinetics. This study aims to develop a liquid chromatographic method to analyze endogenous sugar components in fruit products (e.g., cherry juice) and by-products (e.g., apple pomace and its extracts) that potentially affect postprandial blood glucose levels. The method targets fructose (Fru), galactose (Gal), sucrose (Sac), and catabolites released during starch digestion of white bread (used as a test food): glucose (Glc), maltose (Glc2), and maltotriose (Glc3). The developed method will be applied to analyze sugar profiles in fruit products and in experiments modeling starch digestion of standard white bread with added foods (e.g., fruit products) to assess their impact on starch digestion. Digestion experiments were conducted using a hybrid digestion simulation method based on the Infogest protocol, with samples taken at multiple time points. Samples were prepared with 80% ethanol and centrifuged. Sugar analysis was performed using an Agilent 1200 HPLC-RID system with ACN/water isocratic separation on two columns: amin (Phenomenex Luna NH2) and amid (Phenomenex Luna Omega Sugar). Results indicate successful separation of sugars, with specific coelution issues resolved by using both columns.

Keywords: apple pomace, HPLC-RID, sugar composition

P4.4. Effects of apple cider vinegar extracts on carbohydrate digestion

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The apple is one of the most abundant fruits and a significant part of it is used as a raw material for apple juice production. Consequently, a significant amount of the residual apple pomace is discarded as a by-product of the food industry. The continued use of apple pomace can not only provide a value-added alternative for by-product processing, but also, through its positive nutritional effects, can be a solution to public health problems such as the fight against non-communicable diseases (obesity, type 2 diabetes). The aim of this research is to investigate the nutritional effects of apple pomace extracts (solvent: i) water and ii) 70:30 acetone:water) containing bioactive components as an alternative to the reuse of apple pomace, in particular to observe their effects on the glycaemic properties of food. The studies were performed according to the hybrid digestion simulation method based on the Infogest method. White bread (1.65 g) was used as the sample matrix. During the simulation, extracts (3.35 mL) were added to the bread sample at the oral stage after in vivo mastication. During digestion (240 min), samples were taken at several time points (gastric phase: 15, 30, 45, 60, 90, 120 min; small intestine phase: 150, 180, 210, 240 min) and after selective separation, the amount of glucose released was determined spectrophotometrically by GOPOD (glucose oxidase peroxidase enzyme treatment). The results showed that both apple pomace extracts tested had an effect on carbohydrate digestion. The reduction of glucose release induced by the aqueous extract was negligible compared to that of the acetone extract and was limited to the gastric phase. On the contrary, the addition of acetone extract significantly (t test per time point compared to control, $p<0.05$) reduced the rate of release during the whole digestion period, thus significantly affecting the end-point glucose, i.e. the carbohydrate digestibility of white bread was reduced by 23% compared to the control. The effect induced was presumably due to the amount of bioactive components (e.g. proanthocyanidins) present in the acetone extract, which exert their effects through active enzyme inhibition. In addition, it is important to mention other factors of the extracts, such as the acidic chemistry or the presence of fibres, which also have an effect on the process of carbohydrate digestion.

Keywords: *NA*

P4.5. Recycling Waste Cooking Oil a Successful Way to Sustainability-Transformation of Waste Cooking Oil into Eco-friendly Product

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Waste cooking oil (WCO) is the oil in which significant changes have occurred on its chemical structure during frying process. Although this process gives to food special properties the use of oil several times, not only compromise the food characteristics, but can demonstrate adverse health effect for the consumer. Furthermore, inadequate management of WCO can result in environmental pollution. The goal of this study was determination of physico-chemical parameters of reheated oil and its transformation into soap.

Analysed samples showed that waste cooking oil had different colour, density, and aroma compared to control sample. The acid value of analysed WCO was 0.94 mgKOH/g oil meanwhile, the saponification values were 202.03 mg KOH/g oil and 144.31 mg NaOH/g oil. Transformation of WCO into hard soap was done using different concentrations of lye solution. The best result was reached using NaOH solution with concentration equal to 33%.

The soap was tested for its washing power and the pH. The washing process showed that the soap prepared by WCO had satisfactory washing power.

Thus, the use of recycling process in transformation of WCO into eco-friendly product can be considered not only as a successful way to sustainable environment but even as an economic income.

Keywords: waste cooking oil; sustainability, physico-chemical parameters; eco-friendly product; recycling

P4.6. Effect of encapsulation wall material on aroma retention of citrus pomace

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Citrus pomace is byproduct derived from the industrial processing of juice mostly consists of pectin, cellulose, hemicellulose, and simple sugars. In this study, citrus pomace waste from a mandarin juice processing facility was utilized to extract aroma compounds and encapsulate them using a freeze-drying method. The primary aim of this study was to assess the effect of varying the ratio of carboxymethylcellulose, gum arabic and maltodextrin as wall materials on the properties of the encapsulates and the capacity to retain the aromatic compounds. After an initial analysis, the microcapsules were disrupted in water to confirm the encapsulation of aroma compounds. Identification of these compounds was achieved by comparing their retention indices (RIs), relative to n-alkanes (C9–C25), and matching spectra with commercial mass spectral libraries. In total, 45 aroma compounds were identified, including 17 monoterpenes, 13 sesquiterpenes, and 15 other compounds, with limonene, linalool, and a-terpineol as the most abundant. This study highlights the role of wall material composition in enhancing aroma retention during the encapsulation of citrus byproducts.

Acknowledgement: This work was supported by the Short-Term Scientific Mission Grant from the COST Action CA22134 - Sustainable Network for agrofood loss and waste prevention, management, quantification and valorisation (FoodWaStop)

Keywords: citrus byproducts; encapsulation; aroma compounds

P4.7. Antioxidant Capacity of Orange and Lemon Peel Extracts and Their Use in Biosynthesis of Silver Nanoparticles

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Fruit peels are generally considered as environmental burden and waste. In this paper were studied the antioxidant capacity of orange and lemon fruit peel, as well as their application in biosynthesis of silver nanoparticles (AgNPs). The fruit peels were collected, air dried at room temperature for seven days and homogenized by grinding. The homogenization of the sample was done for 2 hours at 200 rpm in the shaker in 80% methanol. The antioxidant capacities of the obtained fruit peel extracts were quantified by FRAP and ABTS methods. The results showed that the antioxidant capacity obtained for lemon peel by FRAP (mmol Fe^{2+}/100g DW) was 6.31±0.14 and by ABTS (mg TE/100g DW) was 1.50±0.06, while for orange peel was 5.65±0.12 and 1.36±0.09, respectively. AgNPs were synthesized by using aqueous extracts of orange and lemon peels, as a reducing agent, and silver nitrate salts as a source of silver ions. Positive inhibitory effect on the growth of new *Escherichia coli* colonies have shown AgNPs synthesized at a basic pH value and at a 0.1 mM $AgNO_3$ using orange or lemon peel extract, while for a 0.5 mM $AgNO_3$ using lemon peel extract.

Keywords: Antioxidant capacity, orange peel, lemon peel, silver nanoparticles.

P4.8. Developing a Sustainable Milk-Sour Dessert with Pomegranate Seeds Flour: Quantifying and Valorizing Food Waste

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The demand for fermented milk products has increased significantly in recent years, with market trends predicting this growth will continue. Fermented dairy desserts, in particular, are becoming widely popular due to a growing market that introduces new products and innovative concepts. In pomegranate processing, around 30-40% of the peel is left as waste after juice extraction. Yogurt, one of the most widely enjoyed fermented milk products, is favored for its taste, nutritional benefits, and health properties. This study aims to explore the effect of incorporating pomegranate seeds—a byproduct of juice production—into yogurt to create a milk-sour dessert with varying amounts of pomegranate seed flour. The seeds were separated, dried at 50°C, ground into flour, and added to yogurt. The dessert was then monitored over 7, 14, and 21 days for changes during storage, including sensory evaluations. The incorporation of pomegranate seeds notably enhanced the dessert's sensory and chemical attributes. The bioactive compounds in the seeds, together with the activity of lactic acid bacteria, increased titratable acidity and reduced pH. Samples with 5% seeds received the highest scores for color and texture, while 7.5% seeds provided the best taste and acceptability, demonstrating pomegranate seeds' potential as a fortifying ingredient.

Keywords: valorization, dairy products, pomegranate seeds, functional food

P4.9. Food By-Products Valorisation: Nutritional Value and Consumer Acceptance of Wheat Cookies Enriched with Pumpkin Peel Powder

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Converting food by-products into innovative and functional products to minimize waste and contribute to the circular economy is an imperative for food industry. Pumpkin processing generate considerable amount of by-products still rich in valuable ingredients. The objective of this study was to use pumpkin peel, rich in fibre, antioxidants (especially β-carotene) and minerals for enhancing nutritional profile of wheat cookies. Pumpkin peel powder, obtained from fresh pumpkin peel using microwave-assisted convective drying, was further used in cookies preparation for partially substitution of wheat flour at different levels (5-20 %) in standardized recipe. Dietary fibre content (AOAC standard method), mineral composition (inductively coupled mass plasma spectrophotometry method) and sensory evaluation (5-point hedonistic sale) for cookies with/without addition of pumpkin peel powder were determined. Results obtained from this study showed higher content of dietary fibre and minerals in cookies with addition of pumpkin peel powder, compared to control cookies (made from wheat flour only). Evaluation of sensory attributes (colour, odour, texture and flavour) showed better acceptance for cookies with addition of pumpkin peel powder than control cookies. The best-rated cookies were with 10 % substitution of wheat flour with pumpkin peel powder. In conclusion, the addition of pumpkin peel powder can enhance the nutritional value and some sensory attributes (colour, texture, flavour) of wheat cookies.

Keywords: pumpkin peel, cookies, sensory evaluation, dietary fibre

Acknowledgement: The work was supported by the Croatian Science Foundation (research project "Hybrid drying and valorization of plant food waste and byproducts" IP-2019-04-9750) – HYDRYBY

P4.10. Effect of Fruit Waste Substrate on Antioxidant Profile in the Fermentation Process by *S. johnsonii*

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Recovering nutrients from food wastes for biological processes is consistent with sustainable principles. This work aimed to transform fruit waste into beneficial substrates for microorganisms, as well as the production of a large number of antioxidant compounds as secondary metabolites. *S. johnsonii* was grown in four substrate groups, including group 1 (potatoes and molasse), group 2 (pear and molasse), group 3 (apple and molasse), and group 4 (potato, pear, apple, and molasse). On the first day, the antioxidant profile for the four groups was assessed. Total Phenolic Content (TPC): 56.09, 78.15, 82.36, and 69.82 GAE mg/100 ml. 2,2-Diphenyl-1-picrylhydrazyl (DPPH): 37.84, 64.84, 73.86, and 63.15 mg TE/100 ml. The cupric-reducing antioxidant capacity (CUPRAC), 0.15, 0.19, 0.22, and 0.19 mg TE/100 ml, for groups 1 to 4, respectively. After six days of fermentation, the antioxidant profile of the substrates was assessed again. The potato and molasses group had the highest levels of TPC: 155.87 GAE mg/100 ml, DPPH: 104.18 mg TE/100 ml, and CUPRAC: 0.3 mg TE/100 ml, compared to the other groups. Our findings suggest that fruit waste, especially potato waste, can be suitable substrates for microbial secondary metabolite production, additionally, fermentation has a good potential for increasing this value

Keywords: Antioxidant, Fermentation, secondary metabolites, fruit wastes

P4.11. Biorefining Hemp Herb Processing By-Products Into Value Added Functional Food Ingredients by Consecutive Supercritical CO_2 and Pressurized Liquid Extractions

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After extraction of cannabinoids, residual hemp herb (HHR) is often discarded or used as fertilizers. Besides the nutritional aspect, this by-product may be considered as a source of health beneficial bioactive compounds. This study aimed at biorefining hemp herb residues into higher added-value food ingredients. Proximate composition analysis of HHR was followed by supercritical CO2 extraction ($scCO_2E$) to isolate lipophilic compounds. The defatted material was subjected to pressurized liquid extraction (PLE) using ethanol and water. Antioxidant capacity of the products obtained was evaluated by the in vitro assays, fatty acid and phytochemical composition of the fractions was analyzed by GC and UPLC. Linoleic , a-linolenic , and oleic acids were the main fatty acids found in the extracts. On the other hand, PLE using water as solvent resulted in the highest yield of extract with 19.07 % for HHR. Moreover, a considerable amount of cannabinoid was found in the residues, which correlated with the obtained antioxidant values from ethanolic extracts including 49.53 mg GAE/g, 30.13 TEAC mg Trolox/g, and 184.28 mg trolox/ g for total phenolic content, DPPH and CUPRAC, respectively. In this investigation, $scCO_2E$ and PLE resulted into three main fractions with superior functional properties, however, more studies are required to assess their microbiological safety and their bioavailability.

Keywords: Valorization; Hemp; Green extraction; By-products

P4.12. Biorefining of Under-investigated Botanicals for Nutraceutical and Functional Food Applications

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Medicinal plants have been traditionally used for medicines and food, but scientific understanding of their composition and bioactivities is relatively recent. D. canadense (L.) DC. (common name Canada tick-trefoil) leaves are rich in flavonoids; however, its application is limited due to absence of more comprehensive studies focusing on plant processing. This study applied high pressure extraction techniques for the recovery of different polarity fractions from D. canadense leaves collected at different plant vegetation phases (intensive growing, bud formation, beginning, massive and end of flowering) and evaluating their antioxidant potential. Herein, the lipophilic fraction was recovered with supercritical carbon dioxide (SFE-CO2). The SFE-CO2 residues were consecutively fractionated by pressurized liquid extraction (PLE) with increasing polarity solvents, namely acetone, ethanol, and water. Phytochemical analysis of PLE extracts was conducted using ultra-performance liquid chromatography coupled with a quadrupole-time-of-flight (UPLC-Q-TOF) mass spectrometer. This study highlights Canada tick-trefoil leaves as a promising source of polyphenolic antioxidants, ideal for developing innovative nutraceuticals and functional foods.

Keywords: Desmodium canadense, supercritical carbon dioxide extraction, pressurized-liquid, extraction, phytochemicals

P4.13. Sustainable Green Synthesis of Silver Nanoparticles from Fermented *Origanum vulgare* L. Extract and Their Antimicrobial, Antioxidant Activity and Phytochemical Composition

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Green silver nanoparticles (AgNPs) were synthesized using plant extract in aqueous form as bio reducing and bio capping agents. Due to their therapeutic potential applications, various metallic nanoparticles (NPs) are extensively prone to use in nanomedicine. Silver nanoparticles are re-markable in their physical and chemical properties. This study aims to develop biosynthesized AgNPs made using fermented *Origanum vulgare* L. herb extract, having increased antioxidant and antimicrobial activities. The biosynthesized AgNPs were characterized by Transmission Electron Microscopy (TEM), Scanning Electron Spectroscopy (SEM-EDS) techniques, and different spec-trophotometric measurements. Green silver nanoparticles enhance antimicrobial activity against both Gram-negative and Gram-positive bacteria, as demonstrated by the Kirby–Bauer disk diffusion method. The significant increase in antioxidant activity can be attributed to the phenolic com-pounds present in the extract of O. vulgare herb samples. TEM analysis visually confirms the spherical shape and size of 10-20 nm. SEM-EDS was performed for green AgNPs and precise and uniform distribution. This study presents, for the first time, the application of fermented *O. vulgare* herb extracts in the synthesis of silver nanoparticles (AgNPs) and demonstrates an enhancement in both antioxidant and antimicrobial activities.

Keywords: *Origanum vulgare* L.; silver nanoparticles; phytochemical analysis; antibacterial activity; antioxidant activity.

P4.14. Argan by-products protein and fiber contents as potential food and feed Source

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Proteins and fibers are important macronutrients, their combination can help manage weight disorders by improving blood-sugar levels, a high protein and fiber-based diet can curb hunger and limit calories intakes. The protein food group includes meat and poultry, seafood, beans, peas, and soy products. When fibers are mainly composed of carbohydrates that cannot be digested by the organism. Fiber helps regulate the body's use of sugars, helping to stabilize blood sugar levels [1]. The argan tree, Argania spinosa (L.) skeel is a Moroccan endemic species recognized for its several therapeutic and medicinal properties. The argan oil, the main product of the argan tree, is highly coveted by the cosmetic industry for its anti-wrinkle properties. The extraction of argan oil leads to three by-products: the pulp, the shell and the cake, these extraction residues find their traditional use in livestock feeding, as well as for therapeutic and medicinal purposes [2]. The objective of this study is to evaluate the potential use of argan press-cake as source of proteins and fibers, the proteins were estimated using the Kjeldahl method [3], when the fiber contents mainly hemicellulose using the methods described by Van Soest [4]. The obtained results showed the argan press-cake with high protein contents 23.7 – 32.4 % of DW, and fiber values 9.32 - 18.1 % of DW. Those primary results are promising for the use of argan by-products for the development of new nutritional products.

Keywords: argan, by-products, diet, fibers, nutritional value, proteins.

P4.15. Present state and future of management of biodegradable waste in Municipality of Ohrid (N. Macedonia) - Approaching to EU regulatives

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The EU approach to waste management results in encouraging the treatment of biodegradable waste. The European Landfill Directive 2018/850 introduced targets for the reduction of biodegradable municipal waste going to landfills. One of the main advantages of biological treatment of biodegradable waste fractions is the production of compost. Compost is very important in agriculture when used to improve soil. There are several plants for the treatment of organic waste in N. Macedonia. Most of them are (small) composting or anaerobic digestion plants that are primarily intended for the degradation of agricultural waste and especially manure. Annual production of organic waste generated in the municipality of Ohrid is 5,300 tons, of which 4,300 tons are organic waste from municipal solid waste and 1,000 tons of organic waste from agriculture, as well as 57 tons of organic waste from dead animals and 2,9343 tons of waste from livestock. Although a large part of the waste generated in agriculture is used in various ways, a relatively large part is still deposited in inappropriate places, i.e. in illegal landfills or garbage dumps, or is burned. Waste from livestock farming mainly ends up as fertilizer on fields, while waste from dead animals ends up in illegal landfills or other inappropriate places.The selection of the most appropriate composting system depends on the requirements of the Municipality of Ohrid regarding the emission of unpleasant odors from the composting plant, its capacity and the available space or locations available for such a purpose. For the Municipality of Ohrid, it is recommended to choose the technology of composting in piles with forced ventilation. It is expected that this form will create the most optimal combination of cost effectiveness and process control. However, this requires a location not too close to urban areas, and ideally it would be combined with a landfill or industrial zone to prevent problems with the population as a result of unpleasant odors. However, the most recommended option is to determine the location of the composting plant in one of the abandoned industrial buildings on the territory of the Municipality of Ohrid. This will greatly reduce the costs of building the composting plant due to the existence of a complete utility and traffic infrastructure, necessary for such an installation. Also, this solution simplifies the procedures for obtaining the necessary construction and operating permits.

Keywords: biodegradable waste, municipality of Ohrid, EU regulatives

P4.16. Eco-Friendly Extraction Method for Recovering Bioactive Compounds from Plant-Based Waste

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Pea pod waste is a valuable agricultural by-product, rich in bioactive compounds such as phenols, chlorophylls and carotenoids, with potential applications in nutraceuticals and functional foods. Although this biomass is commonly discarded, it offers opportunities for sustainable utilization. The aim of this study was to optimize ultrasound-assisted extraction (UAE) to maximize the yield of these bioactives using environmentally friendly methods and support the development of sustainable bioproducts. Dried pea pods were subjected to UAE under various conditions, including different ethanol concentrations, extraction times and solvent-to-sample ratios. The optimization process used statistical models to determine the ideal parameters for efficient extraction. The optimized conditions resulted in significant recovery of total phenols, chlorophylls and carotenoids, demonstrating the effectiveness of UAE in the processing of agricultural waste. This research emphasizes the potential of UAE as an environmentally friendly and efficient method of extracting bioactive compounds from pea pod waste. By transforming an underutilized by-product into a source of valuable compounds, this approach promotes waste reduction and resource efficiency. These results emphasize the importance of integrating agricultural waste management into sustainable production systems to achieve both environmental and economic benefits.

Keywords: pea pods, ultrasound-assisted extraction, optimization

P4.17. Sustainable Valorization of Raspberry Pomace Using Biocompatible Ionic Liquids

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Raspberry belongs to a group of highly valued fruits, known as berries, which possesses unique flavor and significant nutritional and health benefits attributed to its rich content of bioactive compounds. Bioactives (polyphenols, flavonoids, anthocyanins, and ellagitannins) could exhibit anti inflammatory, antioxidant, and anti-diabetic properties. However, raspberries have a short shelf life and often are processed into juice, wine, jam, or syrup, resulting in substantial amounts of pomace, primarily composed of seeds and pulp, which are commonly discarded as agricultural waste. This study explores the potential of raspberry pomace as a sustainable source of bioactive compounds through the application of green extraction technique. Ionic liquids (hydrophilic: cholinium acetate, cholinium bitartrate, and cholinium ascorbate; and hydrophobic: cholinium decanoate and cholinium dodecanoate) were synthesized and employed as alternative, non-toxic solvents. Direct solid-phase extraction was conducted with the aid of ultrasonic waves. The total phenolic and anthocyanin content was determined spectrophotometrically, while ellagic acid was quantified using HPLC. The results indicate that ionic liquids provide an effective, eco-friendly approach for the valorization of raspberry pomace, highlighting their potential as alternative solvents in bioactive compound extraction. This study underscores the feasibility of utilizing agricultural by-products to obtain valuable bioactive compounds, contributing to sustainability and waste reduction in the berry processing industry.

Keywords: Raspberry pomace, ionic liquids, bioactive compounds, green extraction

P4.18. Transforming Dragon Fruit Peel into High-Value Bio-Based Food Packaging Solutions: A Cascade Biorefinery Approach for a Circular Bioeconomy

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The valorization of agrofood by-products offers an abundant and renewable source of valuable compounds for various industries, including food packaging. Addressing the packaging stage of the food supply chain is a key strategy to reduce food waste and losses. Dragon fruit, or red pitahaya, is a popular fruit in tropical and subtropical regions, with its processing generating significant amounts of by-products, primarily pitahaya peel (PP). PP is rich in high-value compounds such as betalains and carbohydrates such as pectins and cellulose. This study explores the efficient valorization of PP through a multi-product cascade biorefinery approach. The peel has been sequentially processed to obtain the betalain-rich extracts, pectins and cellulose nanofibers (CNF) with high yields (>70% total yield for the entire cascade process). Subsequently, these fractions have been applied in the formulation of active food packaging films. The pectin fraction was used as film polymeric matrix that was reinforced with CNF. The combination of these fractions resulted in an optimal mechanical reinforcement with 45%CNF and high thermal stability. The incorporation of betalain-rich extracts into the films imparted active functionalities, including improved wettability and enhanced UV light barrier properties, demonstrating the potential of PP-derived materials for advanced bio-based packaging solutions.

Keywords: agrofood waste, biomass valorization, dragon fruit, active food packaging

P4.19. Valorization of Potato Peel Waste for Biodegradable Food Packaging Materials Using Deep Eutectic Solvents

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Many packaging materials contain non-biodegradable, petroleum-derived polymers, which has prompted environmental concerns. Circular economy-based solutions are sought. Due to its high starch content, potato peel (PoP), the main waste of potato processing, is a viable biomass source for biodegradable products. To valorize PoP, this study will transform it into food packaging bioplastics. Potato peels are a sustainable and cost-effective source of biopolymers that avoid food resource rivalry and industrial bioplastic manufacturing expenses. In this investigation, a deep eutectic solvent (DES) made of glycerol and choline chloride was used to treat potato peel powder after it had undergone acidic hydrolysis. The plasticization effects of DES, its components (choline chloride and glycerol), and thermoplastic starch films as controls were thoroughly examined. The prepared materials' structural and morphological characteristics were investigated by FTIR and SEM. Besides their mechanical properties, their interaction with water, including moisture content (MC), water solubility (WS), and water vapor permeability (WVP), was studied. TGA and DSC thermochemical analyses revealed the material's performance and biodegradability potential. Preliminary studies show that DES improves the plasticization of potato peel powder, resulting in homogenous and flexible materials. These findings show that PoP-based bioplastics have the potential to be environmentally acceptable food packaging substitutes that lessen dependency on petroleumbased polymers and increase waste value.

Keywords: Potato peel, Deep eutectic solvents, Food-waste, Bioplastics

P4.20. Development of a Coffee Pulp Infusion as A Strategy for Recovery After Moderate Physical Exercise in a Healthy Population

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The coffee industry is among the sectors generating significant waste, with coffee pulp (CP) as the primary by-product discarded. Recently, the EFSA has classified CP as a novel food and a safe ingredient for the preparation of non-alcoholic beverages and infusions following EU regulations. In this context, it is imperative to evaluate the health-promoting qualities of CP in a human population to substantiate the potential benefits of this by-product concerning physical exercise, which induces oxidative stress and inflammation. This research seeks to revalorize CP by creating a functional beverage designed to facilitate muscle recovery following moderate physical exercise, using an intervention study. We have formulated a CP infusion with augmented antioxidant and anti-inflammatory characteristics. Furthermore, we are assessing the effects of this infusion on oxidative stress, inflammation, and muscle repair following physical exercise in a healthy, untrained cohort of both genders. This study will enhance the sustainability of the coffee agrifood chain by offering a solution for CP recycling through an infusion that benefits the sports sector, serving as a foundation for the future development of innovative sports beverages that improve existing options.

Keywords: Coffee pulp, Infusion, Exercise Recovery, Antioxidant properties, Anti-inflammatory properties

P4.21. Sustainable extraction of arabinose- and xylose- based oligosaccharides from beetroot by-products through innovative non-thermal technologies

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Agro-industrial by-products, such as beetroot by-products, hold significant potential for sustainable valorisation under circular economy principles. This study provides preliminary results suggesting that, among the different beetroot by-products, the peel is a notable source of arabinose- and xylose-based oligosaccharides as determined by Gas Chromatography with Flame Ionization Detection. These compounds have the potential to serve as next-generation prebiotics with health benefits. This study compares the recovery of these oligosaccharides from the peel using conventional solid-liquid extraction and innovative non-thermal techniques, such as ultrasound-assisted extraction (UAE) and non-thermal atmospheric plasma (NTAP). Using water as a solvent, response surface methodology (RSM) with a central composite design (CCD) was applied to optimise key extraction parameters, including time, power, amplitude, and temperature, for maximising extraction yield. The content of arabinose- and xylose-based oligosaccharides in the extracts was quantified using enzymatic assay kits. Non-thermal methods demonstrated advantages such as reduced energy consumption, shorter processing times, and avoidance of hazardous solvents. The findings highlight their potential for sustainable bioactive compound recovery, with applications in the food, cosmetic, and pharmaceutical sectors. This research advances sustainable practices, enhances the value of beetroot by-products, and contributes to agricultural sustainability by supporting environmentally friendly and efficient processing methods.

Keywords: Food by-products, Sustainable extraction techniques, Ultrasound-Assisted Extraction, Non-Thermal Atmospheric Plasma, Arabinose and xylose

P4.22. Eco-sustainable Valorization of the Coffee Pulp through the Zero-Waste Strategy

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Food waste is one of the most challenging problems we currently handle worldwide. However, biorefinery and green extractions can valorize it into high-value-added products, leading to a more sustainable food system and zero waste generation. In this context, biorefinery emerges as a suitable strategy to reuse the large amount of coffee pulp produced by coffee agro-industry, resulting in 1 ton of coffee pulp per 2 tons of commercial green coffee production. This work, focused on exploring the applicability of ethanol-modified supercritical carbon dioxide, revealing that this extraction technology has considerable potential for obtaining ingredients with antioxidant, anti-inflammatory, and anticholinergic bioactivities after digestion by biochemical and cellular culturing experimentation. Furthermore, aligning with the principles of circular bioeconomy and following a zero-waste approach, the coffee pulp extraction residue was studied as a potentially useful material for food packaging due to its relevant content of dietary fiber. Promising results regarding physicochemical and techno-functional properties of the residue as well as the suitability of its derived films were obtained. Undoubtedly, this work provides a sustainable zero-waste strategy for the global challenges of the coffee agroindustry related to its waste production, the development of functional ingredients with neuromodulatory properties, and the design of packaging materials.

Keywords: Coffee pulp, supercritical fluids, anti-inflammatory, neuromodulation, packaging.

P4.23. Sustainable Extraction of Truffle Bioactive Compounds Using PEF and ASE for Circular Bio-Economy Applications

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This study explores the sustainable extraction of bioactive compounds from truffles using pulsed electric fields (PEF) and accelerated solvent extraction (ASE). The aim was to assess the impact of these two green approaches on total phenolic content, antioxidant capacity and bioactivity in Caco-2 cell model, while promoting food waste valorization. PEF was applied under four conditions: a) 3 kV/cm and 100 kJ/kg; b) 2 kV/cm and 100 kJ/kg; c) 3 kV/cm and 200 kJ/kg; d) 2 kV/cm and 200 kJ/kg, alongside control maceration method. ASE was performed at two temperatures: 40°C and 120°C. TPC was measured via the Folin-Ciocalteu method, and antioxidant capacity was evaluated using TEAC and ORAC assays. MTT assays and ROS measurements were conducted in Caco-2 cells to evaluate cell viability and oxidative stress. Extraction yield and bioactivity variated with the method and conditions. PEF at 3 kV/cm with 200 kJ/kg significantly increased TPC and antioxidant capacity, while as ASE is concerned, the enhancement was noted at 120°C. Extracts obtained under these optimized conditions were further explored in Caco-2 cell model, revealing their promising cytoprotective effect. These findings underscore potential of truffle residues as a source of bioactive compounds, supporting their valorization within a circular bio-economy framework.

Keywords: truffle, pulsed electric field (PEF), accelerated solvent extraction (ASE), antioxidant capacity, cell viability

P4.24. CoffeeMinds: Integrating Data Science in the Sustainable Valorization of Coffee By-Products as Neuromodulatory Ingredients

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Promoting cognitive health is a global issue as societies seek new and long-term solutions to improve mental health. Coffee by-products, such as coffee pulp, parchment, silverskin, and spent coffee grounds, are abundant but underutilized resources containing bioactive compounds with potential neuromodulatory properties. The *CoffeeMinds* project combines data science and artificial intelligence to sustainably valorize these food wastes, transforming them into functional ingredients that support and enhance cognitive health. The project integrates advanced statistical tools, including response surface optimization and machine learning, to fine-tune green extraction methods such as heat-, microwave-, and ultrasound-assisted technologies. These processes will grant the efficient recovery of caffeine, phenolics, and other bioactives while minimizing environmental impact. Predictive modeling allows for precise identification of extraction conditions and compounds most associated with neuromodulatory activities, reducing experimental workload, and enhancing process sustainability. The main objectives include *i*) obtaining and chemically characterizing bioactive-enriched extracts, *ii*) optimizing extraction protocols through response surface methodology and artificial intelligence, *iii*) generating predictive models to assess biological activity, and *iv*) experimentally validating the neuroprotective effects of the extracts. By integrating sustainable extraction technologies with artificial intelligence, *CoffeeMinds* will provide a circular economy approach to valorize agro-industrial residues, contributing to the development of innovative health-promoting ingredients and nutraceuticals.

Keywords: Coffee by-products, artificial intelligence, green extraction, bioactive compounds, cognitive health.

P4.25. Ultrasound-Assisted Extraction of Phenolic Compounds from Sunflower Seed Shells Using Natural Deep Eutectic Solvents

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Many industrial byproducts are rich in valuable bioactive compounds, especially phenolics, which offer potential applications in the food, cosmetic, and pharmaceutical sectors. Traditional organic solvents for extracting phenolic compounds have significant limitations, including toxicity, flammability, and environmental impact. Natural deep eutectic solvents (NADES) have emerged as a promising eco-friendly alternative, demonstrating high efficiency in extracting phenolics. NADES are composed of a mixture of hydrogen bond donors and acceptors, where choline chloride is frequently used as a donor, and compounds like lactic acid, glycerol, glucose, citric acid, and malic acid serve as acceptors. Various extraction techniques, including NADES as solvents, are effective in recovering phenolics from agricultural waste. In this context, non-traditional methods like ultrasound assisted extraction are particularly recommended. To maximize health benefits, it is crucial that phenolic-rich extracts are bioaccessible. In vitro digestion models, which simulate gastrointestinal conditions, offer an efficient, ethical approach for evaluating the extent to which phenolic compounds reach the small intestine for absorption. According to recent FAO data, global sunflower seed production reaches around 54 million tons annually, with Türkiye among the largest producers worldwide, alongside Russia, Ukraine, Argentina, and China. Sunflower seeds are a popular snack in Türkiye, and with their shells accounting for up to 50% of the seed, large quantities of shell waste are generated yearly. This study aims to investigate ultrasound-assisted extraction of phenolic compounds from sunflower seed shell waste using 12 different NADES formulations. The phenolic extracts obtained through this green extraction technique are subjected to an *in vitro* digestion model, and their bioaccessibility is assessed via LC-MS/MS analysis.

Keywords: sunflower seed shell waste, green extraction, in vitro digestion, phenolics

P4.26. Enhancing the Extraction of Phenolic Compounds from Spent Coffee Grounds Using Cold Atmospheric Plasma

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Cold atmospheric plasma (CAP), an ionised, near-room temperature gas and recognised as the 4th state of matter, presents a novel approach to waste valorisation. This study explored CAP as a pretreatment method to enhance the extraction of phenolic compounds from spent coffee grounds (SCGs). The investigation focused on how different CAP treatment parameters (SCGs layer thickness, distance from the plasma source, duration of the treatment) affects the yield of total phenols, antioxidant activity and the levels of caffeine and chlorogenic acid in SCGs.

Utilising response surface methodology for optimisation, the study identified optimal conditions for CAP treatment: a layer thickness of 1 mm, a distance of 16 mm and a treatment duration of 15 minutes. Under these conditions, CAP treatment significantly improved in the recovery of bioactive compounds compared to untreated SCGs, with statistically significant increases in total phenolic content and antioxidant activity (A_{DPPH}, A_{ABTS}, and A_{CUPRAC}). A significant increase in caffeine content from 799.1±65.1 to 1064±25 mg/100 g dry SCGs and chlorogenic acid content from 79.7±15.3 to 111.3±3.3 mg/100 g dry SCGs, was also observed.

CAP offers a low-energy, sustainable and residue-free method, making it an environmentally favourable option for enhancing the recovery of valuable compounds from SCGs.

Keywords: Spent coffee grounds, Caffeine, Chlorogenic acid, Total phenolic content, Cold atmospheric plasma

P4.27. Maximizing Onion Peels Value: Strategies for a Circular Bioeconomy

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The purpose of this study is to highlight the important progress that has been made in identifying onion by-products as valuable sources of bioactive compounds, the methods that have been employed to extract these bioactives, the potential health benefits of onion by-products, and the investigation of their various potential applications from the standpoint of the circular bioeconomy.

To get food ingredients for this investigation, red and yellow onion skin extract was used. The flavonoids-rich aqueous extract was used to dissolve complex biopolymeric matrices. The powders' microstructure, color, antioxidant activity, phytochemical content, and encapsulation efficiency (EE) were all evaluated. Stability in storage and simulated digestion were also evaluated. Powders functionality was shown by adding it to different food such as salad dressing, ricotta cheese, crackers etc. The concentration of physiologically active substances and antioxidant activity have increased since powder was added.

Keywords: red and white onion skins, encapsulation, circular bioeconomy, encapsulation

P4.28. Magnetically Modified Biological Materials for Dye Removal

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Various types of biological materials including agriculture and food waste and byproducts can be used as biosorbents for organic dye removal from contaminated waters. Magnetic modification of biosorbents enables to prepare smart materials exhibiting response to external magnetic field. Due to the presence of magnetic particles on or within the modified biosorbents, they can be rapidly, easily, and selectively separated from desired environments by means of permanent magnets or magnetic separators. In addition, magnetic iron oxide (nano)particles exhibit peroxidase-like activity, which can be employed for enzyme-like degradation of various organic pollutants including organic dyes. Magnetically responsive biomaterials thus represent very interesting, progressive, and easily obtainable biosorbents/catalysts for potential environmental technology applications.

Keywords: biosorbents; magnetic modification; iron oxides; peroxidase-like activity; organic dyes

P4.29. Sustainable Valorization of Fruits By-Products Towards the Development of Nutraceuticals and Functional Foods

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The consumption of fruits, either fresh or in processed form, has been associated with various health-promoting effects. However; fruit production and processing sectors generate enormous amounts of by-products and wastes that have a negative environmental impact (e.g. water and soil pollution, eutrophication) and result in significant economic losses. Till now, fruit wastes are underutilized as animal feed. However, this biomass, which contains a great variety of bioactive compounds (e.g. polyphenols, flavonoids, dietary fibers, sugars, pigments etc.), can be valorized in the frame of "circular economy", to create products of high-added market value. Prerequisites in order to achieve this goal, is the drying of the fruits and the extraction of these valuable ingredients using novel and "green" approaches (e.g. ultrasound- or microwave-assisted extraction) in combination with alternative environmental friendly solvents, such as aqueous solutions of β-cyclodextrin. In the present work, the potential valorization of by-products and wastes (i.e. pulp, peels, seeds) derived from the processing of pomegranates, apples and cherries towards the development of nutraceuticals, functional foods and food supplements, are presented and critically discussed.

Keywords: circular economy, unltrasound extraction, microwave-assisted extraction

P4.30. Multipurpose valorisation possibilities of apple pomace: an application in functional bakery products.

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Aim of our work is to find possibilities for the valorisation of edible but typically unconsumed food industrial by-products. Among the utilization options, we prefer those that retain these resources within the agri-food sector and preserve the valuable constituents instead of using them in landfills or for energy production, which forms of utilization result in the degradation of the valuable constituents that are already created. In our first case study, we focus on valorisation of apple pomace with a multipurpose approach. i.e., application in upcycled foods, for feeding or as soil amendment. Here we present an application in functional bakery products. According to the WHO, diabetes is amongst the top ten leading causes of mortality globally, however dietary factors are of paramount importance in prevention of type 2 diabetes. The aim is to develop functional bakery products, in which apple pomace is valorised as an ingredient with the aim to improve the glycaemic properties of the products. Apple pomace is one of the most significant by-products of the food industry in Europe, thus its upcycling as a functional food ingredient can also greatly serve the purposes of creating a sustainable and circular food system.

Keywords: apple pomace, upcycling, functional food, bakery, glycaemic response

P4.31. Effects of frass in growth and weed occurrence in oregano (*Oreganum hireochealium* L.)

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The use of insect frass has been increasingly recognized for various agricultural crops in different countries. This study focused on quantifying the impacts of applying frass to organic oregano in open field conditions. The experiment was designed using a randomized block design with four replications, and the elementary plot size was 15 m². The experiment included eight treatments: A: Frass 1 t/ha before planting; B: Frass 4 t/ha; C: frass 3 t/ha; D: 2 t/ha: E: NPK 15:15:15 (300 kg/ha) + NAG-27% (200 kg/ha); F: NPK 15:15:15 (300 kg/ha) before planting; G: Control (without fertilizers or frass). The results showed that the highest average fresh biomass of oregano after two harvest periods was achieved with the frass 4 t/ha, while the lowest biomass was observed in the control plot. The highest average plant height was also recorded where frass was applied in combination with NPK 15:15:15 (300 kg/ha) + NAG-27% (200 kg/ha) and frass 4 t/ha. The dominant weed species in the study were *Kickxia elatine* (L.) Dumort., *Cirsium arvense* (L.) Scop., *Echinochloa crus-galli* L. and *Convolvulus arvensis* L. Based on the results regarding fresh biomass and average height of oregano, it is evident that higher doses of frass, have a significant positive effect on both fresh biomass and plant height. Therefore, the use of frass could serve as a valuable alternative for the future cultivation of medicinal aromatic plants.

Keywords: Circular bio-economy, fertilizers, food waste

P4.32. Food Waste as a Result of Food Product Marking: A Kosovo Perspective

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This study explores the impact of food labeling on food waste in Kosovo. It highlights the confusion among consumers regarding expiration labels like "Best Before" and "Use By" leading to unnecessary waste. Conducted with 337 households, the study finds that many Kosovars misinterpret these dates, associating them with food safety rather than quality. This misinterpretation, coupled with insufficient public understanding, drives significant food waste. Approximately 49% of participants indicated that they sometimes discard food that is still safe, believing it to be inedible due to expired dates. The study suggests that standardized, clearer labels, along with public education on expiration dates, could mitigate food waste. Additionally, the research emphasizes the importance of policies that align with European Union standards to promote sustainability. Key demographic factors such as education level and age influence consumers' understanding of labels and food waste behaviors, underscoring the need for targeted educational initiatives.

Keywords: Kosovo, food waste, expiration labels, consumer education, sustainability

P4.33. Argan Proteins in Press Cakes for Food Applications

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The argan tree [*Argania spinosa* (L.) Skeels] is one of the most important floristic resources in Morocco very known for its several therapeutical and medicinal uses. Argan oil production generates a large quantity of by-products as press-cake traditionally used by the local population for some medicinal, cosmetic and feeding livestock uses. The press-cake could be used as an alternative to animal proteins in plant-based food and dairy products. This study aimed to extract and identify proteins in argan press cake and evaluate their functionality.

Our results showed albumins (42%) and globulins (51%) as major proteins in argan press cake of total extractable proteins. The foam capacity and foam stability of globulins were higher than albumins under moderate homogenization conditions. The test of emulsification with Rotational Shear Homogenization, showed the same droplet sizes (16 µm) for both proteins to produce emulsions. However, High-Pressure Homogenization led to increased droplet sizes for globulins, which may limit their use in systems requiring strong homogenization.

This study concludes the potential of the argan by-product as a protein source. As continuation of this research, we will conduct a thorough examination of the amino acids and the incorporation of the proteins into food matrices.

Keywords: Argan Press-cake, proteins, albumins, globulins, functionality

P4.34. Creating Minimum Viable Products Using Biowaste Transformation Methods

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Waste generated during the processing and consumption of food is a global problem that negatively affects the environment, social status, and the economy. For sustainable development, it is essential to manage biowaste from the circular economy point of view. The application of the biorefinery concept is significant, considering that products with high added value, such as biochemicals and biofuels, can be obtained from the biowaste. Depending on the chemical composition and characteristics of the substances, biowaste can be valorized by the application of conventional and eco-friendly technologies for the extraction of biologically active substances, as well as thermochemical and biochemical conversion methods to produce biofuels and energy. The obtained bioproducts are used in the food and pharmaceutical industry, cosmetics, synthesis processes, and the treatment of wastewater from various sectors.

This work involves the preparation and delivery of a methodological framework for research on how biowaste coming from 30 pre-selected SMEs and companies can be transformed into new Minimum Viable Products (MVP). The MVPs were developed as prototypes using the equipment at the Biohacking Lab in Skopje, with significant cross-collaboration and research with representatives of each of the pre-selected companies. The developed prototypes were characterized by the determination of the chemical composition, textural characteristics, color attributes, total number of bacteria and yeasts, as well as sensory characteristics.

The research and development of new valuable products is the first and most important step for the implementation of all technological stages and operations for the transformation of the biowaste to a semi-final product and a final product.

Keywords: biowaste, valorization, high value-added products, prototype

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P4.35. Consumer Willingness to Pay for Bio-Waste Products: The Case of Hazelnut Chips

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This study explores consumer willingness to pay (WTP) for hazelnut chips produced from agricultural by-products. Using an experimental auction, we focus on three treatments employing different auction mechanisms: a hypothetical second-price auction (SPA), an incentivized SPA, and a combination of an incentivized first-price auction followed by an incentivized SPA in order to study cross game learning. Each treatment includes two bidding rounds with a tasting phase in the second round to assess consumer preferences under varying conditions. This design allows for a robust analysis of consumer behavior, offering insights into the effectiveness of different auction types and has significant methodological implications. The findings will guide stakeholders in the agrifood sector on market potential and pricing strategies for bio-waste products.

Keywords: Willingness to pay, bio-waste products, hazelnut chips, experimental auctions, SPA, FPA

P4.36. Brewers' Spent Grains Upcycling in Foodstuffs

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The beer market is still growing globally, and new trends address the increasing preferences for new beer assortments with more attributes of health or sustainability. Also, new market niches have opened for non-conventional beers obtained using adjuncts or unusual ingredients or relying on various innovative brewing techniques. Large quantities of valuable by-products, such as brewers' spent grains (BSGs), are discharged from breweries, and they could be upcycled to void waste and higher-value their nutrients in new food products. BSGs composition varies relative to barley variety, adjuncts or other added ingredients, malting and brewing parameters, and preserving conditions applied after lautering; this is why there are several opportunities to use BSGs as an alternative feedstock for food manufacturing. This work reviewed how scientists and technologists have succeeded in sustainably valorizing BSGs in new food products according to specific conditions. A qualitative research methodology was used, and a case study about the valorization of non-conventional BSGs in bakery and other farinaceous products was discussed. Our findings reveal that promising advancements for the sustainable use of non-conventional BSGs were made to manage the by-product stream in food processing adequately.

Keywords: brewers' spent grains, upcycling, food, by-product

P4.37. Agro-Food Waste as a Source of Polysaccharides: Tailored Extraction and Structural Characterization

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Agro-Food waste represents a significant reservoir of polysaccharides with various potential applications. However, their isolation and comprehensive analysis are essential. Developing tailored extraction techniques for specific polysaccharides is crucial. Eco-friendly methods such as microwave extraction, ultrasound, and the use of green solvents have gained popularity due to their sustainable nature. Together with sophisticated structural analysis techniques including FTIR, HPLC, HPAEC-PAD, GC-MS, and NMR, provide deeper insights into the complex structures of these polysaccharides. For example, research on hazelnut skins, a by-product of the roasting process, revealed surprisingly the presence of pectic polysaccharides. Detailed structural characterization confirmed that the roasting process induces significant modifications in the structure of this pectin. Similarly, spent coffee grounds, a common household waste, were investigated using microwave extraction to isolate low-molecular-weight polysaccharides. The structural analysis showed that this green extraction technique effectively isolated low-branched galactomannan and arabinogalactan without damaging the glucuronic acid in the arabinogalactan chain. These findings underscore the potential of agro-food waste as a rich source of unique polysaccharides with promising applications in biotechnology and pharmaceuticals.

Keywords: polysaccharides, extraction, structural characterization

P4.38. Rice Straw as a Circular Economy Opportunity for a Better Future

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Rice straw, a significant agricultural byproduct, poses significant environmental risks when improperly managed. Traditional burning practices release harmful pollutants, offering no societal or economic benefits. However, this byproduct presents a prime opportunity for circular economy solutions that yield both economic and environmental advantages for all stakeholders. Our project initiated at the source, engaging farmers in rice straw collection to secure a reliable supply, irrespective of climatic conditions. Subsequently, a sequential extraction process was employed to isolate valuable natural compounds, primarily polyphenols and cellulose, with potential applications in the footwear and cosmetic industries. The remaining post-extraction residues were integrated into construction materials, resulting in enhanced insulation properties and a zero-waste approach. This comprehensive process offers a viable and economically feasible alternative to conventional rice straw management. It underscores the transformative potential of circular economy principles in fostering sustainable business models.

Keywords: rice straw, circular economy, cellulose, phenolic acids, biomaterials.

P4.39. (Poly)phenols and Dietary Fiber in Coffee Husk: Macromolecular Interaction and Bioactivity

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Coffee by-products, such as coffee husk, offer valuable nutritional potential due to their high dietary fiber and (poly)phenolic content. This study examined coffee husk flour and water-insoluble residues (WIRs) from dry (CC) and wet (PC) processing methods, focusing on the macromolecular interactions between (poly)phenols and dietary fiber. Both CC and PC husks presented significant levels of dietary fiber, with soluble fiber primarily consisting of rhamnogalacturonan I (RG-I) and homogalacturonan (HG), and insoluble fiber rich in lignin, cellulose, and other β-glucans. Free (poly)phenols included chlorogenic, protocatechuic, and gallic acids, while bound (poly)phenols were rich in caffeic and ferulic acids. Notably, PC flour exhibited enhanced antioxidant capacity, particularly in ROS scavenging assays using IEC-6 and HepG2 cells under t-BHP-induced oxidative stress, supporting potential oxidative stress reduction benefits. Coffee husk by-products also demonstrated hypoglycemic properties by inhibiting α-amylase (62–96%) and reducing starch hydrolysis (52–97%) and hypolipidemic effects through pancreatic lipase inhibition (54–65%) and a decrease in cholesterol and bile salt absorption (50–88% and 81–90%, respectively). These results highlight coffee husk as a promising sustainable ingredient, where fiber-polyphenol interactions may enhance bioactivity in the digestive tract, positioning coffee husk as a functional food ingredient in health-focused and eco-friendly food applications.

Keywords: coffee by-products; metabolic health; (poly)phenols; polysaccharides; valorization

P4.40. Sustainable Active Packaging from Pomegranate: Development and Application of PCL Films for Apple Preservation

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Recently, in the food industry, there has been a growing demand for active and biodegradable packaging to substitute conventional packaging and extend the packaged product's life cycle. Nowadays, the use of natural additives extracted from agri-food waste is being researched so that high-added-value products are obtained, and the circular economy is being favored. PCL films were developed via casting using blends of pomegranate peel and juice, selected for their proximity and high polyphenol content, to create sustainable packaging materials. Two blends were tested: 60% peel and 40% juice (Blend A) and 40% peel and 60% juice (Blend B), at concentrations of 10%, 15%, and 20% (w/w). The films showed no significant changes in structure or thermal properties, but SEM analysis revealed more uniform surfaces. Films with 20% of Blend A demonstrated the highest polyphenol migration, extending the shelf life of Golden apples by up to two days while maintaining better color despite absorbing water from the fruit. These results highlight the potential of agro-food waste utilization to develop sustainable materials, promoting circular economy practices. The formulation with 20% Blend A (12% peel, 8% juice) proved the most effective for food protection, with future studies planned to evaluate microbiological and other foodrelated parameters.

Keywords: bioactive packaging, pomegranate, valorization, shelf-life

P4.41. Liquid Waste Streams from the Food Industry Treated Through Non Thermal Atmospheric Plasma as a Novel Product to Foster Seed Germination

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Reducing food waste is a global challenge with significant social, economic and environmental impacts. Around one-third of all food produced, including half of fruits and vegetables, is wasted. Nutrient-rich by-products from food processing offer great potential for valorisation, supporting circular economy principles. While traditional nitrogen fixation processes like the Haber-Bosch method are energy-intensive and carbon-emitting, advances in non-thermal atmospheric plasma (NTAP) technology offer an eco-friendly alternative. This study evaluates the potential of NTAP to convert liquid food processing by-products from beetroot and potato industries into high-value seed germination enhancers. Comprehensive physicochemical and nutritional characterization was conducted to assess the suitability of these waste streams for valorisation. NTAP treatments using a catalyst reactor significantly increased nitrogenous compounds, with potato waste streams showing a 59-fold increase in nitrites and a 10-fold increase in nitrates, while beetroot waste streams showed a 29-fold increase in nitrites. These nitrogen-enriched waste streams enhanced seed germination, highlighting their potential as fertilizers or soil improvers. The findings demonstrate that NTAP can sustainably enhance the fertilizing properties of food processing by-products, offering an energy-efficient approach to food waste management while promoting agricultural productivity.

Keywords: Food by-products, Non-Thermal Atmospheric Plasma, Valorisation, Germination enhancers

P4.42. Transforming Food Processing Byproducts into Sustainable Bioplastics and their Properties

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Food processing byproducts, often regarded as waste, represent a largely untapped resource rich in natural polymers with significant potential for value-added applications in bioplastics and biocomposites. In the context of a circular bio-economy, leveraging these byproducts can address critical challenges such as reducing food waste, mitigating environmental impact, and promoting sustainable materials development. This study presents innovative hydrolytic and thermomechanical methods to transform diverse fruit and vegetable residues—including carrot pomace, orange peel, lemon peel, spinach stems, and parsley stems—into biocomposites using small amounts of water and avoiding chemical-intensive processes.

We systematically explore the influence of key processing variables, including temperature, duration, and reagent concentration, to optimize the structural and functional properties of the resulting bioplastics. Comprehensive characterization of these materials was conducted, focusing on their mechanical strength, barrier properties, optical characteristics, antioxidant activity, and water interaction behavior (e.g., moisture content, solubility, and absorption).

This research demonstrates the feasibility of converting agrofood waste into sustainable bioplastics and also underscores their potential to replace synthetic plastics in specific applications. By advancing the valorization of food waste, this work contributes to the development of innovative solutions aligned with the goals of zero-waste production, a circular economy, and sustainable resource management.

Keywords: Food waste valorization; Bioplastics; Circular bio-economy; Agrofood byproducts; Sustainable materials development

P4.43. Bioprospecting Microbial Diversity in Avocado Crop Compartments Using Amplicon and Shotgun Sequencing for Lignocellulosic Biomass Valorisation

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The valorisation of lignocellulosic biomass, such as agricultural residues, is essential for advancing sustainable biotechnological applications. Beyond its chemical components (cellulose, hemicellulose and lignin), lignocellulosic biomass holds diverse microbial communities with potential for valorisation in producing enzymes, organic acids and other bioproducts. The aim of this study was to explore the microbial diversity associated with avocado (*Persea americana*) pruning waste and identify lignocellulose-degrading microorganisms for potential bioconversion applications. Selective microbiological analyses were conducted to isolate lignocellulose-degrading microorganisms from three compartments: tree leaves (LeafT), soil leaf (LeafS) and soil. Isolates exhibiting lignocellulolytic activity were screened and identified using molecular phenotyping. Amplicon sequencing of the 16S rRNA and 26S rRNA genes were used to characterize bacterial and fungal communities, while shotgun metagenomic sequencing was conducted to assess functional gene content focusing in particularly on carbohydrate-active enzymes (CAZymes). LeafS exhibited the highest richness and diversity of lignocellulose-degrading microorganism. Key bacterial genera were identified included *Streptomyces* and *Chloroflexi*, alongside members of the *Sphingomonadaceae* family and fungal genera such as *Aspergillus*, *Alternaria*, and *Cladosporium* were more abundant in LeafS and exhibited strong lignocellulolytic activity. Functional metagenomic analysis revealed a higher abundance of CAZyme genes in LeafS, particularly glycoside hydrolases and auxiliary activities essential for breaking down cellulose, hemicellulose, and lignin. These results highlight LeafS as a promising source for lignocellulose-degrading microorganisms and functional genes with potential in solid-state fermentation (SSF) for producing high-value bioproducts and hydrolytic enzymes for industrial purposes.

Keywords: Lignocellulose-degrading microorganisms, lignocellulosic biomass valorization, Avocado pruning waste, Microbial diversity, CAZyme

P4.44. Advancing Food By-Product Valorization: Membrane Technologies for Sustainable Protein Recovery

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Membrane technology plays a crucial role in food by-product valorization, especially in protein recovery. Initially applied to whey protein extraction from cheese production, it enabled the concentration and purification of whey, leading to the production of protein concentrates and isolates. This success was extended to other animal proteins like blood plasma, fish proteins, and albumen. With a growing shift toward sustainable, plant-based proteins, membrane processes are increasingly important. Industrial-scale recovery of wheat and sunflower proteins has been achieved, while rapeseed protein recovery from oil production by-products is still in development. Recent research focused on optimizing membrane processes for rapeseed protein extraction from press cake in Southern Sweden. Microfiltration was used to remove fine particles, fat, and microbes, followed by ultrafiltration for protein concentration and purification. Additionally, membrane fouling and cleaning was studied using X-ray tomography. This work highlights the potential of membrane technology for valorizing both animal and plant based food by-products, demonstrating its role in enhancing protein recovery and sustainability in the food industry.

Keywords: Food By-Product Valorization, Membrane Technology, and Protein Recovery

P4.45. Microalgae Cultivation Using Enzymatically Hydrolyzed Stale Bread: A Sustainable Biorefinery Approach for Circular Bioeconomy

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This study explores the potential of microalgae, particularly *Spirulina platensis (Arthrospira platensis*) and *Chlorella sorokiniana*, in single-cell protein (SCP) production using enzymatically hydrolyzed stale bread as a nutrient medium. Recognized as GRAS (Generally Recognized as Safe) by the FDA, these microalgae are rich in protein and essential nutrients, offering a sustainable alternative for human and animal nutrition. Utilizing stale bread as "waste", rich in carbon and nitrogen, aligns with waste management and food waste valorization objectives, transforming discarded bread into a valuable resource. Stale bread was hydrolyzed with amylolytic and proteolytic enzymes to create nutrient media (containing 25%, 50%, 75%, and 100% bread hydrolysate) for microalgal cultivation. While protein enhancement in algae was not statistically significant, lipid content increased by 25% in *Arthrospira platensis* and 50% in *Chlorella sorokiniana*, with Spirulina biomass showing a notable rise in unsaturated fatty acids and DHA. These findings validate a bio-refinery approach, producing diverse high-value compounds alongside SCP and supporting circular bioeconomy principles. This strategy addresses both sustainability and cost-efficiency, contributing to waste reduction while generating valuable bio-based products in multi-product value chains.

Keywords: waste management, valorization, bread, microalgae

P4.46. From Valorization to Zero-Waste: Advancing Circular Bio-Economy in Agri-Food Systems

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The valorization of agricultural by-products, such as sugar beet leaves and olive pomace, offers sustainable solutions for waste reduction and functional food innovation within the circular bio-economy. This study explores the production of Rubisco protein from sugar beet leaves, a by-product of sugar production, and olive powder from olive pomace, focusing on their economic and environmental impacts alongside proposed improvements for sustainability.

Rubisco transforms agricultural waste into a high-value protein source for food applications, while olive powder retains critical nutrients like antioxidants and fibers. Life Cycle Costing (LCC) and Life Cycle Assessment (LCA) sustainability analysis highlights economic trade-offs: Rubisco production involves higher energy demands and operational complexities, whereas olive powder production benefits from low-cost raw materials and straightforward processes. Key improvement points include optimizing the energy-intensive steps of Rubisco extraction, such as drying, through the adoption of more efficient technologies. For olive powder, reducing transport-related emissions and exploring local sourcing strategies are recommended.

These findings demonstrate the potential of upcycled by-products like Rubisco and olive powder to integrate waste valorization into food systems, contributing to economic prosperity and environmental protection. Furthermore, zero-waste strategies that eliminate waste entirely, rather than solely valorizing it, should also be benchmarked as a transformative approach to advancing circular bio-economy practices and achieving truly sustainable agri-food systems.

Keywords: Waste valorization, Sugar beet leaves, Olive powder, Circular bio-economy, Sustainability benchmarking

P4.47. Edible Films and Coatings: Enhancing Food Preservation and Waste Valorization through Bioactive Compounds Encapsulation

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Edible films and coatings provide an alternative, sustainable packaging solution for food products. These films can be enhanced with bioactive compounds such as vitamins, minerals, antioxidants, and probiotics, which not only extend the shelf life of food but also serve as carriers for these functional molecules. Edible coatings, play a critical role in prolonging the shelf life of fruits and vegetables by protecting them from spoilage and deterioration. Additionally, extracting bioactive compounds from food waste and encapsulating these components is a crucial method for enhancing their bioavailability, while also converting them into economically valuable and sustainable products. This study summarizes various approaches for developing edible films and coatings, along with methods for extracting bioactive compounds from food waste. It evaluates the extraction and encapsulation of these bioactive components to assess their potential in enhancing functionality and stability as food products.

Keywords: edible films, coatings, value-added products, encapsulation, shelf-life

P4.48. A Policy Coherence Analysis of the Food Use and Waste Hierarchy

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The recently updated food use and waste hierarchy ranks different options for the management of surplus food, food processing by-products and food waste according to their perceived sustainability and added value, cascading downwards through four levels of prevention (avoidance of surplus food generation, redistribution to people, feeding to animals, transformation into added-value products for food and non-food purposes) and three levels of waste treatment (recycling and nutrient recovery, energy recovery, disposal in landfill). Waste valorisation industries are emerging as a key component of the circular bioeconomy, and balancing the demands for biomass of different industries will require cooperation between several policy domains and a collective effort to mitigate the impact of trade-offs across different policy goals. For example, while there are synergies between the recovered fertiliser industry and the bioenergy sector through the valorisation of anaerobic digestate, there is the potential for competition for resources with other sectors, such as animal feed, biomaterials, and pharmaceuticals. This paper presents an analysis of the coherence between the food use and waste hierarchy and other EU policy domains and goals to identify synergies, conflicts and trade-offs, and suggests that outdated definitions of waste, food waste, and by-product are obstructing circular bioeconomy objectives.

Keywords: waste hierarchy, policy coherence, valorisation

P4.49. Thermoformed Fiber-Polyethylene Biocomposites: Sustainable Packaging Solutions for Cherry Tomatoes

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This study explores the development of bio-based materials as sustainable alternatives for food packaging, driven by the need to comply with new regulations. The research focuses on producing trays using agricultural residues, finding that cost-effective methods like thermoforming can be used for fiber concentrations up to 30%, while higher concentrations require more advanced technologies like injection molding. All tested formulations exhibited strong antibacterial properties, with the BioPE-APF20% sample showing the best results. Additionally, the materials demonstrated water absorption capacity, peaking around day 4. Although the packaging materials were not biodegradable, a significant reduction in weight occurred at fiber concentrations above 10%, confirmed through visual and FTIR analyses after soil burial. Migration studies showed that most materials complied with EU regulations, although BioPE-APF30% and BioPE-APF40% samples exhibited excessive migration in acidic environments, suggesting a need for lining when used with acidic foods. Practical applications showed that BioPE-APF20% trays outperformed traditional HDPE trays in preserving the shelf life of cherry tomatoes, which could reduce food waste by extending the commercial availability of fresh products.

Keywords: Biocomposites, Thermoforming, Sustainable Packaging

P4.50. Closed-cycle bioactive substance farm model – sea buckthorn farm case study

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The aim of the research was to create a closed-cycle model of processing sea buckthorn harvest (berries, leaves, seeds and twigs) into sea buckthorn bioconcentrates for humans and the earth in a technological farm, avoiding the loss of biologically valuable substances. One of the main goals were to create a profile of health-friendly, economically useful pharmaceutical-grade and health-friendly food (nutraceuticals) biological substances derived using low-impact biotechnological processes for processing sea buckthorn secondary raw materials. The main physicochemical markers of bioactive substances have been identified as a basis for data digitization and selection of biotechnology regimes. Also, sustainable biotechnology models have been created, validating the energy (heating and cooling processes) life cycle methodology. Safe functional, health-friendly sea buckthorn bioconcentrates have been created in packaging models and a methodology for managing risk factors in processes has been developed. The collected research data and results will be used to prepare national recommendations for small businesses and farms operating in the berry processing sector, on reducing food waste and losses of biological materials, by applying a closed-cycle technology model. During the research, various modes of aqueous, ethanolic, and oil extraction of secondary raw materials from the sea buckthorn harvest - sea buckthorn berry pomace, leaves, and twigs - were performed, microbiological indicators were determined, and the composition and properties of the extracts were studied to describe possible and potential biologically active compounds that can be produced to improve not only sustainability of the farm, but also generate high additive value products.

Keywords: closed-cycle farm model, sustainable berry farm, sea buckthorn farm, sea buckthorn, bioactive compounds.

P4.51. Antioxidant Properties and Anti-Fungal Activity of Citrus Peel Extracts

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Citrus peel, a byproduct of the citrus industry, is a rich source of phenolic compounds known for their diverse bioactive properties, including antifungal activity. This study aimed to evaluate peel extracts derived from two species *Citrus reticulata* (Hernandina) and *Citrus sinensis* (Newhall and Washington navel) in terms of total polyphenol (TP), flavonoids (TF) and antioxydant activities (DPPH and FRAP).

The highest TP (24,9 mg GAE/g) and TF (13,5 mg CatE/g) contents were respectively quantified in Washington navel and Hernandina peels extracted with acetone,

Concerning free radical scavenging activity of DPPH, Hernandina peel extracted with acetone showed the highest value (IC_{50}=1,33 mg/ml). For the ferric reducing ability (FRAP), Washington navel peel was the most efficient extract (EC50=0,35 mg/ml).

The antifungal efficacy of the ethanolic extracts at 10 mg/ml was evaluated against *Rhizoctonia solani,* and results revealed significant antifungal activity, with inhibitory effects varying based on the citrus species. The highest inhibition percentage (31,25 %) of *R. solani* mycelial growth was registered with Hernandina extract, followed by 28,8 % with Newhall and 17,5 % with Washington navel.

The effect of higher concentrations of Citrus extracts on mycelial growth of *R. solani* fungus in relation to their phenolic composition will be discussed.

Keywords: citrus waste, phenolic compounds, antifungal activity

P4.52. Presentation of the QuaReVAlentejo27 project

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QuaReVAlentejo27 - Quantification, Reduction and Valorization of Food Waste in Alentejo Companies, is a Portuguese project that starts on January 1, 2025 and ends on December 31, 2027. It involves two universities (University of Évora and University of Aveiro) and seven companies, five of which are food producers. This project aims to stimulate knowledge-generating initiatives that promote the development of technologies and/or practices that make it possible to increase environmental sustainability and make better use of losses and waste in the agri-food sector. The aim is to: 1) Quantify, reduce and value food losses and waste from food production and marketing companies in the Alentejo (a Portuguese region); 2) Develop new food products using food losses and waste as raw materials; 3) Study the use of environmentally friendly packaging; 4) Evaluate the environmental performance of the new food products developed, using the Life Cycle Assessment (LCA) tool, in order to guarantee the environmental sustainability of these products. In addition, the environmental benefits of the new products will be assessed by comparison with similar conventional products on the market, to which LCA will also be applied.

Keywords: Food lost, Food waste, Reduction, New products

P4.53. Use of agricultural by-products from mustard varieties as a dietary source of trace elements and bioactive compounds

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This study evaluates, from a nutritional point of view, the green parts (leaves and stems) present in two varieties of mustard: white mustard (*Sinapis alba*) and Ethiopian mustard (*Brassica carinata*). Considering that mustard varieties are grown to collect only the seeds, these green parts are usually considered as an agricultural by-product. Nevertheless, the presence of bioactive compounds (glucosinolates) and trace elements with a high bioaccessibility in these parts, makes of them an excellent ingredient to develop functional foods.

Two mustard varieties (white mustard and Ethiopian mustard) were grown at experimental farms in similar conditions than those developed to obtain seeds. 3 – 5 months after sowing, green tissues (leaves and stems) from individual plants of these two mustard varieties were harvested, pooled, and processed for chemical analysis. The assayed conditions of the INFOGEST digestion method were used to estimate the glucosinolate and trace element bioaccessibility.

The glucosinolates found in the green parts of *Brassica carinata* were the aliphatic sinigrin (4.30 – 23.24 µmol/g), and the indolics glucobrassicin (1.11 – 1.39 µmol/g), and neoglubrassicin (0.11 – 0.58 µmol/g). The main glucosinolates found in *Sinapis alba* were sinalbin (21.39 – 22.91 µmol/g) and glucotropaeolin (22.18 – 30.81 µmol/g). Glucosinolates have been suggested to decrease the risk of cancer. Indeed, these compounds are hydrolyzed by the myrosinase enzyme in the digestive tract producing breakdown products (isothiocyanates) with antioxidant, anti-inflammatory, and anti-cancer properties. Glucosinolate bioaccessibility reached values at least 50%. Regarding trace elements, Ca, Cu, Se and Zn bioaccessibility was high. As opposed to other green leafy vegetables, vegetables belonging to the Cruciferae family (mustards) could be considered as being a good source of bioaccessible inorganic micronutrients due to a low content in chelatin agents such as oxalates. In addition, for Se, cruciferous plants have the ability to transform inorganic Se into organic methylated forms (methyl-selenocysteine), a potent anticancer agent.

The presence of a high concentration of trace elements and bioactive compounds, such as glucosinolates, in the green parts of these mustard varieties shows their

potential to be considered more than a by-product. They could be considered as ingredients in the development of functional foods. It is therefore advisable for these vegetables to be included as part of a balanced, healthy diet.

Valorization of green parts of mustards as a dietary source of bioactive compounds and inorganic micronutrients.

Keywords: Bioaccessibility, Glucosinolates, Trace elements, Mustard, food waste

P4.54. From Byproduct to Benefit: Valorizing Oat Bran as a Fat Replacer in Cookies

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Oat processing byproducts, particularly oat bran, present a valuable source of dietary fiber and bioactive compounds, making them promising fat replacers in bakery products. This study investigates the effect of replacing 30 – 50 % of fat with an oat bran-based gel (22% oat bran gel prepared by hydro-thermal treatment) in cookie formulations, aiming to enhance nutritional value while maintaining desirable sensory characteristics. The impact of partial fat replacement with oat bran gel was analyzed through rheological, textural, and physicochemical assessments. Results indicate that oat bran gel incorporation significantly modified dough rheology, leading to increased viscoelastic properties. Furthermore, cookies with 30% fat replacement exhibited reduced fat content and enhanced dietary fiber levels while preserving overall textural integrity. Further increase in fat replacement (up to 50%) resulted in increase in hardness and decrease in cookie spread ratio. Sensory evaluation confirmed that partial fat replacement did not compromise consumer acceptability, supporting the feasibility of utilizing oat bran in functional bakery products. These findings contribute to sustainable food production and the valorization of oat byproducts, promoting their application in healthier formulations.

Keywords: oat bran, fat replacer, cookies, dietary fiber, sustainability

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WG5. Cross-cutting strategies and smart systems for food management

P5.1. Effect of Encapsulation Wall Material on Aroma Retention of Citrus Pomace

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Citrus pomace is byproduct derived from the industrial processing of juice mostly consists of pectin, cellulose, hemicellulose, and simple sugars. In this study, citrus pomace waste from a mandarin juice processing facility was utilized to extract aroma compounds and encapsulate them using a freezedrying method. The primary aim of this study was to assess the effect of varying the ratio of carboxymethylcellulose, gum arabic and maltodextrin as wall materials on the properties of the encapsulates and the capacity to retain the aromatic compounds. After an initial analysis, the microcapsules were disrupted in water to confirm the encapsulation of aroma compounds. Identification of these compounds was achieved by comparing their retention indices (RIs), relative to n-alkanes (C9–C25), and matching spectra with commercial mass spectral libraries. In total, 45 aroma compounds were identified, including 17 monoterpenes, 13 sesquiterpenes, and 15 other compounds, with limonene, linalool, and a-terpineol as the most abundant. This study highlights the role of wall material composition in enhancing aroma retention during the encapsulation of citrus byproducts.

Keywords: citrus byproducts; encapsulation; aroma compounds

Acknowledgement: This work was supported by the Short-Term Scientific Mission Grant from the COST Action CA22134 - Sustainable Network for agrofood loss and waste prevention, management, quantification and valorisation (FoodWaStop)

P5.2. Design of an Innovative Responsive Package Based on Biomass to Improve the Safety and Extend the Shelf Life of a Minimally Processed Fruit Salad

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Smart active packaging systems that respond to the storage microenvironment and efficiently release active components to improve food safety and shelf life are the next generation of active packaging. These new packages can reduce food waste by extending the shelf life of the packaged product. This study aimed to develop an antimicrobial active packaging with a controlled release system for trans-2-hexenal to extend the shelf life of a fruit salad. Chitosan films were designed by anchoring trans-2-hexenal via imine formation. These aldehyde-functionalized films were characterized to confirm bond formation and reversible hydrolysis in acidic conditions. Antimicrobial efficacy was tested in vitro against Salmonella enterica, Escherichia coli, Listeria innocua, and Botrytis cinerea. The films were integrated into double-bottom polylactic acid (PLA) containers and tested with a fresh fruit salad prepared with melon and pineapple cubes and grapes. The salad was stored at 4 °C for 12 days, and microbiological load and freshness parameters were monitored through storage. The salad also was inoculated with the afore-mentioned pathogenic bacteria and the microbiological effectivity of the package evaluated. The films demonstrated in vitro microbicidal activity, with fruit exudates triggering imine bond hydrolysis and aldehyde release. The active system maintained microbial loads within acceptable limits, with significant reductions compared to control. By day 12, mold, yeast, and mesophilic counts were 5.2 log CFU/g in the control, versus 2.9 log CFU/g in fruit packed with the active system, highlighting its efficacy in preserving fruit quality. The new packages show their effectivity extending the shelf-life of a minimally processed fruit salad which contributes to minimize food waste in the retail sector and consumers home.

Keywords: antimicrobial active packaging, chitosan, trans-2-hexenal, fruit salad

P5.3. The Production of New Biodegrdable Materials Based on Polyhydroxyalkanoates

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Polyhydroxyalkanoates (PHAs) are biopolymers produced by bacteria under unfavourable growth conditions and are they stored in the bacterial cytoplasm [1]. PHAs are biodegradable and biocompatible that allow their usage in various industries, such as: agriculture, construction and biomedical engineering as medical devices alone or included in composite materials [2]. The major advantage of these materials is biodegradability. The use of different carbon sources led to the obtainment of polyhydroxyalkanoates with different properties.

Regardless of the carbon source used, polyhydroxyalkanoates retain their biodegradability property. The average biodegradation rate obtained from this experiment was 66.21%.

Keywords: polyhydroxyalkanoates, biodegradable, medical devices.

WG6. Networking and dissemination, communication and transfer of knowledge

P6.1. Reducing Food Loss and Waste in the French Agrofood Sector: Challenges and Innovations

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Food loss and waste (FLW) remain significant challenges in France, impacting food security, economic sustainability, and environmental health. This study focuses on understanding FLW dynamics within the French agrofood system, particularly in the fruit and vegetable sectors.

Key objectives include:

1. **Quantifying FLW Hotspots in France**: Identifying critical points along the value chain where FLW is most prevalent, from production and processing to distribution and consumption.
2. **Adopting Technological Innovations**: Exploring and piloting advanced technologies, including precision agriculture and smart logistics, to mitigate FLW.
3. **Promoting Circular Bio-Economy Solutions**: Investigating strategies for valorising agrofood waste, such as bioenergy production and the development of biodegradable materials, aligning with France's commitment to a low-carbon economy.
4. **Policy and Stakeholder Engagement**: Collaborating with policymakers and industry stakeholders to develop guidelines and best practices, driving alignment with the European Green Deal's Farm to Fork Strategy.

This study highlights the unique challenges and opportunities within the French context, contributing to the broader goals of the FoodWaStop Network. By leveraging France's strong research infrastructure and commitment to sustainability, this work aims to foster innovative solutions and policy frameworks to reduce FLW.

Keywords: Food Loss and Waste (FLW), Agrofood Value Chain, Circular Bio-Economy

P6.2. A Comprehensive Approach for Enhancing Knowledge and Skills Among Farmers to Limit Agrifood Loss and Waste

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Agrifood loss and waste (FLW) represent significant global challenges, impacting environmental sustainability and economic viability of the agrifood sector. Farmers, as primary food producers, play a critical role in preventing and reducing FLW at various stages of the supply chain. However, lack of access to targeted knowledge, technology availability and networking at food supply level can limit their ability to implement effective FLW management practices. This poster presents a comprehensive approach for enhancing knowledge and skills among farmers to limit or, in the best-case scenario, completely avoid FLW. Through workshops, on-site training, and digital resources, the suggested approach aims to equip farmers with context-specific strategies to minimize losses in pre-harvest, harvest, and post-harvest phases. Key areas covered include optimizing harvesting techniques, improving storage and handling, and leveraging by-products through valorization, such as converting crop residues into bioenergy or animal feed. In addition to technical skills, the program also incorporates data-driven tools for FLW quantification, enabling farmers to monitor, assess, and continually improve their FLW management practices. Scientific literature suggests that these capacity-building efforts can significantly lower food loss on farms, reduce input costs, and create new revenue streams. Ultimately, this knowledge-driven approach contributes to more sustainable and resilient farming systems, aligning with global efforts to achieve the United Nations' Sustainable Development Goal 12.3: halving food waste and reducing food losses by 2030.

Keywords: food waste prevention, food loss avoidance, farmers dissemination, science communication

P6.3. Foodwaste Discourse-Current Stage and Future Perspectives

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The aim of the presentation is to show the multidimensionality of foodwaste communication, visible in the plethora of communication strategies and tools, used for the effective discourse focused on the environmental, economic and social dimension of modern life. In the first part verbal and nonverbal communication used by diversified stakeholders and to different recipients is discussed. In this part, communication is understood senso largo, focusing not only on the verbal but also the visual interaction and how synergy effect is achieved. Secondly, the current stage of foodwaste discourse is researched, showing how messages are coined in different languages. The research corpus encompassing materials originally written in English, Italian, German and Polish has been gathered by analyzing websites, brochures and social media. Apart from the multilingual aspect of the research, such factors as age are examined, showing how the message should be coined by taking into account different types of audience and their expectations. The research is not only of synchronic and diachronic character, but also offers the discussion on the future perspectives of foodwaste discourse. In this part, attention is focused on neuroscientific methods and AI in creating ad analyzing this type of discourse.

Keywords: foodwaste, discourse, AI, technology

P6.4. Bringing Knowledge and Consensus to Prevent and Reduce Food Loss at the Primary Production Stage (Folou Project)

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Each year, a substantial amount of food loss is generated at the primary production stage. The European Commission has made progress in tackling food loss and waste, but significant challenges remain. Regulatory, technical and social barriers constrain reduction efforts, particularly at the primary production stage where measuring food loss is complex and costly. The European project FOLOU aims to set up all the necessary mechanisms to (i) measure and estimate, (ii) monitor and report and (iii) assess the magnitude and impact of food losses, while assuring the appropriate adoption of the project outcomes by the key targeted stakeholders (primary producers, policy makers and researchers).

FOLOU's approach is based on four levers of change: understanding food loss, measuring it accurately, providing training, and adopting best practices. In terms of understanding, FOLOU has created a common definition of food loss aligned with the EU definition of food waste. Also, the drivers of food losses (behavioural, societal, and environmental) are currently being investigated using both literature review and conducting interviews to practitioners. With regards to measuring and with the objective to obtain real data on how much food is lost for different commodities, the project is developing a harmonised and cost-effective methodology to measure and estimate food losses, which will later be incorporated in a registry to monitor and report those losses at distinct territorial levels. Moreover, FOLOU is also developing and testing 6 innovative tools (UAVs, satellite images, blockchain, among others) to measure food losses in a more straightforward way. Concerning training, a Learning Centre is being developed which will contain 5 courses to equip different targeted stakeholders with the skills needed to drive meaningful change. Last, a twinning region program has been designed to promote, test and replicate project outcomes in other regions, which will be complemented with policy recommendations to be adopted by the different stakeholders playing a role in food losses.

Tackling food loss is essential to ensure global food security. FOLOU is contributing with innovative methodologies to quantify and monitor food losses and understanding its root causes. At the same time, FOLOU offers capacity building opportunities and policy recommendations to support stakeholders in paving the

way to lead significant progress towards more sustainable food systems in the EU and beyond.

FOLOU aims to equip practitioners and policy-makers with innovative tools and evidence-based policies to tackle the challenge of food losses in primary production, which is still rather unknown.