Bridging Training and Research
for Industry and the Wider Community

7th International ISEKI-Food Conference

"Next-Generation of
Food Research, Education and Industry"

BOOK OF ABSTRACTS

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7th International ISEKI-Food Conference

Next-Generation of

Food Research, Education and Industry

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PREFACE

As part of its mission, ISEKI-Food Association establishes and maintains a network among universities, research institutions, and companies in the food chain in addition to working to ensure that food studies are of high quality. However, we must also begin planning how to gear science, education, and the food industry to meet the needs of future generations as well as how to contribute to the sustainability of our planet by these food actors. In light of this, the 7th International ISEKI-Food Conference, which had as main theme "**NEXT-GENERATION OF FOOD RESEARCH, EDUCATION AND INDUSTRY**", focused on future challenges in education on food science and technology, in research activities related to processing, quality and safety, packaging of foods and in societal engagements in the field divided in three main sections: **EDUCATION: CHALLENGES OF EDUCATION IN A CHANGING WORLD; RESEARCH: NEXT GENERATION OF FOODS**; and **SOCIETY ENGAGEMENT: SOCIETY AND FOOD INDUSTRY**.

The conference was dedicated to all food actors, creating bridges among them. The delegates had the opportunity to exchange new ideas and experiences face to face, to establish business or research relations, and find global partners for future collaborations.

We were privileged to host the following keynote speakers: **HUGO DE VRIES** from INRAE, France, talked about ***"FOODPathS towards sustainable outcomes";*** **JESPER TÆKKE** from Aarhus University, Denmark whose talk was about ***"Digitalization of education - the theory of the three waves";*** **LAURENT GUILLIER** from ANSES, France informed us on ***"Challenges and perspectives in food safety";*** **GILLES TRYSTRAM** from AgroParisTech, France, presented ***"Some research questions in food and biotechnological process engineering";*** **HORST-CHRISTIAN LANGOWSKI** from Fraunhofer Institute, Germany, talked about ***"Circular Economy for Plastic Food Packaging – Options and Challenges";*** **CATHERINE BAYARD** from Givaudan Naturals, France, questioned us ***"Are you ready for the future of dairy alternatives?";*** **MAURO SERAFINI** from Teramo University, Italy, spoke about ***"Functional food and health: essentiality of human evidence";*** **STELLA CHILD** from GFI Europe, Belgium informed us on ***"The 3 pillars of future protein production: Plant-based, cultivated, and fermentation-made meat, eggs and dairy"*** and **FERRUH ERDOGDU** from Ankara University, Türkiye presented the ***"Future of Food Engineering in the Digitalization Era – Preparing for Industry X.0".***

There were 244 abstracts submitted and accepted! Among them, 80 were selected to be oral presentations and all the others poster presentations. The abstracts of the keynote speakers together with the abstracts of the oral and poster presentations can be found in this Book of Abstracts.

The authors of the best oral and poster presentations have the possibility to publish their works in the Food and Bioproducts Processing Journal, in the International Journal of Food Studies, and in a book published by Springer entitled **NEXT-GENERATION OF FOOD RESEARCH, EDUCATION AND INDUSTRY**.

We would like to express our sincere appreciation to all participants, speakers, and contributors for their valuable inputs to the success of the 7th International ISEKI-Food Conference.

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CONTENTS

SESSION 1: EDUCATION – CHALLENGES OF EDUCATION IN A CHANGING WORLD

Session 1: Oral presentations

Digitalization of education - the theory of the three waves

Jesper TAEKKE

Aarhus University, Denmark

We are in the midst of a media revolution, where digital media is giving rise to new social structures. As a result, we need to adapt to the changing social world across all arenas. Traditional social norms and methods are no longer sufficient in the face of the new digital information and interaction situations. Unfortunately, the education system often responds inadequately, either by prohibiting the use of digital media or by ignoring their presence. Neither approach is constructive, as we need to develop new norms and teaching methods to meet the challenges posed by digital media.

This keynote presentation introduces an empirical-based theory on how classroom teaching appears to change in the era of digital media and suggests a more adequate approach. The keynote proposes a dialectic process between "new conditions" and "school reactions," which involves deconstructing the traditional closed classroom and promoting an open community among students, teachers, and external parties. However, this deconstruction occurs gradually through three waves.

In the first wave, the traditional classroom is opened up, but students become easily distracted, and teachers struggle to adapt. Digital media presents a challenge to traditional teaching methods. In the second wave, attention is refocused on educational interaction between teachers and students using social media. In the third wave, teachers and students take a step further and successfully establish educational interactions with third parties, such as authors, researchers, foreigners, and AI systems. Only in this final phase do digital media become a means of introducing new perspectives that fundamentally transform the traditional educational setting.

The keynote emphasizes that a narrow focus on competencies alone is insufficient for adequate teaching in a digital media environment. Instead, an adequate approach to "Bildung" is necessary. We must educate critical-thinking, autonomous citizens capable of taking social responsibility in a digitalized society.

Future of Food Engineering in the Digitalization Era – Preparing for Industry X.0

Ferruh ERDOGDU

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`Engineering` is science and math application to solve problems, and the math background is a must for prediction. For example, without knowing the derivative of the function of tan(x), it is not possible to solve for the following integral:

$$\int \left(\tan^2 x \right) dx = ?$$

The physicist `Freeman Dyson` combines the definition of `engineer` with the presence of designing. The field of engineering is divided into mechanical, electrical, civil, chemical, aerospace, biomedical, *etc.* while the concept of food engineering is more like an evolved discipline. It might, however, require the combination/application of the other disciplines. For example, designing a microwave process for thawing of food products seems to be the direct focus of food engineering, but manufacturing the microwave system requires additional knowledge of electrical, mechanical and even software engineering disciplines. As demonstrated by this example, the evolved discipline of food engineering is still evolving. In fact, the initial applications of food engineering focused on the chemistry-oriented studies with emphasis on physical – chemical properties in the area of (food) science and technology, the recent trends are towards to process design, manufacturing and even molecular biology and nanoscale science. This brings out the requirement of in-depth knowledge of math, physics and computer applications such as simulations and computer-aided design. On the other hand, this discipline is not yet included in the possible engineering applications of the future, e.g. drone designing, robot creation, space engineering, *etc.*

In the view of food processing and food science/technology concept, improved food safety and quality assurance with productivity with applied simulation, artificial intelligence and machine learning approaches (in addition to the use if IoT and big data usage) are expected in the near future. With the introduction of Industry 4.0, combining the digitalization, IoT and cloud for improved smarter processes, the on-going evolution will be more significant, and it should be reserve a seat in the future engineering applications. For this expectation, the engineering background should be in a solid state to prepare the young generation for digitalization and integration of the engineering science with food science and technology.

1.1. Challenges in education in a changing world

#109: No student left behind: students' experiences of a self-paced online learning orientation in undergraduate studies during COVID-19 pandemic

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The rapid transition to remote online learning modality during the COVID-19 pandemic forced traditional brick-and-mortar universities to implement student support mechanisms to ensure that student learning is not impaired. This paper presents data derived from a study aimed at investigating students' perceptions of a self-paced online learning orientation (OLO) in an undergraduate Food Science and Technology course. To elicit student responses, a mixed-method survey with a five-point Likert scale and open-ended qualitative questions was conducted via the Blackboard learning management system (LMS). In this study, participants reported having access to the LMS: using smartphones (66.3%), followed by a laptop with a webcam (38.55%), and a laptop with no webcam (26.51%). The participants also felt that it was easy to navigate (M = 3.95 ± 0.88) the OLO course, and they were able to locate the required content (M = 3.83 ± 1.03). Furthermore, results also showed that participants expressed a high commitment to accessing the LMS and reviewing course announcements (M = 4.72 ± 0.57) and kept up to date with the course activities (M = 4.58 ± 0.70) after completing the OLO. Therefore, the authors suggest that using a learner-centered OLO with authentic learning activities that mimic course activities is crucial to online students' success in online learning. These findings have significant implications for educators who intend to re-design their courses and enhance remote online learning experiences for students.

Keywords
COVID-19 pandemic, online learning pedagogy, online learning orientation, remote learning, students perceptions

#129: Reshaping food science, technology and engineering education embracing nutrition integration and sustainability

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A recent global survey taken among food professionals that included more than 700 respondents, mainly food scientists and technologists (FST) and food engineers (FE), revealed that the food industry has significant major roles impacting many education attributes. It included: academic partnership and collaboration (ranked #1), sustainability, circular economy food waste management, internships, and the most influential professional organization considering education. It was quite surprising that almost 70% of the respondents were affiliated with academia, the majority with a PhD and above. On the other hand, the food industry suffers from a very low image for many nutritionists that are promoting ultra-processed foods (UPFs). For instance, "… these products are highly palatable, cheap, ubiquitous, and contain preservatives that offer a long shelf life. These features, combined with aggressive industry marketing strategies, contribute to excessive consumption and make these products highly profitable for the food, beverage, and restaurant industry sectors that are dominant actors in the global food system" (Monteiro et al., 2019). This discrepancy between the FST and FE reflection of the food industry and a large number of nutritionists calls for a new paradigm to overcome the chasm separating these two domains. The professional study showed that the concept of enhanced integration with nutrition received a weighted average value of almost 'high' (on a Likert-type scale). This opens a new avenue for innovative and paradigm shift considerations such as mutual curricula, industrial internships, and novel methodologies for education such as project-based learning, hybrid-learning, the flipped classroom, design thinking, personalization, and sustainability. These new ideas will be covered.

Reference

Monteiro, C.A., Cannon, G., Lawrence, M., Louzada, M.d.C., & Machado, P.P. (2019). Ultra-processed foods, diet quality, and health using the NOVA classification system. Rome: FAO 48.

Keywords

innovation, nutrition integration, sustainability, education, ultra-processed foods

#179: Emerging issues and key focus areas in food science, technology, and engineering higher education

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Food studies is an interdisciplinary field involving food production, distribution, consumption, and social, economic, and environmental impacts. Food science, technology, and engineering have undergone a significant transformation over the past few decades. Moreover, the food industry faces numerous critical challenges ranging from food safety, sustainability, health, and nutrition to changing consumer preferences and global food security. The food industry needs a workforce prepared for the most recent technical developments and also highly skilled.

Working group 1.2, on Emerging Issued, Key Focus Areas, of IUFoST (International Union of Food Science and Technology) activities address education materials and methods on topics such as sustainability of food systems, emerging technologies, food safety, food insecurity, ethical considerations, among others.

The working group organizes webinars series on teaching methods and methodologies, current critical topics in food studies, and, more recently, is opening an international web forum. This forum will promote effective communication and sharing of information in the field. It will cover topics such as curricula development, education in specific world regions, opportunities of collaboration, research education-related topics, and industry collaborations.

Working group 1.2 of IUFoST is also a key element for networking with several other organizations working towards a new generation of food science, technology, and engineering professionals with the skills and knowledge required to drive innovation and reshape the industry.

Keywords
emerging education, food studies, methods, materials

Acknowledgements
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#50: Local wisdom-based food education as a strategy for disaster resilience: A case study of Shihu Elementary School in Miaoli County, Taiwan

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With the intensifying effects of climate change, disasters are becoming increasingly destructive. The Great East Japan Earthquake of 2011 highlighted the key role of emergency and alternative food supplies in disaster preparedness. Taiwan is a small island country that is prone to earthquakes and typhoons. In 2019 Taiwan's Ministry of Education launched a three-year program titled Building Disaster Resilient Schools and Technology which emphasizes “thinking outside the box” and making disaster preparedness a part of everyday life. In line with the Food and Agriculture Education Act passed in 2022 by Taiwan's Legislative Yuan, teachers at the Shihu Elementary School in Miaoli County developed a course on disaster mitigation and food security which is based on local traditional wisdom and integrated it into the existing curriculum.

Through participant observation and in-depth interviews, the purpose of this study is as follows: (1) to understand how and what the local food wisdom is transformed into educational resources; (2) to understand what change has been brought about to the participants by the food education course.

The study found that the curriculum revolves around the linkages between Hakka culture, rural resources, and emergency food sources, with the campus as the learning base for disaster survival. The traditional Hakka food wisdom in disaster mitigation is divided into the following three phases: (1) Pre-disaster: focusing on building local food systems and preparing emergency rations, such as planting, harvesting, and learning the traditional Hakka techniques of food preservation. (2) During a disaster: survival skills have been emphasized. Such as edible herb identification, making fire, and cooking without utensils skills. (3) After a disaster: building a recycling agricultural facility in the schoolyard for children's learning and experience in daily life.

The study also found that implementing food education together with local elders brings benefits to all parties involved.

The study would like to emphasize the importance of food education that integrates local knowledge and disaster prevention, which can generate a greater appreciation of traditional dietary knowledge.

Keywords

local wisdom-based food education, emergency rations, disaster food, community and teaching collaboration

#242: European educational programs in Safe and Sustainable Food Systems

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There is a need for EU educational programs in Safe and Sustainable Food Systems (SSFS) due to increasing concerns for the severe and complex global crises of climate change, biodiversity loss, waste management and more, where an accelerated transition to SFS in Europe is necessary. To further advance SFSS education in Europe, identification of existing programs is necessary.

SSFS programs from 2018 through present, across the EU, at all educational levels – Elementary, Secondary, Bachelor, Master, Postgraduate and Lifelong Learning (LLL) – were identified between Oct 2022 and Jan 2023. Search methodology required identification of terms through iterative review by 3 researchers to form 4 thematic blocks: 1 for educational level, one for food (e.g., food, agriculture, garden, et al.), one for systems (e.g., sustainable, safety, system, et al.) and 1 for location (e.g., Europe, member states). All 29 possible search combinations were used to search several platforms: Erasmus and Horizon projects, partner contacts, teacher associations in selected member states, the IFA Curricula database, internet search engines, and databases of LLL courses.

The most SFSS programs were found at university level where 6 search term combinations returned 69 university programs. IFA members provided 13 programs, combined, these 82 programs were spread across 22 countries. The fewest programs were found at the Post Graduate level where 2 search term combinations returned 13 Post Graduate programs. IFA members provided 2 programs, and these 15 were in 7 countries. At the Elementary and Secondary levels, 8 and 14 search term combinations returned respectively 90 EU funded projects of which 18 in 10 countries, and 195 projects of which 54 in 20 countries were judged relevant after review of the project abstract. At the LLL level, 12 search term combinations returned 49 Lifelong Learning programs, mainly offered online by 20 providers.

Results suggest that most education about SFSS is taking place at the University level in Europe. However, there may be a lack of specialisation possibilities for SFSS university graduates as few Postgraduate programs exist. Overall, SFSS education in Europe is being studied at all educational levels and in all EU countries, and these existing programs can inspire more growth in this timely educational subject.

Keywords
sustainable, food systems, lifelong learning, SSFS, all educational levels

1.2. Innovative learning approaches

#236: FitNESS: Open courseware for responsible food packaging and supply chain education

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The COVID-19 pandemic highlighted the need for web-based platforms in communication and collaboration. ERASMUS+ projects FitNESS 1.0 and 2.0 were developed to address food packaging and supply chain challenges. These projects target gaps in food engineering curricula and address issues like river littering, microplastics, and chemical contamination.

FitNESS offers a comprehensive overview of food packaging, including shelf life, material chemistry, properties, hazards, environmental impacts, and eco-responsible design. The content, created by a consortium of European universities, research centers, and other organizations, includes lectures, slides, videos, case studies, and books.

The open-source platform is accessible as a client-side web application with compatibility for various screens and online/offline use. A search engine understands 7,000+ concepts, enabling content reuse and non-linear learning. Web plugins support online computations and interactive case studies. Multiple mirrors are available in Europe and the USA.

The platform enables the creation and distribution of independent syllabi and tests, with AI-assisted content adaptation based on trainee preferences. It caters to various professionals, encouraging innovation and responsible decision-making. Standardized tests are being developed to certify knowledge and skills in safe and reusable packaging design.

FitNESS has the potential to tackle food engineering challenges while fostering interdisciplinary collaboration. It supports the upcoming European Waste Management Directive revision and is aligned with the European Green Deal and waste reduction targets. FitNESS is an essential resource for promoting sustainability and achieving waste reduction goals across Europe.

Keywords
lifelong training, food packaging, opensource platform, sustainable practices, European Green Deal

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#185: Educational approach: Metaverse and the perspectives of hybrid teaching

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The learning Brazilian Society has changed at an astonishing rate consequently calling for professionals with specific skills and competencies to deal with challenges and decision-making in a contemporary world. The improvement of higher education quality is a recurring theme in National Councils of Education Collegiate and Institutions, also in Brazil. There is therefore a clear need for innovative solutions that may contribute not only to students' experience but to the professional profile of university egresses. To address the range of needs among learners, educators, and other stakeholders, it must be understood that emerging technologies can contribute to engaging perspectives on diverse areas of expertise. Adding to the context, there is a question to be answered regarding advanced learning as if the Metaverse can draw on evidence-based strategies to be paved in the same direction. Given the above, the present study considers the contemporary transformation in education, highlighting an urgent need to support the regulation of Brazilian Educational Applications. It considers the Subject of Opinion n° 14/2022, of the National Council of Education, and the Ordinance n° 315/2022. The study also emphasizes "Teaching for Comprehension" underlining its relevance for future professional development, when facing some of the present paradigms in traditional education, promoting the protagonism in the academy context. The study underscores teaching-learning processes focusing on intellectual autonomy and on the individual and collective development potential. Among arising questions to be answered, it is noticed: Does the traditional teaching-learning logic align with the social contours of post-modernity? How to prepare autonomous students to solve complex questions in multifarious scenarios. How to support students in a world that can outrun the traditional contours? Adding to the theme, and by touching elements linked to the Metaverse on Education, how to exploit Augmented Reality (AR), Mixed Reality (MR), and Virtual Reality (VR) in everyday life? A bibliographical technique thus supports the relevance of hybridism, while effective pedagogical proposals are considered, to promote access to Education, in a context strengthened by mentoring teachers and by the use of appropriate technologies

Keywords
challenges, education, changing world

#220: EduFerm, a simulation software dedicated to the control of bioprocesses

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Simulation based learning is a comprehensive approach that help students to get hands-on expertise through practice, in order to gain long-term knowledge retention. We develop this approach in the field of bioprocessing. In fact, microbial biotransformations represent a huge potential for the future. By considering food applications, they allow obtaining fermented bioproducts that meet challenges such like nutrition, flavor properties and conservation. They also participate to a better sustainable approach of transformation processes in other application fields like green chemistry, as they are considered as less energy and solvent consuming and less greenhouse gas emitting.

However, bioprocesses are complex to implement, as they must combine microbiological constraints (axenic environment, nutritional needs, oxygen supply, pH control, shear stress sensitivity, inhibitions) to industrial conditions (large scale bioreactors, agitation and aeration capacities, heterogeneities). Teaching this complex approach to engineer students is really challenging as they have to combine skills related to microbiology and process engineering, in the context of microbial growth that is dynamic, variable and in constant evolution.

To help engineer students to integrate this complex problem, we developed an open source web simulation software called "EduFerm" that refers to the batch production of a secondary metabolite in a 35 m^3 bioreactor. It is based on the fundamental principles of microbiology and process engineering, by considering mass transfer, growth kinetics and process inhibition. It gives students the power to conduct a microbial bioprocess, by controlling the pH, modulating agitation and aeration conditions, modifying substrates addition and taking account substrate inhibitions. Finally, a simple economic assessment allows them to efficiently observe the results of their choices, in order to rapidly define the relevant conditions to achieve a cost-effective process.

Keywords

Bioprocess, fermentation, secondary metabolite, simulation software

#156: Immersive technology for food science education: digital twin laboratory, safety and experimental modules for practical works

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It is currently assessed that education can benefit from immersive technology. As a result, teaching practices are changing for good to integrate these technological tools, especially in continuous vocational education and training and adult learning. In the CAP'VR project we developed immersive courses or training for educational purposes in food sciences, more specifically for practical works. First, an immersive digital twin of one of our laboratories was developed associated with a virtual tour module. During this tour, tooltips pop up with dangers addressed by collective protective equipment. Then several security immersive modules allow the students to grasp safety aspects of the work in a research laboratory: protective gear, lab safety sign, *etc.* In the next step, students go through small safety procedures learning modules with virtual endangerment, one of the strengths of virtual reality being its ability to reproduce dangerous situations in complete safety. Several levels of difficulty are available which can be used as training before the real practical work session or as an evaluation after the practical work session. Experimental modules are now in development: the chemical synthesis of a food additive (tartrazine) associated with the purity control steps (thin layer chromatography) is already completed. The steps of synthesis are all independent modules that can be used in different fields (chemistry, analysis, food science, process engineering). Thanks to an innovative open-source analytics platform Mimbus Vulcan, we have the possibility to personalize pedagogical paths and exercises adapted to learners and to monitor the progress of each of them in VR: It allows a real time follow-up of the execution of an exercise and a precise analysis of the student's performance. As perspective, next modules will be developed such as a digital twin of a bioreactor and an HPLC system.

Keywords

immersive twin laboratory, virtual reality, personalized pedagogical path

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1.3. Promoting the attractiveness and prestige of Food Studies

#139: Knowledge sharing by short food supply chain stakeholders through the Sustainable Food System Innovation Platform

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Short food supply chains (SFSCs) can be a key driving factor in the transformation of current food systems towards more environmental and social sustainability as they offer several benefits including greater trust and transparency and the improvement of producer income and status.

Several European projects are working together to overcome one of the barriers hindering SFSC development – information sharing. In the EU4ADVICE Project, digitalization and consolidation of SFSC multi-actor networks will occur through the Sustainable Food System (SFS) Innovation Platform which was developed in 2019 by the SMARTCHAIN Project and is now managed by the FAIRCHAIN and CO-FRESH projects. This Platform had 17,296 visitors in 2022.

The Platform offers many searchable inventories relevant to SFSC stakeholders including initiatives, innovations, practice abstracts, weblinks, publications and the newest inventory, case studies. Registered users can upload their own work, comment on the work of others, and even find the contact information of contributors. EU4ADVICE has so far added to the case study inventory with its four Living Labs displaying a graphic, a short description, and a photo and contact information. The GAIN transition model, which shows how the obstacles of SFSCs can be overcome by moving through four levels, is integrated into several Platform activities.

Knowledge transfer is essential for SFSCs to move forward and the SFS Innovation Platform makes this transfer happen digitally so that stakeholders can access the information they need when they want it.

Keywords
short food supply chain, lifelong learning, digitalization, innovation, living lab

Acknowledgements
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#102: Entrepreneurship competences development for the food industry: key facts from the EntreCompFood project

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The food sector is currently confronted to important challenges, which require new competencies. The EntrecompFood Project, supported by the European COSME program, was launched in 2020, with the objective to evaluate new tools to develop entrepreneurship competences as a way to reinforce attractivity. In between the fifteen competences of the EntreComp framework, seven competencies were identified as key for the food sector: creativity, vision, ethical and sustainable thinking, motivation and perseverance, mobilizing resources, working with others, and learning through experience. One of the focus was to develop and test different tools and methods to develop entrepreneurship competencies for students in food science and engineering curricula, as well as for university-hosted young entrepreneurs. In France and Slovenia, learners' level was evaluated through a self-evaluation questionnaire developed for this purpose. This questionnaire helped the students to evaluate their level but also to identify their margin of progression. Based on the diversity of situations and results, the study suggests that a combination of different tools can be used to accompany the progressive development of entrepreneurial competencies, based on the students' level relatively to each specific competence. Different activities were implemented: (i) activities for ongoing courses, (ii) in-curricula students' entrepreneurial projects (iii) entrepreneurial tournaments, accessible to any member of the community and therefore organized out of the traditional curricula, (iv) development of specific courses, specifically devoted to entrepreneurial competences. Coordination of these activities at the university level through an entrepreneurial committee can help to ensure a continuous progression for students and the right combination of the different tools.

Keywords
entrepreneurship, competencies, self-evaluation questionnaire, entrepreneurial projects

#108: Flipped laboratory classes: Student performance and perceptions in undergraduate food science and technology

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In STEM (science, technology, engineering, and mathematics) courses, under- graduate laboratory classes are vital for students to develop competencies such as critical observation, collaboration, critical thinking, technical and problem-solving skills. Thus, for students to successfully acquire these competencies, preparation for laboratory classes is essential. This study aimed to explore the students' performance and perceptions of online pre-laboratory videos and quizzes in undergraduate food science and technology. Quantitative data on student usage statistics of the videos, student performance in online quizzes and practical reports scores and student perceptions were analysed to provide a detailed perspective of the course. The students' performance was above 60% in all pre-lab quizzes for both the 2018 and 2019 cohorts. The average pre-lab video views were higher in the 2019 cohorts compared to the 2018 cohort. The majority of the students felt that the topics were well explained in the videos ($M= 4.25 \pm 0.84$), and it was easy to learn from the videos ($M= 4.31 \pm 0.76$). In terms of students' perceptions, a strong positive correlations were found between course organisation and motivation and self-efficacy ($r = 0.86$, $p < 0.05$); course engagement and motivation and self-efficacy ($r = 0.82$, $p < 0.05$). The strongest positive correlation was between course organisation and online engagement ($r = 0.95$, $p < 0.05$). The results of this study suggest that the introduction of multimodal/digital preparation resources (pre-lab videos and online quizzes) was positively received and benefited the students. Students have engaged enthusiastically with these resources and completed the majority of the tasks set. These findings will further expand research directed towards student perception of the lab experience and aid in the adaptation of food science and technology curriculums to accommodate both student and university needs.

Keywords
flipped classroom, blended learning, online learning

Session 1: Poster presentations

#39: Innovative biology education for high school students: enhancing students` interest in food science through direct engagement in scientific research activities

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The transdisciplinary field of food science provides a unique opportunity for young students to explore the benefits of direct involvement in scientific research activity for their cognitive and psycho-emotional development. In Romania, the professions associated with Biology (except Medicine) are less known among students, even after facing the pandemic situation.

We investigated the impact of the participation of students aged between 15-18 years, in extracurricular activities in Biology career decision-making process, including food science research. In this context, we implemented a program of extracurricular activities named "The invisible world of beneficial microorganisms". A number of 20 high school students were engaged in two scientific experiments: Biotechnological importance of microbial strains from different ecological sources; The superpower of plants - modern strategies to prevent food products contamination using hydro alcoholic plant extracts. During the experiments, 7 yeast and 13 bacterial strains were isolated from spontaneously fermented dairy products and fruit epidermis. The strains were identified using morphological observations and Maldi-Tof Mass Spectrometry, as belonging to *Saccharomyces, Pichia, Metschinikowia, Issatchenkia, Candida, Bacillus, Lactobacillus* and *Klebsiella* spp. Hydro alcoholic extracts from *Rosmarinus officinalis L., Salvia officinalis L., Rhus coriaria L.* and *Allium sativum L*. obtained using microwave extraction were tested for antimicrobial activity against foodborne bacterial pathogens by disc diffusimetric method. Best results were obtained for rosemary and garlic extracts. The involvement of students and the impact on their professional perspectives were monitored using an observation grid and a satisfaction questionnaire. The involvement in practical activities raised students' awareness on the practical applicability of theoretical biology aspects. Students' interest can be stimulated by similar activities, providing also numerous benefits for their psycho-affective development and the improvement of European key competences.

Therefore, the extracurricular activities involving scientific experiments represent an important premise for the clear outline of future options in building a career in Biology.

Keywords

extracurricular activities, action learning, transdisciplinarity, food microbiology, educational partnerships

#64: The use of gamification for food handlers' training in a large–retail company: preliminary outcomes

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Food handlers' training is one of the prerequisites to establishing and maintaining a safe food environment; therefore, adopting effective and efficient training methodologies is determinant. Conventional lectures can lead to limited effectiveness, loss of attention, lack of engagement over relevant organizational costs, and poor flexibility. In addition, different workers' ethnicities and educational backgrounds can create further limitations and should be considered to overcome learning barriers. This study aimed to present the initial outcomes of the implementation of Food Safety Trainer (FST) WebApp, developed as an innovative training tool for food handlers based on gamification. The project is the result of a partnership between the University of Pisa and a large retail company. After a design phase, the WebApp was released online and made accessible from pc. From February to September 2022, FST underwent a testing phase in 26/94 retailers' stores of different sizes and complexity, reaching 1,112 food operators. This testing phase allowed to collect initial feedback on the new training methodology and assess the technical reliability of the platform. The administration of a questionnaire to the stores' managers (20 answers), permitted to gather first impressions and suggestions about FST use, and to address the later implementation. Results showed a good appreciation of the gamification method (70% of 4-5 on a scale of 1-5) and considered it better than the traditional one (70%). Higher engagement and shared knowledge were considered major strengths. The customized graphical interface and user-friendly usage are expected to promote an active learning and the option of choosing between single or multiple game session makes FST appropriate both for individual insight and team building activity. During 2023 the company will adopt FST in all its stores and the study will continue with a comparison between the stores' non-conformities identified before FST adoption and after a suitable period of its implementation. Meanwhile, other food companies are adopting FST, that will be tested both as an integration and a full alternative to traditional training.

Keywords

food safety, training, gamification, webapp, digitization

#132: Inclusive mindset in teaching agrifood sciences: From a toolkit to experiences

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Can the integration of gender in agrifood science lead to opportunities for the future? Is gender inclusivity important while teaching agrifood sciences? The gender dimension is an essential aspect of research excellence as it increases the societal relevance of the knowledge produced, as well as technologies and innovations. Gender SMART (Horizon 2020) focused on the goal number 5 of the SDGs and it aimed in achieving gender equality in Research Performing and Research Funding Organizations operating in the agricultural and life sciences research field by implementing Gender Equality Plan in each partner institution and integrating the gender dimension in the culture, career support measures, decision making and in funding, research and teaching.

The inclusion of the gender dimension in teaching is a dynamic concept when educating the next generation of scientists. How and why it's important to integrate the gender dimension in academic teaching, which practices, tools and methods are appropriate to achieve this and have an impact for change for gender equality will be presented from the experiences acquired through Gender SMART implementation at the Cyprus University of Technology and the Department of Agricultural Sciences, Biotechnology and Food Science as well as from international literature and sister projects.

Keywords
gender equality, inclusive, gender+, SDG5

Acknowledgements
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#158: Development of a serious game to promote links between teaching modules in a Msc in Food Science and Nutrition : NSA'muse

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The MSc Food Science & Nutrition (Université Paris-Saclay) is a two-year full-time program that provides a solid multidisciplinary foundation in biology, microbiology, food science and technology during the first year (M1) to approach the second year of specialization (M2) in a more open manner and pursue a wide range of professions in the field of food and nutrition. At the end of the M1 year, it is observed that students do not take sufficient advantage of the multidisciplinarity offered to them. This is mainly due to the absence of a readable and effective thread that links the main teaching modules and gives an integrated approach to the problems.

A serious game (called "NSA-muse") is therefore being developed, with the objective of offering learners a simulation of professional situations aimed at addressing the major current issues of the food transition. It is designed in the form of a role-playing game that is played throughout the year (game board, challenge envelopes, event cards, reference cards for tutorials or practical work, reference cards for digital activities accessible on Moodle, clue cards, bonus/penalty cards, *etc.*) and it is supplemented by an "individual progress notebook". This innovative pedagogical approach has several goals: to increase the skills of the teaching staff involved in these serious game approaches, to propose a "demonstrator game" whose design methodology, development approach and evaluation system to measure its success will serve as an example for future projects, and to allow students to experience active learning through immersion in a serious game.

Our objective here is to present the methodology developed by this pedagogical team to design the different phases of the game, in collaboration with a game designer, and to build the associated scientific content.

Keywords

serious game, multidisciplinarity, integrative approach, food science and nutrition, innovative learning approach

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#191: Project-based pedagogy within the Erasmus Mundus FIPDes joint master's degree: an integrated and international approach to food innovation training

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Innovation applied to food processes and products is guided by different challenges: meeting the needs of individuals, considering the needs of society, while ensuring the availability of natural resources and reducing environmental impacts. An integrative approach at these levels accelerates innovation at the stages of ideation, concept and prototype development, and process and product development.

Companies, from start-ups to multinationals, need multi-skills to improve their innovation potential. Moreover, there is a growing need of internationally trained professionals and entrepreneurs able to integrate the multidisciplinary aspects of food innovation and product design. The joint Erasmus Mundus Master's Degree in Food Innovation and Product Design 'FIPDes' was created to meet this need and contribute to meeting the global challenges of innovation for sustainable food systems. FIPDes offers an innovative pedagogical training based on projects and learning by doing approaches, benefiting from the intercultural intelligence of its learners and promoting their professional exposure.

The FIPDes's project-based pedagogy can be illustrated by the "Transversal Innovation Project, TIP" course. This course starts during the first semester of the Master at AgroParisTech, through intercultural creativity sessions for the ideation of an innovative food concept. During the second semester at TUDublin, learners focus individually in prototyping their food concepts through experimental cooking in interaction with chefs and teachers in culinary arts and food science and technology. Finally, the prototypes are showcased during an evaluated exhibition where experts from academia and industry give their feedback and select the best prototypes. The TIP course is then pursued during the 3rd semester of the master as part of the "Senior Project" course. This latter is a multidisciplinary course where learners mobilize their knowledge to scale-up their prototypes at AgroParisTech, or to develop packaging and logistics solutions at Lund University, or to study nutritional quality assessed by specific consumer populations at UNINA (Naples). Learners are thus exposed to transversal training situations where they gain proactive and creative abilities and shape multidimensional employment profiles.

Keywords
active pedagogy, transversal skills, intercultural creativity, ideation, prototyping

#202: New challenges for e-learning post-graduate course on Sustainable Food Systems

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The significant advances in digital technologies are responsible for the tremendous impacts on the format and on the approach to teaching and learning, particularly in terms of online education programmes. This approach was enhanced with the COVID pandemic, where the courses were required to be delivered in an online environment. This is particularly relevant, as the increase of e-learning courses in higher education requires a very specific online pedagogic methodology for both the teachers and students.

The Post-graduate course on Sustainable Food Systems results from an agreement between the Food and Agriculture Organization of the United Nations (FAO) and Universidade Aberta (UAb), the Portuguese distance learning university. It has the institutional support from the Community of Portuguese Language Countries (CPLP) context and therefore it was developed and is being delivered in Portuguese in e-learning mode. It is targeted towards professionals in charge of creating and developing projects and activities in food security and nutrition, and sustainable livelihoods, particularly under the CPLP context.

The purpose of this explorative study is to evaluate the post-graduate online course on Sustainable Food Systems, considering the following variables: i) structure of the e-learning activities; ii) educational resources; iii) interactive situations; iv) teacher profile; and v) students' profile.

This paper presents such results, collected for the two course editions, for the academic year of 2021/22 and 2022/23. The students enrolled have different nationalities (namely Brazil, Cape Verde, Mozambique, Portugal, Sao Tome and Principe), with a diverse academic background, coming from areas such as engineering, environmental sciences, life sciences (nursing) or social sciences. The course is successfully implementing by UAb's teachers and those belonging to the Mechanism to Facilitate the Participation of Universities in the Food and Nutrition Security Council of the CPLP.

Keywords
CPLP, e-learning, FAO, food system, sustainability

#218: Syllabus proposal for a self-paced, modular e-learning platform aiming to empower young European agrifood entrepreneurs.

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Most Food Science and Technology curricula are very technical driven, preparing the students to meet the industry demands or embrace a researching career. Although this model accomplishes its purpose when the students follow that path, it also understimulates their entrepreneurial creativity, potentially adding to the overall inertia of starting new businesses.

On the other hand, nearly all the available didactic materials that cover entrepreneurship are very generic in their approach and lack the scientific know-how required to tackle the particular challenges of the agrifood industry.

To make these ends meet, the YOUAREIN (YOUng AgRifood European INnovators) project was developed, aiming to provide a framework of e-learning events that will culminate in a self-paced, open access, modular course platform focused on the journey from the ideation to the full development and production of an agrifood product.

A syllabus proposal for this project was drawn in modules, each corresponding to specific learning objectives, to allow the participants to match the received content to their specific needs. Additionally, to provide a framework that would unify all learning objectives, an example of an innovative food product was included, following every step of the process and serving as an overarching theme of the whole platform.

Throughout the entire course syllabus, technical concepts of novel food engineering, designed to assist in the development of a prototype and the later transition to a scaled-up production, were intertwined with practical tools for the creation of innovative and sustainable business models, resulting in a multidisciplinary approach to agrifood entrepreneurship where each decision is influenced by the holistic perspective of the process.

Keywords
entrepreneurship, syllabus, agrifood, e-learning

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#247: What skills are needed to boost a Sustainable Agri-Food sector in the near future

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The agrifood sector is under a transition pathway towards more sustainable, green and innovative value chains. This transition poses new challenges like novel processes, markets or business models but also, external factors such as globalization, governance and consumers increasing awareness and demands have to be considered. To tackle these present and upcoming challenges, it is necessary to prepare the new generations and up-skill or reskill the actual workforce. Under this context a survey was launched in December 2020, lasting for 53 days, to assess the skills and knowledge needs of future professionals in the agri-food and forestry sector, from the European stakeholders' perspectives. A fair set of responses (394) were obtained from stakeholders working in different areas of activity, in the European Union and other countries under the EU economic influence. At a glance, digital, sustainability and soft skills were identified as the most important and necessary in the future. Regarding each addressed topic, food safety management and control, quality management and assurance of processes and products, and planning and coordinating production, ranked higher in technical skills set; the efficient use of resources was the main skills in the sustainability topic; organization, planning, visioning and strategic thinking, had higher importance in the considered soft skills; and data handling analysis in the digitalization skills. Regarding available training, the outcomes showed that formal training may cover the identified needs better than non-formal training, but many participants found it difficult to assess. For both organizations and individuals, having the skills to perform a task was clearly more relevant compared with having a training recognition. The outcomes of this study are important to map the sectors' needs and may provide insights to update curricula and better meet the agri-food sector skills needs in the future.

Keywords
skills survey, skills training, sustainability, agri-food sector, bioeconomy

#258: Impact of service learning on graduate attributes at second-year level of study in Food Science and Technology

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Service Learning (SL) is a course-based project wherein students do meaningful service in a community to address a specific need while gaining educational and real-life practical experiences related to subject theory and personal growth. At first- and second-year level, most students are unable to integrate horizontal and vertical knowledge, mainly due to lack of practical experience in the field of study, but also due to failure to adopt the Food Science and Technology "culture" or academic discipline at the beginning of their studies. Service Learning has been part of teaching and learning in the Department of Food Science and Technology, CPUT, for 13 years (since 2010). A train-the-trainer approach has been followed where students are trained as workshop presenters to address training needs for food safety and quality within small-scale fisher communities along the Western Coast of South Africa. Student activities included site visits to the community to gain understanding of the community need, design their own workshop presentation materials (notes and power point slides) from course manuals and relevant literature sources, and opportunity to present their power point presentations in class, during which they were evaluated by the lecturer and by their peers. In guiding the students to make the necessary connection between the academic theory and the service activity, student reflection was accomplished through formal written assignments and reports, classroom discussions, classroom power point presentations, and post-Service Learning project surveys and questionnaires. Student survey responses showed that SL activities facilitated students towards "self-directed" learning, increased their confidence and integration of subject matter, and developed graduate attributes of professional communication and presentation skills. By involving second-year students in SL projects, the bridge between subject theory and relevance to the Food Science and Technology discipline can be crossed in a very practical and rewarding way. This facilitates the development of the graduate attributes: executing complex practices, problem solving skills, and professional communication, as early as second-year level of studies in Food Science and Technology.

Keywords
service learning, professional practice, communication skills, community

#261: Navigating the changing landscape of the food industry: the EQVEGAN project's approach to addressing sustainability, skills gap, and the rise of plant-based diets

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Over the past decade, the food industry has undergone significant transformations in response to various critical issues such as sustainability, health concerns, and the skills gap in the job market. One notable change has been the rapid advancement of technology, including the integration of information technology, artificial intelligence, automation, and robotics. These advancements have led to the displacement of certain jobs and a demand for new skill sets. The food industry, in particular, has faced unique challenges as consumers increasingly seek vegan alternatives driven by sustainability, animal welfare, and dietary considerations.

The rise of plant-based diets can be attributed to both vegan and flexitarian consumers. Vegan consumers consciously avoid all meat and animal products, while flexitarians reduce their meat consumption without completely eliminating it. Both groups have a significant influence on the choices made by their peers, including friends and family. The market for vegan products is still in its early stages, with revenue expected to grow and stabilize within the next two decades.

To bridge the skills gap resulting from these emerging trends, the EQVEGAN project aims to address the challenge through reskilling and upskilling initiatives. The project focuses on providing training in soft skills, green skills, digital and automation skills, as well as new plant-based processing technologies. Additionally, the project seeks to establish job profile certifications and create work-based learning opportunities to ensure that workers stay updated with the latest industry developments. By actively confronting these challenges, the EQVEGAN project aims to position the food industry as a pioneer in innovation and enable it to effectively meet the evolving demands of consumers.

Keywords
keywords, skills need, innovation in education, work-based learning, vegan food

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SESSION 2: RESEARCH – NEXT GENERATION OF FOODS

Session 2: Oral presentations

Some research questions in food and biotechnological process engineering

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Numerous developments have marked the last forty years in the understanding and innovation of food and biotechnological process engineering. At the same time, constraints have been added in nutrition, in the search for better controlled sensory properties, in food safety and increasingly in the demand for control of the ecological impact of processes. It is therefore relevant to consider the major challenges that remain to be met and the research questions associated with them. Some topics are relevant, starting from the search for a better understanding of the mechanisms implemented in these processes. The progress in instrumentation gives access to new spatial and temporal scales opening a better understanding of the dynamics of operations and the couple product-process. The association of experimental data, sometimes massive, with numerical models (concept of numerical twins) carries many hopes and opens new fields of application for the control of processes.

If a large number of operations and processes have been studied, there are not so many breakthroughs innovation and the field of research questions appears very open for the future. Some examples illustrate both potential innovations at the scale of an operation, but also the strength of combinations of operations to build all the expected properties of food or bio products. Finally, a third field is opening with new possibilities for processes using microorganisms. On the one hand, adaptations of biological agents (bacteria, fungi, ..) accelerate or specify processing routes, but on the other hand, precision fermentation or cell culture provide either ingredients or finished products that compete with classical food systems based on agricultural diversity.

The aim of the conference will be to discuss these different topics, to illustrate them and to open some avenues for research in food and biological process engineering.

Challenges and perspectives in microbial food safety

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ANSES - French Agency for Food, Environmental and Occupational Health & Safety, France

The importance of food safety cannot be overstated. It is a fundamental concern for all stakeholders in the food industry, from health authorities to food business operators, and ultimately to consumers. Over the years, significant progress has been made to improve the microbiological safety of food, but there are still challenges that need to be addressed.

One of the primary challenges is to better understand the sources of foodborne illnesses. While significant resources have been devoted to detecting and identifying foodborne pathogens, it is often impossible to trace the source of an outbreak. This can make it difficult to prevent future outbreaks and protect consumers. Another challenge is to ensure food safety in a constantly evolving environment. With changing supplies and environmental conditions, it is essential to stay vigilant and adapt to new risks. A third challenge is to reconcile the goal of food safety with other consumer expectations. Consumers are increasingly concerned about the environmental impact of food production, as well as issues related to waste and sustainability. While these concerns are important, they can sometimes conflict with the goal of ensuring food safety. Finding ways to balance these competing priorities is essential to building consumer trust and confidence in the food industry.

To address these challenges, new perspectives and approaches are emerging. For example, the use of massive and genomic data is allowing researchers to better understand the microbiological risks associated with different types of food. This can help inform the development of new control measures and interventions. Technological innovation in food processing is also opening up new possibilities for improving food safety. From advanced sensors to novel preservation techniques, there are many developments that can help ensure food safety. Finally, education for food business operator personnel and consumers is critical. By providing training and resources to food business operators, we can help ensure that they have the knowledge and skills to prevent foodborne illnesses. At the same time, educating consumers about safe food handling and preparation can help reduce the risk of illness and build trust in the food industry.

In conclusion, ensuring the microbiological safety of food is a complex and ongoing challenge. However, by working together and embracing new perspectives and technologies, we can make significant progress in protecting consumers and building a more sustainable and resilient food system.

Circular economy for plastic food packaging – options and challenges

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The basic elements for a Circular Economy for plastic packaging are located both in the recycling path of the circle as well as in the path of product design and product production. *Design for Recycling* (D4R) is generally seen as one key element. However, for the packaging sector as the largest application area of plastics, the reuse of recyclates in the same sector is also essential; otherwise, the recyclate markets for the special packaging plastics will become too small in the long term. Moreover, the EU is setting specific targets for recycled content of packaging. The requirement for the high-quality reuse of recyclates makes *Design from Recycling* an additional necessity, especially for food packaging applications. This, together with *Design for Recycling*, establishes *Design for Circularity* (D4C) and thus helps to close true material cycles. In the case of packaging, however, it is also necessary to keep the loss of packaged products at a minimum in order to minimize the environmental impact of the entire product. This puts up another necessity for design, namely *Design for Functionality* (D4F). To this end, the barrier function of the packaging is an essential prerequisite that must not be sacrificed in favor of easier recycling. Technologies to apply thin barrier layers to plastics are able to both maintain packaging functions and minimize the risk of product contamination from recyclates without compromising recyclability. On the post-consumer side of the circle, technologies for sorting, cleaning and decontamination are needed to finally achieve the targets for recycled content without endangering the health of consumers. All of these individual building blocks must be consistently linked in the long term, in which artificial intelligence will help to master the great complexity of the tasks.

Keywords
D4R guidelines, recyclability standards, food packaging applications, design for functionality, functional barriers

2.1. Sustainable Technologies for Food Preservation

#34: Bioremediation of dairy processing side-streams by pure culture or consortium of microalgae

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Acid-casein production generates waste streams that are rich in nitrogen (in the form of protein and nitrate) and phosphate. This makes this type of waste very difficult to treat using conventional techniques resulting in a high amount of operating cost and costly investment. In this research, the application of single culture or consortium of microalgae for uptake of nitrogen and phosphate in the wastewater of an acid-casein factory was investigated. The waste was a 1:1 mixture of nanofiltered whey permeate and dairy processing wastewater. Monocultures of Chlorella vulgaris, *Tetradesmus obloquus, Nonnochlropsis ocenica* and a consortium of the three microalgae were analyzed. The results showed that the consortium exhibited more efficient nitrogen and phosphate removal compared to the individual species. The consortium was able to rapidly hydrolyse exogenous protein present in the waste medium, removing 88% of protein and breaking down complex protein molecules into simpler compounds (such as nitrate) for assimilation into the biomass. In the first fourteen days of cultivation, the rate of nitrate assimilation by the consortium biomass was lower than that of nitrate formation from protein degradation, leading to a net increase in nitrate concentration in the medium. As protein source was depleted and biomass concentration increased, however, the rate of nitrate assimilation began to exceed that of nitrate formation allowing for net removal of nitrate. The microalgae consortium was shown to successfully bioremediate all nitrates by day 21. It was indicated that Chlorella and Nannochloropsis species were responsible for nitrogen removal in monocultures. Phosphate, on the other hand, was efficiently removed by Tetradesmus. The results indicated that a consortium cultivation of three species of microalgae led to effective elimination of both nitrogen and phosphate. Combined flow-cytometry and microscopy analyses revealed that Chlorella overtook Tetradesmus and Nannochloropsis to emerge as the dominant population in the consortium by the end of the cultivation cycle. It can be concluded that the application of microalgae consortium for simultaneous recovery of nitrogen and phosphate is a promising approach for treating acid-casein wastewater.

Keywords
microalgae, dairy wastewater, phosphate, nitrogen

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#57: The effect on shelf life and food waste production of the use of monosilicic acid as bio stimulant in combination with optimization of food packaging design for baby leaf spinach

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In the fruit and vegetable sector, high barrier polypropylene (OPP) films are widely used as a material for primary packaging, the recyclability of this solution actually is nil as regards the film and the only alternative to landfill is energy recovery. It is necessary to optimize and where possible, to replace OPP with sustainable solutions aligned to the circular economy paradigm like polylactic acid (PLA) films. The selection of films able to meet the required performance it's constrained by technological limitations, but agricultural interventions may be applied to slow down the senescence process. The positive effect of silicon (Si) as a fertilizer on crop yield, and post-harvest quality is a known practice in cultivations of rice and other vegetables. However, very little research was done regarding its effect on green leafy vegetables. This work aims to assess how the replacement of OPP with PLA in combination with an agricultural intervention with silicon-based bio-stimulant, affects the associated food waste production. Storage studies were conducted to assess the amount of product that would run out of technological specification across a usability period to estimate waste. A mathematical model able to predict the effect of silicon dosage on the process of senescence during the storage and selling of EMAP packaged foods with OPP and PLA was built using the experimental data. The model was used to predict the effect of the silicon dosage and the packaging film on food waste production. evaluating the amount of product likely to be out of specification for fixed threshold of acceptability for the relevant parameters. The model indicates that Silicon is able to reduce the respiration rate in baby spinach by 15%. This respiration rate reduction translates in an equivalent reduction of quality decay rate. The model predictions showed that 1% waste was produced with OPP and no-mitigation, while potential waste of 26% using compostable films was predicted. The silicon-based supplementation managed to reduce waste by an average of 35% in the case of the use of PLA. The integration of environmentally sustainable packaging with the use of design optimization models, and novel agricultural interventions, such as the use of silicon fertilizer on crops, opens the possibility of a sustainable transition to green packaging.

Keywords
food packaging, food waste, monosilicic acid, spinach, polylactic acid

#172: Dynamic modeling of phage attack to reduce milk waste during cheese production

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Milk acidification is a key step in the cheese-making process. In the industry, bacteriophages can attack lactic acid bacteria (LAB), which are responsible for the conversion of lactose to lactic acid. In consequence, acidification can be reduced or even stopped, leading to a halt in the production. This results in the waste of raw materials as milk is discarded, severe economic losses for cheese-makers, and negative impacts on the environment. The goal of this study is to develop a dynamic mechanistic model to predict the dynamics of phage attack.

To build the model, acidification curves, i.e. pH measurements *versus* time, were generated for 96 different couples of initial LAB concentrations and phage titers.

A dynamic mechanistic model was then constructed and consisted of 5 ordinary differential equations for the state variables: lactose and lactic acid concentration, susceptible and infected LAB concentration, and phage titer. The model parameters were estimated from the observed data. The model was analyzed and new optimal experiments were designed with different initial conditions and additional measurements. The model and its optimization were implemented using python and MATLAB.

The acidification data showed that normal acidification takes place when the LAB concentration is high and phage titer is low. When the LAB concentration decreases, the acidification is delayed. With high phage titers, acidification can be delayed, prematurely stopped or not take place at all.

The model was able to predict satisfactorily most of the cases. Parameters were estimated with a reasonable confidence interval. The model simulates time evolution of phage and bacteria concentrations which are not measured routinely.

The model succeeded in predicting most of the phenomena taking place in the experiment. Important parameters and behaviors were deduced from simple and low-cost acidification measurements. The model can be expanded to include different phages and bacteria species, and blends of both to mimic a typical cheese-making environment. The model can be used to raise awareness amongst cheese-makers on the importance of cleaning to avoid food and material wastes.

Keywords
mechanistic modeling, cheese making, lactic acid bacteria

#229: Development of Labaneh shelf life using protective cultures of *L. paracasei* and *Propionibacterium freudenreichii* subsp. shermanii

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Labaneh (strained yogurt) is a traditional dairy product. It is usually produced without chemical preservatives, as Jordanian standards of labaneh prevent this addition. Its shelf life is limited to two weeks. The idea of this research came to develop the shelf life of labaneh using eco-friendly methods (i.e., protective culture addition). The objective was to compare traditional labaneh as a control with labaneh that contains protective cultures (developed). Protective cultures were prepared after activating DVI freeze-dried (*Propionibacterium freuendereichii*, susp. shermanii, and *L. paracasei*) in sterilized skim milk. Fifty kg of fresh milk was divided into two portions, the first containing the traditional yogurt starter culture (2%) and the second processed by adding both the starter (2%) and protective cultures (1%).

Both types of Labaneh were evaluated for microbiological (coliforms, yeast, mold, and lactic acid bacteria) and chemical tests (pH, Ash, acidity, moisture, protein, fat, and titratable acidity) at different time intervals (0, 3, 7, 10, 14, 21, 30 days). The shelf life of the developed labaneh was determined based on coliform. yeast and mold counts, and titratable acidity. Regarding the above specifications found in Jordanian standard, the shelf life of labaneh was extended to 30 days. The counts of yeast and mold and coliforms were generally higher in the traditional labneh than in the developed one, while the number of lactic acid bacteria was lower in the traditional labneh than in the developed one. The titratable acidity, pH and moisture were lower in the developed labneh than that in the traditional one, but the titratable acidity, ash, protein, and fat were higher in the developed one. Most of the sensory panelists prefer organoleptically the developed one.

Keywords
labaneh, shelf life extension, *L. paracasei*, *Propionibacterium freudenreichii* subsp. shermanii, protective cultures

#91: Modelling the dynamics of microbial population and *Salmonella* spp. in milk kefir

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Kefir is a dairy product, fermented by bacteria and yeasts. It is produced by adding kefir grains, consisting of a consortium of microorganisms, to milk in order to start a natural fermentation (1,2). Kefir is recognized as a source of probiotics, however, there have been concerns about the potential growth of pathogenic microorganisms in kefir and the potential health hazards associated. (3,4).

A mathematical model was developed in order to describe the evolution of microbial populations present during kefir fermentation and the potential growth of *Salmonella enterica* serovar Seftenberg. whatever as one example of a potential food safety hazard. For this, equations previously described in the scientific literature (5,6) were combined and adapted to the milk kefir matrix. In order to assess the safety of the product, the growth of *S*. *seftenberg* was predicted considering its interaction with the medium and the other species. The drop in pH; generation of yeasts metabolites such as ethanol; and buffer capacity were described and considered when modelling *S*. seftenberg' kinetics. Interaction between the pathogenic species and the background microflora was included in the model.

Parameters of some well-described systems were taken from the scientific literature (6,7,8). A small group of parameters were estimated using the experimental data. The growth of yeasts, lactic acid bacteria, and *S*. s*eftenberg* together with the pH were experimentally collected in a kefir challenge inoculation experiment at critical processing times and fitted to the mathematical model by minimizing the residual sum of squares (RSS). Confidence intervals of 95% were calculated. For further validation, the output of the model was contrasted with an independent data set.

S. seftenberg was able to grow during the first hours of the kefir fermentation process. Inactivation was apportioned to the drop in pH as a consequence of the LAB metabolism after the pH in kefir reached values below 4. After this, no growth of *S*. *seftenberg* was predicted by the validated model. No residual population of the pathogen was observed. The model extrapolations to industrial populations of the pathogen suggest that controlling the growth and metabolism of the fermenting microflora may be a critical control point in milk kefir safety.

Keywords
milk kefir, *Salmonella*, mathematical modelling, predictive microbiology

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2.2. New Technologies to Reduce Food Loss and Waste

#72: Investigating the efficacy of macroporous resins in recovering polyphenols from roasted hazelnut skins

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Hazelnut skin is a great source of polyphenols and bioactive compounds, however it is usually discarded in large quantity as byproduct, given the widespread production and use of hazelnuts globally. Efforts to valorize and reuse of agricultural byproducts, such as hazelnut skin are becoming increasingly important, both for economic and environmental reasons, as the demand for sustainable solutions in the food industry continues to grow. In this study the efficiency of different polymeric resins in recovering polyphenols from hazelnut skins was compared. The type of macroporous resin, and the operating condition parameters including the amount and type of resins, type of solvent and dynamic adsorption/desorption flowrate were optimized, the kinetics of adsorption were studied and a method for polyphenols recovery has been developed through static and dynamic adsorption and desorption. The results of static experiments showed that XAD16 Amberlite resin was highly effective in selectively adsorbing and separating polyphenols from hazelnut skins, resulting in the adsorption capacity of 40.06 ± 0.55 mg GAE/g. The adsorption kinetic is well fit by a pseudo-second-order model and using 70% v/v ethanol solution demonstrated the highest desorption of total phenols (81.17 ± 1.19 %). The best dynamic adsorption performance of the resins was obtained using the lowest flow rate (1.5 BV/h), where the breakthrough point was achieved after 120 min. The desorption flow rate of 1.5 BV/h reached the highest amount of polyphenols recovery (87.7%) through dynamic experiment and the purified extract showed higher phenolic compound levels and antioxidant activity than the crude extract. The process was efficient, environmentally friendly, and scalable, making it a promising alternative to traditional method. The findings of this study demonstrate the potential for macroporous resins as tool for recovering polyphenols from hazelnut skins and maximizing the potential of these agriculture by-products which support the development of new, high-value products in the nutraceuticals and functional food industries.

Keywords
macroporous resin, polyphenols, adsorption/desorption

#177: Valorizing apple by-products as low-fat emulsions stabilizers: from physico-chemical properties to sensory acceptance

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Food sauces, often found as emulsions can contain up to 80% fat which overconsumption can lead to chronic diseases (obesity, cardiovascular problems…). The demand for products with increased nutritional and environmental qualities is growing. However, reducing foods fat content remains a challenge for the food industry as it can be detrimental to their stability and sensory qualities. The stabilization of emulsions by particles from vegetal by-products from the food industry enables to combine "clean-label" and fat reduction. This work aimed: 1) to study the textural properties of emulsions stabilized by apple pomace over a wide range of oil contents; 2) to assess the consumer acceptability of fat replacement by apple by-products in common food sauces.

First, the physical stability range of emulsions containing 2 to 50% oil was determined through light-matter interactions study. Secondly, a model for predicting texture as a function of formulation parameters was established over a range of oil contents more typical of low-fat food products (5-30%). Emulsions stability, drop size, rheological properties and microstructure were studied to provide insight into the different stabilizing mechanisms involved and structure-function relationships. In a second time, a consumer study carried on about 60 consumers aimed to determine the consumers acceptability of a low-fat mayonnaise-style sauce stabilized by apple-pomace.

The feasibility of replacing egg yolk and partially fat in mayonnaise-style sauces by unfractionated plant by-products was demonstrated from a stability and a sensory point of view. Indeed, apple pomace powder was used as the only stabilizer for low-fat emulsions, whose textural properties can be tailored by the formulation parameters (by-product powder and oil contents). A wide range of textures was obtained, covering the universe of classic products (cream desserts, sauces, spreads,...). The promising results obtained during the consumer test allow future research to be envisaged, particularly on the complexification of formulas to meet the organoleptic expectations of such products. This study highlighted the potential of vegetal by-products use as emulsions stabilizing agents in order to tackle the major issue of food waste by promoting the sustainable use of up-cycled raw materials.

Keywords
by-products, emulsion, low-fat, rheology

#186: Impact of vacuum filtration step on the production and characteristics of protein hydrolysates from oilseed meals. Application to malt rootlets and study of their technological properties

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The aim of this work was to study the protein hydrolysates production directly from food by-products, such as those from oil and malting industry, using an innovative and scalable extraction process, involving vacuum filtration in the solid/liquid step recovery in comparison to conventional centrifugation step. Parameters as enzyme type, temperature and pH were also studied.

The results suggest that the vacuum filtration process produced protein hydrolysates with higher weight yield, protein content, and protein yield than the centrifugation process in both studied meals (with higher values of 55.56 % on weight yield for rapeseed meal; and 57.61 g/100 g on protein content and 71.87 % on protein yield for sunflower meal). The protein fraction was also influenced by the extraction process, with a higher degree of hydrolysis, reaching a high value of 20.51% on vacuum filtration process of rapeseed meal, and lower molecular weight distribution in the protein hydrolysates achieving the same angiotensin-converting inhibition activity as the protein hydrolysates from the centrifugation process. The vacuum filtration process was applied on two other by-products for the validation of the newly proposed extraction process. The fat content effect of the oilseed meals was studied in a sunflower press cake, and no significant differences were stated in comparison with sunflower meal in terms of weight and protein yield.

The vacuum filtration process was also applied on malt rootlets, a by-product barely explored in the research into their valorisation. Our study confirms that the extraction conditions for the type of enzyme and concentration, as well as the temperature, can affect the production yield and properties from malt rootlets protein hydrolysates. Protein hydrolysates with a higher protein content, reaching 33.21 %, which in turn implies a higher emulsifying activity (up to 33.87 %). Protein hydrolysates do not improve foaming capacity on, but all showed a high ACE inhibitory activity attributed to the similar amount of low molecular fraction (500 to 200 Da) present in all samples.

Keywords
by-product, protein hydrolysates, oilseed meals, vacuum filtration, malt rootlets

#221: Ball milling: a green technology for the enhancement of biomolecules functionalities and the development of innovative food ingredients

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The food production sector is challenged to reduce its impact on the planet's natural resources and to improve the sustainability of the food value chains.

Ball-milling, a technology pioneered by the pharmaceutical sector, nowadays is being considered also for food applications with a "green" imprinting due to the no use of solvents or high temperatures. This technology is based on the application of intense mechanical forces on dry or low-moisture materials through the collision of balls within a jar subject to high rotational speed. Its thermo-mechanical effect causes not only size reduction, but also solid-state modifications of biomolecules physical properties and functionalities. In particular, studies showed that ball-milling may induce state and phase transitions of biopolymers, alteration of the crystalline structure up to an amorphous state. However, data availability on the application of this technology for the processing of ingredients and food materials is limited.

In this presentation, the results of the application of ball-milling on different biomolecules (i.e. starch, small carbohydrates-trehalose-, and proteins (phycocyanin)will be presented with focus on the effects on their physical properties and functionalities.

Corn starch subjected to ball milling (up to ≤ 30 min) showed main modification of its native structure and changes of its technological functionalities. Crystalline structure was partially destroyed with loss of birefringence and higher cold-water solubility. Thermal analysis revealed a starch pre-gelatinization with lower enthalpy at increasing milling times.

The application of this technology to small carbohydrates such as trehalose caused a phase transition from a crystalline system up to an amorphous state with a progressive phase change completed after 12 h of treatment. Conversely, same treatment durations in proteins (phycocyanin) induced completely denaturation, compromising its functionalities and the applications on this biopolymer will require further investigations.

Keywords
ball milling, starch, trehalose, amorphous matrices

#167: Optimized pressurized ethanol extraction enhances the recovery of antioxidant-rich fractions from silver birch (*Betula pendula* R.) leaves

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Birch trees, belonging to the *Betulaceae* family, are widespread in the Northern-Hemisphere in natural and planted forests. The leaves of *Betula pendula*, called silver or European birch, have been traditionally used for centuries for their several medicinal properties. The potential health benefits include anti-inflammatory, antioxidant, antimicrobial, enzyme inhibiting, gastroprotective, diuretic, melanogenesis suppressing, *etc.* A variety of bioactive compounds are responsible for these effects, including flavonoids, tannins, essential oils, and triterpenes. *B. pendula* leaves are available in the form of teas, tinctures, extracts. However, the extraction process of potential bioactive compounds from birch leaves was not extensively studied.

This work aimed to optimize pressurized ethanol extraction (PLE-EtOH) time (15-45 min) and temperature (40-100 °C) for the recovery of valuable polar constituents from *Betula pendula* leaves using a central composite design coupled with response surface methodology (CCD-RSM). The response factors were extraction yield, antioxidant activity measured by three different *in vitro* assays (ABTS, CUPRAC and ORAC), also total phenolic and flavonoid content (TPC and TFC). Optimized PLE-EtOH conditions (86°C, 39 min) yielded 32.2 g extract per 100 g birch leaves, with 97.3 mg of GAE (TPC), 37.3 mg QE (TFC), 392.3 (ABTS), 297.0 (CUPRAC) and 999.3 (ORAC) mg Trolox equivalents per g of extract, under a significantly shorter extraction time compared to typical methods. The *B. pendula* leaves extract prepared at optimal PLE-EtOH conditions contained hyperoside (10.1 mg/g extract), betuloside (3.4 mg/g extract), chlorogenic acid (3.1 mg/g extract) and various quercetin-, and myricetin glycosides. Additionally, the results indicate that the PLE-EtOH extract from *B. pendula* leaves could be potentially used as an active ingredient with UV-protective effect in various phytodermatological preparations (SPF of 22.4 at 0.5 mg/ml).

Keywords
birch leaves, pressurized liquid extraction, extraction optimization, phytochemical characterization

2.3. Novel food products from the valorisation of biowastes

#24: New functional food development with olive phenolics obtained from olive vegetation water using molecular gastronomy techniques

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Wastes of olive oil production (pomace and olive mill wastewater), representing an environmental problem for Mediterranean countries is a source of phenolic substances due to the antimicrobial, antioxidant, and anti-inflammatory antiviral health effects. There is a potential market for these products and there are many studies on the recovery of olive phenolics, however, low added value causes insufficient demand and as a result, industrial recovery studies are not widespread. The USA and EU polyphenol sector have reported that the utilization of polyphenols (polyphenol enriched juice and bakery products) is limited and olive phenolics are not at the forefront. In this study, we aimed to increase the added value of innovative food additives and nutraceuticals produced from olive oil wastes by facilitating their application in molecular gastronomy.

Hydrogels enriched with commercial olive phenolic powder (Hytolive®) according to EFSA report, containing dominantly hydroxtyrosol (HTY) and tyrosol, obtained from olive fruit vegetation water is usually used in functional food production. In this study, “methyl cellulose and gelatin” with low temperature gelling feature has been preferred for the formation of the hydrogel. The hydrogel-containing recipes favorably with minimum loss of phenolic substance and sensory properties were developed. HTY content were determined by HPLC-UV. Interaction of HTY with salt, sugar and citric acid were tested and orange juice was added before gelling. Sensory characteristics was assessed by trained panelists through descriptive grading test for interactions and consumer acceptance for the final product.

New functional hydrogel was used as a cover gel such as “mochi” in a new dessert and a new appetizer. Olive phenolics having bitter taste could be offered in a consumer accepted recipe. The cover gel can be diversified by using different phenolic sources by using different fruit juices including grape or aronia. Inner part of the recipe can be reproduced with various recipes. This study represents the initial step of future studies to enhance molecular gastronomy for functional food recipes and recipes for geriatric patients considering with malnutrition due to dental problems, hyposalivation and reduced digestive system functions.

Keywords
olive phenolics, functional food, hydrocolloids, hydroxytyrosol, molecular gastronomy

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#152: Process integration for the intensified biotechnological production of 2-phenylethanol for its use as a natural food additive

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There is a growing preference towards natural food additives to improve flavour and other sensory qualities. The biotechnological production of natural aroma compounds, such as 2-phenylethanol (2-PE, rose-like flavour), is a promising study case to identify more stable and sustainable ways of manufacturing biologically derived molecules from renewable resources (biomass, bio-wastes). However, to develop robust biotechnological processes, it is necessary to address challenges on the upstream and downstream processing steps and their integration. For instance, low productivity is observed when 2-PE is accumulated in the fermentation medium, which can be tackled with the implementation of an "In Situ/In Stream Product Recovery" (ISPR).

In this work, we study bioprocess intensification through understanding the mechanisms that govern cellular physiology, fermentation performance and mass transfer in membrane-based liquid extraction, and through process integration. To this end, *Kluyveromyces marxianus* CBS 600 was used for 2-PE production. The conditions of substrate and oxygen supply for fermentation in a bioreactor were set. Prior to implementing the integrated extractive fermentation process, we studied the extraction performance of several organic solvents and their biocompatibility towards the producing yeast. Biocompatibility was evaluated in terms of impact on the cell physiological state, assessed by fluorescent double staining detected by flow cytometry.

Two solvents with the best compromise between extraction performance and biocompatibility were selected and evaluated in extractive fermentation. Flow cytometry results showed that the integrity of the membrane and cells enzymatic activity were preserved during contact with these solvents. A 53% increase in 2-PE titre was achieved compared to non-extractive fermentation.

Coupling fermentation/bioconversion to extraction processes, is a promising strategy to alleviate end-product inhibition and intensify aroma compounds bioproduction with *K. marxianus* CBS 600. In addition, results gave insight to understand the mechanisms of cell inhibition for further process optimization. Membrane-based processes offer flexibility and biocompatibility advantages, which facilitate their integration to fermentation.

Keywords
natural aromas, bioprocess engineering, process intensification, food additives, extractive fermentation

#90: Valorization of immature wasted tomatoes to innovative fermented functional foods

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Lactic fermentation of unripe green tomatoes (GT) as a tool for food ingredient production is a viable and circular economy-oriented alternative for valorising industrial tomatoes unsuitable for processing and left in large quantities in the field (up to 25 tons/ha). To produce appealing and functional food ingredients with probiotic potential, this study evaluated the use of lactic acid bacteria (LAB) as starter cultures in GT fermentation. The first trial assessed the probiotic character of *Lactiplantibacillus plantarum* (LAB97, from GT microbiota) and *Weissella paramesenteroides* (C1090, from INIAV collection). Both strains underwent an *in vitro* gastrointestinal digestion simulation, and the probiotic potential was assessed by plate counts. Results showed that LAB97 and C1090 met the viability criterion for probiotic potential by maintaining counts of 106 CFU/mL after *in vitro* simulation.

The second trial assessed the LAB starters' fermentative ability in GT. Homogenised (with 2.5% NaCl) and partially decontaminated (TT; 110 °C for 2 min) GT pulp was used to prepare the singly inoculated samples (Id: LAB97 & C1090). Non-inoculated samples with and without TT (Id: CTR-TT & CTR-NTT, respectively) were prepared as controls. Fermentation was undertaken (28 °C; 100 rpm) for 14 days. Throughout storage (0, 24, 48, 72h, 7 and 14 days), all samples (triplicates) were tested for LAB counts (CFU/mL), titratable acidity (TA; g LA/100g), solid soluble content (SSC; °Brix), total phenolic content (TPC; mg GAE/100g), antioxidant activity (AOx; µmol TEAC/100g), organic acid profile, and sensory evaluation (14th day). LAB growth reached *ca*. 109 CFU/mL for all samples after 72h. However, LAB97 samples had an earlier and higher acidification rate than the remaining samples, highly correlated to lactic acid increments. Inoculated samples showed a faster and higher decrease rate in SSC levels compared to controls. A nearly two-fold increase ($p<0.05$) during the fermentation period was observed in all samples' AOx and TPC over time ($p<0.05$, $r = 0.93$; similar pattern). LAB97 samples obtained the best sensory acceptance for aroma and overall appreciation scores compared to others. In conclusion, LAB97 was selected as a GT fermentation starter for a faster, controlled process to obtain a pleasant probiotic potential ingredient.

Keywords
functional foods, green tomatoes, food waste valorization, lactic acid bacteria, lactic fermentation

#60: Quercetin recovery, antimicrobial and antioxidative properties of waste streams in onion production

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New approaches and alternative strategies to waste disposal are required for the notoriously linear food production chains, focusing on pathways of re-use. Onions (Allium cepa L.) are the second most commonly harvested fresh vegetable in the European Union. The annual residues in onion production are estimated at approximately 0,45 million tonnes, which are abundant in bioactive compounds. To understand the potentially beneficial functional properties for the fortification of foods, we examined various parts of the onion (edible/inedible waste/outer skin of red, yellow and white onion, and white shallots) and prepared green extracts in water/ethanol and by shaking/sonication. Initially, the ethanol extracts of the waste fraction were identified as particularly promising, as they had the highest quercetin content and antioxidant capacity among all varieties and parts. When dried, the waste ethanol extracts exhibited high antioxidant capacity (25-40 mg Trolox equivalents g-1extract) and provided a high recovery rate of quercetin (0,200–0,400 mg quercetin g^{-1} harvested dry produce). Amongst the tested sources, the dry skin of the yellow onion was is the most commercially available fraction. The dried yellow onion skin exhibited high antimicrobial activity and showed good chemical and microbiological stability for the quercetin content under various storage conditions (4, 25, 37, 40 °C; dark/light; dry/moist air/in water). The combination of the identified properties of the dried yellow onion skin was utilized to demonstrate two different applications: (i) tableting for home use (convenient for storing and straightforward dosing for home cooking), and (ii) as a stabilisation additive for prolonging the shelf-life of olive oil. Both approaches represent efficient and straightforward circular approaches through waste prevention and food fortification.

1. Osojnik Črnivec IG, Skrt M, Šeremet D, et. al. Waste Manag, 2021, 126, 476-486.

Keywords
quercetin, food waste, onion skin

2.4. Functional Microbes for Food Processing and Health Improvement

#35: Mycoprotein as novel functional ingredient: mapping of functionality, composition and structure throughout the Quorn fermentation process

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The production of mycoprotein using the microfungus *Fusarium venenatum* by Quorn Foods for use in their meat-free products is a potential source of novel sustainable functional ingredients. We previously showed that an extract from the Quorn fermentation co-product (centrate) displayed high foaming, emulsifying and rheological properties.

This current study provides the first mapping of mycoprotein functionality, composition and structure throughout the whole Quorn process. The different fermentation streams and their centrifugation deposits and supernatants were investigated: broth, RNA-reduced broth (following a heat-shock RNA-reduction process) and centrate (following a second heating step and centrifugation).

The broth, RNA-broth and their deposits showed high viscosities while their hydrogels displayed high viscoelasticities in comparison with a whey protein concentrate (WPC) control. The RNA-broth and centrate supernatants showed higher foaming ability and stability than WPC. Oil-in-water emulsions prepared with the broth or its supernatant displayed similar emulsifying activity, emulsifying stability and oil droplet size distribution to WPC.

Large hyphal structures were observed in the broth, RNA-broth and their deposits, which contributed to their high rheological properties, while small fungal fragments contributed to oil droplet stabilisation in emulsions prepared with these samples.

A cerato-platanin was found in higher concentrations in the RNA-broth supernatant and centrate as a result of cell damage following the two heating steps and contributed to their higher foaming properties. Proteomic and metabolomic analyses showed evidence of upregulation of the mRNA decay pathway following the two heating steps. As a result guanine and guanosine derivatives were reported in higher concentrations in RNA-broth and centrate samples and contributed to their foaming, emulsifying and rheological properties.

This study identified previously unreported gelling, foaming and emulsifying properties for the main Quorn fermentation streams, highlighting opportunities to use this process to produce novel sustainable alternatives to animal-derived ingredients. This work also highlighted the possibility to modulate the structure and functionality of mycoprotein via heating.

Keywords
quorn, mycoprotein, functionality, composition, structure

#58: Production of short-chain fatty acids (SCFA) and antioxidant capacity of postbiotics from *Lactobacillus plantarum* 299v and *Bifidobacterium lactis* BPL1 using whey and soluble fibers

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Postbiotics are a mixture of metabolites or cellular material in the presence or not of inactivated probiotics that confer a health benefit to the consumer. Within these metabolites, the short-chain fatty acids (SCFA) are produced from the fermentation of soluble fibers by different species of probiotics. Furthermore, whey is a good choice as a culture medium for adequate bacterial growth, given its chemical composition and commercial availability. Postbiotics are a source of antioxidants due to their complex chemical composition. The aim of this study was to analyze the SCFA production of cell-free supernatant (CFS) *Lactobacillus plantarum* 299v and *Bifidobacterium lactis* BPL1, using whey with different concentrations of inulin and chia mucilage to enrich the culture medium and determine the antioxidant capacity of the postbiotics recovered. The production of SCFAs was determined by HPLC and the total antioxidant capacity by KMnO4 agar method of whey-based culture medium with 1% w/w inulin or 1% w/w chia mucilage. The results showed that B. lactis BPL1 produced the highest amount of SCFA (28.67 mM acetic acid, 13.56 mM butyric acid, and 16.92 mM propionic acid) when whey was enriched with inulin. The addition of soluble fibers in the whey mediums showed a significantly high antioxidant capacity ($p < 0.05$) of the postbiotics produced by *L. plantarum* 299v with respect to the ones produced by *B. lactis* BPL1, and with respect to the non-enriched whey as culture medium. From these results, we can conclude that this formula based on whey and natural fibers can be considered as a good alternative to produce postbiotics in the food industry.

Keywords
posbiotics, SCFA, probiotics, soluble fibers

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#55: *Lacticaseibacillus casei* CNCM-I5663 : a probiotic to reduce Sarcopenia in undernourished older people

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In 2050, the ageing population will reach 35% of European population, within it, 30% will suffer sarcopenia. Sarcopenia is recognized as a hallmark of undernutrition in adults. Nutritional enrichment with proteins and exercise limit sarcopenia, but these strategies are difficult to apply to frail people because of their loss of appetite, non-compliance for exercise or disability. Based on the existence of a gut-muscle axis and the role of microbiota in supplying energy to host (1), the aim of the study is to isolate a probiotic strain that could protect muscle mass for frail individuals.

We have used fecal samples of one patient with a short bowel syndrome (SBS) as a source of new strains. This patient has had an extensive surgery shortening his gut length and deeply modifying its intestinal microbiota. Since the gut microbiota of SBS is efficient to rescue energy and is very rich in Lactibacillacea, we isolated lactic acid strains from their faeces(2, 3).. The neamatode *Caenorhabditis elegans* model was used to select a strain able to protect muscle integrity. *Lacticaseibacillus casei* CNCM-I5663 strain promotes longevity and maintains the mitochondrial networks of wall muscles in *C. elegans*. Then, this strain was tested *in vivo* with aged rats (18 months) under moderate caloric restriction (75% of ad libitum), mimicking frail individuals. This strain improves insulin sensitivity (HOMA-IR after 2 months of supplementation with probiotic, ANOVA, $p=0.056$) and preserves the mass of the rats' hindlimb muscles by 12% compared to the restricted controls (ANOVA, $p<0.05$)(4).

The strain *Lacticaseibacillus casei* CNCM-I5663 strain could be a promising probiotic to limit sarcopenia in specific populations, like undernourished older people.

1) Giron M, et al; Journal of Cachexia, Sarcopenia and Muscle 2022 Jun;13(3):1460-1476.

2) Gillard L, et al ; Frontiers in physiology 2017 Apr 19;8:224.

3) Gillard L, et al; Sci Rep. 2016 Jun 21;6:28345.

4) Giron M et al; Frontiers in nutrition, 2022 Front Nutr. 2022 Aug 10;9:928798.

Keywords

probiotic, gut-muscle axis, sarcopenia, undernutrition, elderly

#93: *In vitro* bioaccessibility optimization and enhancing oxidation stability for functional yoghurt incorporated with encapsulated krill oil nanoemulsion systems

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Background: Lipid oxidation is one of the main problems in food industry, because it causes off-flavor and formation of potentially toxic compounds. Aim: This study aimed to enhance oxidation stability of krill oil using black cumin oil and optimization of *in vitro* bioaccessibility using two different physical encapsulation techniques (freeze-drying and spray-drying) and application in functional set-type yoghurt. Materials and methods: The nanoemulsion systems were prepared using krill oil (10 %, S1), krill oil & black cumin oil (1:1, S2) and krill oil & β-carotene (0.001%, S3, as a slandered antioxidant). The particle size and zeta potential for nanoemulsion systems were evaluated. The freeze and spray-drying were used to encapsulate the previous nanoemulsion systems. The encapsulation efficiency (EE) and Surface morphology of microencapsulated powder were assessed. Set- yoghurt fortified with microencapsulated nanoemulsion systems powder and the physicochemical properties, oxidative stability (peroxide value (PV) and Thiobarbituric acid-reactive substances (TBARS)) and *in vitro* bioaccessibility determined during cold storage. Results: The particle sizes were 154.43, 189.57 and 169.97 for S1, S2 and S3 respectively. EE of S2-spray dryer was the highest (85.5%) compared to S2 and S3. The yoghurt fortified with S2-spray dryer sample showed the strongest oxidative stability and *in vitro* bioaccessibility was the highest throughout the storage period (14 days). Also, the physicochemical properties of this treatment had slight effect compared to control. Conclusion: this work showed that nanoemulsion system from krill oil and black cumin had been encapsulated using spray drying successfully with strong oxidation stability and high *in vitro* bioaccessibility.

Keywords
oxidation stability, *in vitro* bioaccessibility, microencapsulation, functional yoghurt

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2.5. Sustainable Technologies for Food Preservation

#224: Thermal and functional properties of pre-treated cassava flour from two landraces using response surface methodology

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Cassava flour (CF) is mostly constituted to "dough form" when applied in various food applications, through the incorporation of water in the presence of heat. This study investigated the effect of two pre-treatments (calcium chloride and citric acid) and their interaction with varying drying temperatures on the functional, hydration and thermal properties of CF from red and white cassava landraces. Response surface methodology was employed in determining the linear, interactive and quadratic effect of varying concentrations of pre-treatment (0.6 – 3.4%w/v) and drying temperature (45 – 74^{o}C) on CF. Differential scanning calorimetry gave the following range for onset gelatinisation temperatures (60.32 - 120.30 ^{o}C), peak (71.85 - 126.84 ^{o}C), conclusion (93.31 - 140.98 ^{o}C), and enthalpy of gelatinisation (0.14 - 54.95 J/g) in all the CF samples. The CF processing conditions significantly increased the gelatinisation enthalpy. Citric acid pre-treatment had a significantly decreasing effect on the water-holding capacity when compared to calcium chloride. Drying temperatures significantly influenced the bulk densities of CF, while the loose bulk density increased with drying temperature. An increase in enthalpy of gelatinisation in CF, due to the pre-treatment, infers that more energy will be required for gelatinisation to occur. Therefore, the processing conditions confer on CF more stability in the presence of heat and water. The optimal processing conditions varied due to the influence of the independent variables.

Keywords
bulk densities, cassava flour, pre-treatment, thermal properties, hydration properties, response surface methodology

#120: Numerical simulation of microwave processing of solid-liquid mixtures

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In pasteurization, when a solid-liquid mixture is thermally processed, the flow of particles within the liquid through a holding pipe is a conventional liquid–particle interaction example. From the food processing point of view, the temperature change of the liquid phase and solid particles must be known for the safety of the process. Designing such a process where the solid-liquid mixture is pumped through a microwave cavity also requires knowledge of electromagnetic field distribution. Therefore, this study aims to develop a mathematical model to predict the temperature and velocity profile of the liquid-solid mixture during microwave processing.

For this purpose, the movement directions of the particles were first determined using a particle tracing model, and then the heat transfer and electromagnetic field physics were coupled using a finite element-based Multiphysics software (Comsol V6.0, Comsol, AB, Stockholm, Sweden). The particles paths through the liquid and pipe system were used within the heat transfer and electromagnetic field distribution determination models. The developed model was validated with experimental data for particle movement within a low-viscosity Newtonian liquid and temperature distribution for microwave processing of low- and high-viscosity liquids. Following the model validation, process design studies were carried out for continuous flow microwave systems with straight and helix pipe structures to innovate the conventional process for improved sustainable processing.

These features demonstrated the innovation potential of the developed model for sustainable food process modeling.

Keywords
CFD, solid-liquid mixtures, thermal processing, heat transfer, microwave heating

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#145: Can electroheating technologies contribute to food industry sustainability?

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United Nations Sustainable Development Goal 7 (SDG7) is aimed to ensure the access to affordable, reliable, and sustainable and modern energy for all. Ensuring access to modern food heating solutions is a key component to achieving for SDG7, and also the access to modern food heating solutions must be considered as a key component to achieving for SDG7. Electro-heating applications in food processing include all processes using the interaction of a food material or product with an electromagnetic field, as in microwave, radio-frequency, and moderate electric fields processing. These technologies involve the use of electrical and -more recently- electronic circuits and require professional figures in their design. As result, the installation cost of these technologies is way higher than installation cost for heating processes using fossil sources, as fuel for fire boilers, as an example. Furthermore, at industrial level, these technologies may require ad-hoc design. Consequently, the food processing industry is quite slow in embracing such technologies along the productive lines. This paper presents a viewpoint on the challenges and opportunity to use electro-heating applications along the food processing chain, as a contribution to food processing sustainability. The role played by CAFE (Computer Aided Food Engineering) to accelerate the shift towards the use of such technologies is discussed too.

Keywords
sustainability, microwaves, radio-frequencies, MEF, electroheating

#97: Improving functionality of fibre concentrates obtained from various agri-food side streams by colloid milling

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Agri-food side streams generated during industrial processing can potentially be valorized as fibre-rich food ingredients e.g., dietary fibre concentrates (DFC). However, the DFC is limited in food applications due to poor functional properties. In this study, colloid milling was firstly investigated as an environmentally friendly and physical method to improve the functional properties of DFC. Several selective functional properties such as swelling capacity, water holding capacity and emulsifying activity showed significant improvement after colloid milling treatment. Secondly, the functional properties and the particle morphology of colloid-milled DFCs from six different sources were evaluated. It was showed that the effectiveness of colloid milling treatment on improving DFCs' functionality depended on their origin and the improved functionality could be attributed to the increased elongation of fibre particles. This study shows that the difference in morphological properties of DFCs particles from various sources led to completely different functional behavior of colloid-milled samples, which helps to select and further valorize the DFCs from various argi-food side streams.

Keywords
colloid milling, agri-food side stream, dietary fibre concentrates, functional properties, particle morphology

#171: Observing the wetting of a tomato leather-cheese sandwich by Magnetic Resonance Imaging (MRI)

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Tomato leather is a dried product obtained by drying a mix of crushed tomatoes and other ingredients (salt, spices) by hot air drying. The leather formulation can be enriched by adding plant proteins. Leathers have the potential to be used as support material for a cheese sandwich to substitute bread and can be considered as the 'wafer' in a confectionery product. In this study, we have formulated tomato leathers using pea and RuBisCO proteins obtained from sugar beet leaves and produced cheese-leather sandwiches. Four slices of leather were used and cream cheese was used in between. Migration of water to leather slices was monitored by using Magnetic Resonance Imaging (MRI) to see how long it will take for an undesirable wetting of the leather. Leathers of different formulations were used and proton density-weighted MR images were acquired. Sandwiches were stored at room temperature and 6 images were acquired during the storage. T_1 and T_2 relaxation times were acquired as well during storage. Texture analysis experiments also confirmed the results. Signal intensity changes in the images with storage were calculated and the rate of wetting for different formulations was determined.

Keywords
magnetic resonance imaging, wetting, tomato leather

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#199: Small fruit pomace ingredients for healthier and safer processed meat products

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International Agency for Research on Cancer (IARC) classified processed meat as carcinogenic to humans (Group 1). Since then, mitigation of the adverse health effects of such meat products has become a challenge to the researchers and industry. In addition, meat products are highly sensitive to microbiological and oxidative spoilage during storage. It is hypothesized that plant origin phytochemicals, particularly antioxidant polyphenolics, may reduce the carcinogenicity of processed meat *via* various chemical and biological mechanism; however, unambiguous evidence of reducing disease risks are very difficult to obtain. On the contrary, antimicrobial and antioxidant effects of plant ingredients in foods may be easily determined and have been reported in many studies. This paper reviews the results, which we obtained during the last years on using ingredients recovered from the small fruit (commonly called berries) pomace in meat products. Firstly, we developed high pressure, ultrasound and enzyme assisted technology for a stepwise biorefining of berry juice pressing by-products into the high nutritional and biological value ingredients with different composition, properties and targeted applications. Composition, antioxidant and antimicrobial activities as well as cancer cell antiproliferative properties of the extracts were determined by using various *in vitro* assays. Afterwards, the organoleptically acceptable doses of ingredients from raspberry, black chokeberry, black currant and cranberry pomaces were established and the ingredients were added into the meat products. In general, polyphenolic-rich extracts inhibited the growth of meat spoilage bacteria and reduced the rate of oxidative processes. The effects on other meat quality characteristics were rather insignificant, except of color, which was strongly influenced by the anthocyanin pigment-rich ingredients. The products were also subjected to the simulation of gastrointestinal digestion and antioxidant properties as well as inhibition of the selected cancer cells by the digesta extracts were determined at different phases of digestion. The results obtained revealed the advantages of using pomace ingredients in meat products for obtaining double effect, *i.e*. increasing their shelf-life and providing health benefits.

Keywords
processed meat, berry pomace ingredients, bioactivities, health benefits, phytochemicals

#77: Development of a smart tool for avocado fruits (*Persea americana*) ripening evaluation, shelf-life management and waste reduction

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Recent years have seen a remarkable growth trend in avocado consumption, with projections that its exports will overpass those of pineapple by 2030, becoming the second most traded tropical fruit. When paired with their high unit value, this growth could make avocados one of the most important fruit commodities of the next decades.

As the production of avocados is still limited to the tropical and subtropical regions, its exports are directly impacted by time-consuming distribution channels. Combined with the relatively high unpredictability of their post-harvest behaviour, this makes avocado fruits highly prone to wasteful practices.

The development of non-destructive tools that accurately trace the ripening process of avocado fruits could be key to a better management of their shelf-life, optimizing their post-harvest handling to a point of drastically reducing distribution waste.

A smart data-driven tool was developed that uses Machine Learning to improve the traceability of the ripening process of Hass avocado pears. A total of 476 avocados were divided between three storage groups, with different environmental conditions, and their ripening behaviour was traced by the implementation of an innovative 5-stage Ripening Index that classified the ripening stage of each sample according to a set of common traits.

This information was paired with daily photographs of each avocado to build a database of labelled image data that was then fed to two Convolutional Neural Networks, AlexNet and ResNet-18, taking advantage of the concept of transfer-learning where pre-trained knowledge is used to improve their adaptation to new sets of data.

The networks were trained to recognise the specific visual traits of each ripening stage, so that they could predict the state of new unlabelled data. This knowledge was tested on new datasets, reaching an average final accuracy of 77,8%, with an average of 95,0% of the predictions falling within one stage of the attributed classifications.

These results represent an important step for the integration of Computer Vision tools on the post-harvest management of perishable products, which could not only improve shelf-life determinations, but ultimately be expanded into other assessments, with a major potential impact on waste prevention and quality improvement.

Keywords
avocado, ripening, smart tool, shelf-life

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#36: High percentage cassava flour inclusion in bread using enzymes from indigenous yeast as improvers

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The bread cost in Sub-Saharan Africa has risen beyond the average person's reach, mainly due to the cost of wheat importation. Cassava, a starchy tuber predominantly produced in Africa, especially in Africa is gluten-free and a cheap source of flour. In the current study, enzymes from indigenous yeast strains were explored as possible improvers for achieving high-percentage cassava flour inclusion in bread. Sixty yeast strains were isolated from palm wine, decaying fruits, and cassava effluent polluted soil. Strains were selected based on the ability to produce cellulase, xylanase, lipase, pectinase, amylase, and protease and the effect on high cassava composite bread quality. Composite bread was evaluated based on physical and sensory attributes, weight loss during storage, staling properties, and shelf-life. The influence of cell concentration and fermentation time on multiple enzyme production and composite bread quality was determined. The effect of enzyme volume and percentage of cassava flour on product quality was also evaluated. The isolate identified as *Candida phangngaensis*, an anamorphic and oleaginous yeast, gave the best bread and was applied for further studies. Enzyme extract from 4h fermentation with 2 ml cell concentration ($1.91x10^6$ cells/ml) gave the best loaf quality, while the most minor quality was from 8h fermentation with 5 ml cell concentration ($6.49x10^6$ cells/ml). The extract which gave the best quality product had in Uml^{-1}: amylase (201.00), protease (0.00), xylanase (29.0), pectinase (0.499), and lipase (20.3), cellulose (0.466) as compared to amylase (15.75), protease (5.25), xylanase (36.0), pectinase (2.542), lipase (18.0), and no cellulase from the extract which gave the least quality. An enzyme volume of 12.5 ml gave the optimum loaf quality with specific volume (1.11) and loaf volume ($198.9cm_3$). Remarkable improvements were observed in the loaf quality when the enzymes were partially purified. The results of the physical and sensory evaluation using partially purified enzyme showed no significant difference ($P \geq 0.05$) in the bread quality with up to 40% substitution compared to the 100% wheat bread. The results indicate that properly using these enzymes in baking will surmount many problems associated with cassava flour and enable 40 % > cassava substitution in wheat bread.

Keywords
cassava flour, wheat bread, composite flour, *Yarrowia phangngaensis*, enzymes

2.6. Environmentally Sound Packaging

#204: Graphene-based materials for food packaging applications

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Graphene-based materials (GBMs) and their nanocomposites have been used widely in numerous industries. Due to their remarkable properties, these materials are being explored for potential use as food packaging materials. GBMs offer efficient reinforcement in mechanical properties, barriers to light, water vapour, and gases, as well as antimicrobial and antioxidant properties. Their functional properties are crucial for prolonging the shelf life of foods. Some factors that affect the behaviour and properties of the GBMs during the film production and fabrication of the composites are revealed. Then, GBMs have been combined with chitosan to produce active food packaging to extend the shelf life of margarine. Films were prepared by casting method, and the mechanical, barrier and antioxidant properties were determined. The composite films with 2.0% graphene oxide showed lower water vapour permeability and oxygen permeability ($P < 0.05$) by up to 55%. Graphene oxide also increased ($p < 0.05$) the radical scavenging activity. Furthermore, the margarine that was wrapped with composite films and stored for one month at 4 ºC exhibited lower ($p < 0.05$) peroxide value and thiobarbituric acid reactive substances (TBARS) than regular low-density polyethylene films. Therefore, GBMs in packaging film showed high potential as antioxidant food packaging material.

Keywords
graphene film, active packaging, biodegradable polymer, shelf life, nanocomposites

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#98: New bio-based food packaging: an innovative multilayer architecture based on poly(lactic) acid and nanocelluloses

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New solutions for the food packaging industry are mandatory to reduce the impact of plastics on the environment. Consequently, bio-based and biodegradable food packaging has attracted new interests. Among all bio-based solutions, nanocelluloses i.e. cellulose nanocrystals (CNC) and cellulose nanofibrils (CNF), have multiple advantages: renewability, transparency, good mechanical and barrier properties, which makes them of highest interest for food packaging applications[1]. However, in the presence of water, their outstanding barrier properties are not preserved[2]. Consequently, the use of nanocelluloses in food packaging, while extremely promising, is still a challenge. To overcome this sensitivity to water, a multilayer architecture with an hydrophobic layer of poly(lactic acid) (PLA) could be a solution to protect nanocelluloses. Different studies have been devoted to the use of nanocelluloses as fillers in PLA matrix3, but in this work, a new architecture was developed: nanocelluloses layers coated on PLA. This multilayered structure preserves and combines the favorable properties of PLA and nanocelluloses. The effects of nanocelluloses coating on the oxygen barrier properties and water vapor barrier properties were studied, as well as the organization of the nanocellulose layers. Very promising results were obtained, with oxygen permeability of PLA/nanocelluloses samples reaching food packaging requirements, thus validating this innovative process.

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Keywords
nanocelluloses, poly(lactic acid), multilayer films, barrier properties, food packaging

#235: Bionanocomposites for food sensing and packaging

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Nowadays, nanotechnology has provided significant advances in food sensing and packaging. The properties of materials at the nanoscale have attracted attention to developing new technologies to improve the quality of food, increasing its shelf life and evaluating its safety. Currently, food packaging relies on the use of non-degradable plastics. One solution to this problem is to consider biodegradable materials in food packaging and improve their properties. This can be done by incorporating nano-biomaterials into biodegradable polymers to form bionanocomposites which are ideal materials for developing environmentally friendly and degradable food packaging with enhanced mechanical strength, improved gas barrier properties, increased water resistance, and especially with high antimicrobial and antioxidant properties. They can also be used to develop fast and highly sensitive nano-sensors to assess food freshness, detect allergens or pathogenic contaminants.

This work aims to present a state of the art regarding nanomaterials in biodegradable food packaging and nano-sensors for food appraisal.

Keywords
bionanocomposites, food packaging, food sensing, biopolymers, bionanomaterials

#112: Polysaccharide based (nano)materials for active food packaging

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The exploitation of active packaging technologies and biopolymeric materials are among the emerging trends for the implementation of a more sustainable food packaging industry. Polysaccharides, e.g., cellulose (including its nanometric forms, nanofibrillated cellulose (NFC) and bacterial nanocellulose (BNC)), starch, pullulan, and chitosan, among others, have gained relevance in this field due to their unique properties (including, renewable nature, biodegradability, tailorable surface chemistry, film-forming ability and good mechanical properties), which, combined with distinct bioactive compounds (e.g., plant extracts, and other biopolymers) allows the fabrication of advanced biobased (nano)materials for sustainable active food packaging.

The present communication describes innovative polysaccharide-based materials, fabricated following simple and eco-friendly approaches. Focus will be given to recent works carried out in our research team on the combination of nanocelluloses with other polysaccharides (e.g. starch, xylans, pullulan, among other) and/or bioactive compounds to produce active films with improved properties, including mechanical performance, antioxidant and antibacterial activities, for active food packaging. The main challenges and achievements will be presented and discussed.

Keywords
active food packaging, sustainable materials, bio-based materials, polysaccharides, nanocelluloses

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#111: Assessing the thickness of characteristic layers in a polymer-coated cardboard

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Papers and cardboards appear to be excellent candidates for the conventional and polluting plastics' substitution in the field of packaging. However, despite their biodegradability in natural conditions, papers and cardboards present poor barrier properties towards gas and water vapour, thus hindering their use for a large range of application. An emerging solution is to coat a thin layer of high-barrier biopolymer (which would also be biobased and biodegradable) as functional layer, on the surface of a cellulosic substrate. Due to the paper intrinsic porosity, a part of the coated polymer unavoidably penetrates within the cellulosic substrate leading to the creation of a complex multi-layered structure with at least three layers having their own properties. Understanding this complex structure is necessary for the development of materials with tailored properties for packaging applications.

In this context, the aim of this study was to characterize the thickness of each layer of cellulosic-based multilayer materials, including the impregnated layer.

For that purpose, a range of coated cardboards displaying contrasted structures were considered. Two polymers were selected to reach different impregnation levels into the cellulosic substrate: PHBV, poly(3-hydroxybutyrate-co-3-hydroxyvalerate), a biopolymer having a low melt viscosity and a high melting point, and LLDPE, linear low-density polyethylene, a conventional polymer with a higher melt viscosity and a lower melting point, as benchmark for coating polymers. Untreated blotting papers and commercials cardboards (Cup Forma Natura, Stora Enso) were selected as cellulosic substrates to emphasize the phenomenon of polymer impregnation.

Two methods were compared for thickness assessment. The first one was based on image acquisition (X-ray microtomography and scanning electron microscopy) and analysis which allows the visualisation of the different layers and thus give thicknesses close to reality. The second one relied on direct measurement of total thickness of coated cardboards and analytical calculations using physical parameters of the substrate (total porosity, grammage) and the polymer (density, coating weight). This second method represents an easiest, cheapest, and more accessible way to determine the impregnated layer thickness.

Keywords
coated cardboard, cellulose-based materials, structural analysis, impregnation, thickness characterization

#113: Development of starch/cellulose nanofiber bionanocomposite films containing thymol as active food packaging material

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The main issue encountered in the food industry is the contamination and spoilage of food caused by microbes that result in food wastage and foodborne illness. Active food packaging is a new and innovative type of packaging that can help to solve this issue. Due to the consumer demands for environmentally friendly and sustainable packaging materials, the development of active food packaging material is now directed towards utilizing biopolymers and natural antimicrobial agents. Biopolymers such as starch are promising to be developed into food packaging material owing to their film-forming ability, biodegradability, and low cost. Hence, this work was directed towards exploiting starch for the production of active food packaging material that is environmentally friendly and sustainable. Cellulose nanofiber (CNF) which acts as a reinforcing compound was incorporated into the starch films, thus producing starch/CNF bionanocomposite films. Moreover, thymol, an antimicrobial agent was also added producing starch/CNF/thymol films. The films were produced using a solvent casting method and characterized in terms of mechanical, thermal, barrier, and antibacterial properties. The addition of CNF to the starch films was found to improve the mechanical, thermal, and barrier properties of the films. Meanwhile, the addition of thymol reduced the mechanical and barrier properties but increased the thermal stability of the films. The disc diffusion assay revealed clear inhibition zones of starch/CNF/thymol films against bacteria. A liquid culture analysis also confirmed the inhibitory effect of the films whereby there was a reduction in the number of bacteria in log CFU/mL. To demonstrate the application of the films, the films were applied in contact with meat slices and stored for 7 days. The meat samples in contact with the films containing thymol were less impacted by microbes than the films without thymol. In conclusion, this study will be advantageous to the agri-food and packaging industries, whereby the new environmentally friendly active food packaging material can be produced and applied to improve the shelf life of food products and has the potential to be commercialized, contributing to economic growth.

Keywords
active packaging, biopolymer, cellulose nanofiber, nanocomposite, thymol

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#100: Starch-based active films enriched with plant extracts: a review on a new type of eco-friendly food packaging material

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With the increase in the consumption of plastic packaging, the large amounts of wasted plastics have resulted in serious environmental concerns, and even endangered animal and human health. Developing effective alternatives to troublesome materials, like non-biodegradable petroleum-based plastics, is the focus of much current research in various scientific areas, especially food packaging. In this context, new trends are focused on replacing conventional plastics by biodegradable biopolymers such as starch, cellulose, alginates and proteins, among others. Starch-based films, in special, is qualified as a future green biopolymer-based material substitute for non-biodegradable polymers-based films, because it is widely available and produced in several continents in an economical way, from renewable sources and it represents a good matrix to load active compounds. At the same time, many research have focused on extending the shelf life of food through exploiting new active packaging films that could effectively prevent food oxidation and microbial contamination, because it is well known that these are the major issues affecting food quality. Antioxidants can be part of the composition of food or added to products during processing, however the use of synthetic antioxidants has been questioned mainly due to their potential toxicity and the consciousness of people, who are paying more attention to natural, organic, and green food ingredients. So, natural antimicrobial and antioxidant compounds, like phenolic compounds, found mainly in plant leaves, have shown potential applications for the production of active packaging, in order to prevent the degradation and extend the shelf life of products. For this reason, this review cover films loaded with different plant extracts, like basil leaves, yerba mate, licorice residue, rosemary, oregano, green tea, “erva baleeira”, “pitangueira” leaves, and others. The starch films added with extracts have excellent antioxidant activity, because no interactions between the chains of the biopolymer and the active compound occurs, and these properties vary depending on the type of extract, besides these films present themselves as eco-friendly and useful material for food packaging and coating.

Keywords

wasted plastic, biodegradable biopolymers, active food packaging

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#119: Development of carboxymethyl cellulose and chitosan edible films with incorporation of kesum (*Persicaria minus* Huds.) essential oil nanoemulsion

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The purpose of this research was to compare the physical properties and antibacterial activity of kesum essential oil (KEO) emulsions and nanoemulsions for edible film formulation. Furthermore, the current study compared the physicochemical, mechanical, and antibacterial properties of carboxymethyl cellulose-chitosan based edible films containing KEO nanoemulsion. In comparison to coarse emulsions (243nm), the droplet sizes of KEO nanoemulsions were 91 nm. KEO nanoemulsion and emulsions had PDI of 0.16 and 0.41, respectively. The PDI value obtained for KEO nanoemulsions (PDI less than 0.3) demonstrated a narrow pattern of size distribution and droplet uniformity. KEO emulsions and nanoemulsions had zeta potential values of -27 and -26 mV, respectively. The incorporation of KEO nanoemulsions significantly reduced the L * values of the film samples. The increased concentration of KEO nanoemulsions (12% v/v) in films resulted in thicker (0.1405 mm), more opaque (1.5850), low moisture content (19.21%), and low water solubility (65.50%), resulting in excellent mechanical properties with higher tensile strength (5.833MPa) and elongation at break (51.20%), as well as higher antibacterial activity against *Escherichia coli* (zone of inhibition of 0.71 mm) and *Bacillus subtilis* (zone of inhibition of 0.78 mm) as compared to other edible films with no or lower concentration of KEO nanoemulsions. By observing the SEM images obtained, the surface of the KEO-free film was smooth, with vesicle-like structure and bubbles, and no holes or cracks were observed. However, the films containing KEO nanoemulsion had a rougher surface with wrinkles, small cracks, and some holes. Furthermore, as the concentration of nanoemulsified KEO increased, the incorporated KEO nanoemulsion improved the compactness and density of the edible film matrix. In conclusion, the study showed that the prepared active film containing KEO nanoemulsions had a high potential for use as effective and natural alternatives for active food packaging.

Keywords
food preservation, essential oil, nanoemulsions, edible film, antibacterial activity

2.7. Plant-based Healthier Foods

#255: The effect of sweet cherries (*Prunus avium* l.) on choline metabolism and trimethylamine production

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Choline is an essential nutrient that is present in animal products such as meat, cheese and eggs and in some dietary supplements. It has also been shown to be converted to trimethylamine (TMA) by bacteria in the human gut, and this TMA is absorbed and converted to TMA-N-oxide (TMAO) in the liver. Higher circulating TMAO is associated with increased risk of cardiovascular and multiple other diseases and with inflammation and insulin resistance. There are also several studies in rodent models and one in humans showing that increasing TMA(O) exposure causes disease, for example cardiovascular disease by increasing platelet reactivity and thrombosis. We have shown that metabolism of choline in a faecal inoculated batch fermentation model of the human colon authentically replicates what happens *in vivo*, and we seek to use this to identify dietary components that may effectively inhibit the gut microbial conversion of choline to TMA.

The aim of this study was to investigate the effect of sweet cherry on the production of TMA from choline by gut microbiota.

In this research, in-vitro colon model was inoculated with 1% faecal inoculum from different healthy donors (n = 3, ClinicalTrials.gov registration number NCT02653001), together with 2 mM choline, and 1g of freeze-dried cherry fruit. Samples were collected from the model at various timepoints over 30 hours. The concentrations of choline and TMA were quantified in the samples using LC-MS/MS.

Cherry showed an inhibitory effect on the metabolism of choline to TMA. In the model conditions treated with cherry, choline metabolism was slower (24h) compared with the control (20h) ($p < 0.01$). TMA appeared in all models between 9-30h, but were at significantly lower concentrations in the cherry treated vials with the significance at timepoint 20h between the control and the treatment ($p < 0.05$).

We found that cherry contains one or more components that affect the choline metabolism and the production of TMA. Cherry suppressed choline conversion to TMA which might be a promising way for the reduction of TMAO levels. For further studies, by isolating the components of the nutrients based in cherry matrix or different fruit samples that have high polyphenol content and potential to reduce production of TMAO's precursor TMA can be performed as a dietary strategy.

Keywords
sweet cherry, choline, trimethylamine, colon model, phenolics

#184: Application of pectin and grape seed polyphenols to restore consistency and emulsion stability in reduced oil vegan mayonnaise obtained from chickpea aquafaba

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Aquafaba has recently gained popularity as an egg substitute suitable for production of vegan mayonnaise. However, although aquafaba could be successfully employed to obtain O/W emulsions with desired rheological properties in high vegetable oil containing mayonnaise formulations (~80% oil) it lacked to give the desired consistency and emulsion stability in reduced oil formulations (~60% oil). This study aimed to produce reduced oil aquafaba mayonnaise as a healthier substitute than standard high oil aquafaba mayonnaise. For this purpose, for the first time in the literature, pectin (HMP) alone or in combination with grape seed phenolic extract (GSE) is employed to restore consistency and emulsion stability in reduced oil (25% less oil) aquafaba mayonnaise. The back extrusion tests of classical (M80, 80% oil - 15% aquafaba) and reduced oil (M60, 60% oil – 35% aquafaba) aquafaba mayonnaise with HMP and/or GSE were conducted to compare consistency and viscosity indexes, firmness, and cohesiveness of samples. Compared to M80 the consistencies of M60 and M60 with HMP (at 1%) reduced by 8.1- and 1.6-fold, respectively. In contrast, the addition of HMP and GSE (each at 1%) into M60 caused 7.6 fold higher consistency than that of M80. The particle size (D43) and zeta potential values were also obtained as 40.2 µm and -18.5 mV for M80, 32.2 µm and -17.7 mV for M60, 25.2 µm and -25.7 mV for M60 with HMP, and 30.8 µm and -19.8 mV for M60 with HMP and GSE, respectively. Additionally, the microscopy images obtained suggested destabilization of M60 due to flocculation while samples with HMP and HMP-GSE lacked signs of flocculation. The positive effects of HMP in emulsion stability were attributed mainly to its effect on increased consistency, reduced emulsion droplet size, and increased electro negative charge intensity of protein coated droplets. While the effect of GSE in the presence of HMP is more likely due to the increased entanglements among linear pectin molecules interacting with polyphenols. This work showed that the production of reduced oil aquafaba is possible by addition of HMP alone or HMP in combination with GSE. The enhanced stability of emulsions like mayonnaise by GSE is quite promising since polyphenols are effective antioxidants preventing oxidative changes in lipid rich food and showing health benefits on consumer.

Keywords
vegan mayonnaise, reduced-fat mayonnaise, pectin, grape seed extract, polyphenols

#23: Rheological investigation through 3D printed omega-3 rich analogue cheese using grass pea and microalgae biomass

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In this study, a 3D printed plant protein-based cheese analogue was formulated using a blend of grass pea protein, starch, and microalgae cells. Protein concentrates from *Lathyrus Sativus* and *Lathyrus Rotundifolius* were extracted by an alkaline method and the chemical, rheological and functional properties of the protein were investigated. *Nannochloropsis ocenica* was cultivated on nanofiltered acid whey permeate to form omega-3 rich cells and their fatty acid composition was analysed by gas chromatography. Then the microalgae cells and protein concentrate were used for the formulation of an ink for 3D printing. Cheese analogue samples were printed using a 3D printer equipped with a syringe pump. The textured product was fabricated based on blends of 6 % protein, 14 % starch, and 1 % microalgae biomass by a heating-cooling cycle followed by 3D printing. Both grains provided high amounts of proteins with acceptable functional properties, i.e. 12 % gelation concentration and high sulphuric amino acid content. Rheological investigations revealed that the ink was Newtonian initially, while a gel structure was formed upon heating and cooling. L. Sativus exhibited higher viscosity values. Texture analysis of the printed product revealed that the hardness of the 3D printed was decreased in comparison with the moulded gels. Incorporation of microalgae cells decreased the hardness significantly, while the stickiness was increased. The final product contained 0.25% PUFA including 0.03% DHA and 0.15% EPA providing the recommended daily omega-3 fatty acid (500 mg) in each 30 g portion. In conclusion, the application of grass pea protein in combination with microalgae biomass can be regarded promising for the formulation of 3D printed analogue cheese.

Keywords
plant based cheese, grass pea protein, 3D printing, microalgae, DHA

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#135: Digestive characteristics of poultry meat tenderized by acidic and enzymatic marination

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In this study, chicken breast meat was tenderized using acetic acid and proteolytic enzyme solutions and the characteristics of the samples were examined after cooking and *in vitro* digestion. Chicken meat was kept in distilled water, acetic acid solution (1%) and commercial meat tenderization solution (proteolytic enzyme solution) for 24 hrs at 4°C in order to fulfill the tenderization process. After tenderization, control and the tenderized treatments were cooked at 105°C for 1 hour in an oven. *In vitro* digestion of the samples was conducted in simulated saliva, gastric juice and intestinal juice. As expected, the pH value of the sample treated with acid was lower than the values of other samples before and after cooking ($p<0.05$). Cooking process raised the hardness (Warner-Bratzler Shear Force) values of all the treatments ($p<0.05$). Similar to the pH result, the treatment marinated with acetic acid had the lowest hardness value before and after cooking ($p<0.05$). Thus, acetic acid is found to be more effective than enzyme solution in the tenderization of chicken breast. After digestion, the control and the samples treated with acetic acid had the lowest hardness values ($p<0.05$). While *in vitro* digestion process reduced the hardness values of the control and the sample kept in distilled water, it led to an increment in sample tenderized by acetic acid ($p<0.05$). However, the hardness value of meat marinated with enzyme solution did not change significantly after *in vitro* digestion ($p>0.05$). According to NMR results, T2 value of the sample tenderized by acetic acid was higher than the other samples ($p<0.05$) before and after cooking. Also, the sample marinated with acetic acid had the highest T2 value ($p<0.05$) after *in vitro* digestion. It was determined that the total soluble protein content of the sample marinated with the enzyme solution was higher than the other samples ($p<0.05$). This was likely due to higher protein degradation in enzymatically tenderized meat during *in vitro* digestion. The free amino group released from meat to digestion juice was higher than control in meat samples treated with acid and enzyme solutions ($p<0.05$). Consequently, the tenderization increased the digestibility of the chicken breast in terms of total soluble protein and the free amino group.

Keywords
tenderization, acidic, enzymatic, marination, poultry

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#46: In depth-exploration of the interactions between prebiotics and a panel of gut bacteria of health interest

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The gut microbiota plays a fundamental role in various biological functions and contributes significantly to host health. The provision of dietary substrates for resident microorganisms to modulate the composition and the metabolic activities of the gut microbiota incorporates the concept of prebiotics. These non-digestible food ingredients, through their bacterial metabolization, provide essential nutrients and confer beneficial effects on the host physiology. A dietary supplementation of prebiotics constitutes a nutritional strategy to restore and/or maintain the equilibrium within microbial communities. Nevertheless, it is still unclear how the dynamic interplay between prebiotics and microbes maintain intestinal homeostasis. The current challenge is to understand the interactions that link prebiotics to digestive health and wellbeing. In this study, we explored the relationships between a panel of putative health-promoting bacteria and a range of indigestible food ingredients present in our diet. Genomic analyses allowed the characterisation of enzymatic repertoires involved in the metabolization of extremely diverse polysaccharides providing substrates for the gut microbiome. These predictions were further investigated through single-carbohydrate cultures to evaluate their prebiotic metabolization. Short Chain Fatty Acid production profile suggested complementary phylum-dependent levels of commensal bacteria to metabolize prebiotic ingredients. Each bacterial species showed different degrees of dietary carbohydrate utilisation, which seemed driven by their enzymatic capabilities. Finally, a transcriptomic approach was used to identify the genes involved in the metabolism of prebiotics. Replenishing health promoting bacteria through prebiotics represents a prerequisite for personalized nutrition and an opportunity to tailor dietary interventions.

Keywords
prebiotic, gut microbiota, dietary fiber

#47: Polyphenol variability in *Nothofagus antarctica* infusions when different raw material origins are considered

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Nothofagus antarctica leaves have recently been suggested as a valuable source of polyphenol compounds and its combination with green tea has shown a superior antioxidant capacity than green tea infusions. However, no information about the quality differences in N. antarctica raw materials have been reported until now. The present study aimed at assessing the polyphenol variability in the N. antarctica infusions when different populations are considered. Analyses by reverse phase HPLC-DAD were carried out to quantify the polyphenol concentration in each studied infusion. Principal Component Analysis and correlation analyses were carried out to determine which variables contributed the most to the quality differentiations among infusions. In this study, the two first components explained almost 61% of the observed variance among N. antarctica infusions. In addition, quercetin-hexoside and quercetin-pentoside were the only polyphenol compounds that contributed more than 10% to the first dimension. Minor constituents such as caffeoyl-hexoside, tetragalloyl-glucoside and Di-Galloyl-HHDP-glucoside contributed the most to the second dimension. In addition, significant differences (p-value < 0.01) among *N. antarctica* populations were found in total polyphenol content and total flavonoid derivatives. At compound level, the concentration of caffeoyl-hexoside, quercetin- hexoside, quercetin-pentoside, and quercetin-galloyl-pentoside were significantly different (p-value< 0.01) among infusions. These findings revealed the existence of diversity in the *N. antarctica* secondary metabolism production, highlighting the need of determining the quality of raw material for elaborating superior *N. antarctica* beverages.

Keywords

ñire, flavonoids, cinnamic acids, healthy beverage, Patagonia forest

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#190: The formation and mitigation of Maillard reaction products in gluten-free bakery products: A systematic review on safer and healthier food production

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Acrylamide, 5-hydroxymethylfurfural (HMF) and furan are Maillard reaction products which may occur in heat-treated products and have proven negative effects on human health. Among them, acrylamide is mostly formed in plant-based foods with high starch content such as potatoes, cereals and bakery products due to heat treatment. 5-Hydroxymethylfurfural, on the other side, is an intermediate compound with furan structure which is formed as a result of dehydration (caramelization) of sugars in acidic environments during heat treatment. HMF is known as a heterocyclic Maillard reaction product formed in heat-treated foods rich in carbohydrates and asparagine. Furan is a volatile food contaminant, which is also formed during thermal processing of foods. Especially bakery products pose a risk for the formation of these toxic products since they are usually baked at elevated temperatures. Therefore, there are many different approaches in literature to reduce the formation of these toxic contaminants in the final product. Among these, the main methods used are modifying the product formulation, adding different agents, antioxidants or antioxidant extracts to the formulation, extending fermentation time, changing process parameters, performing the baking process under vacuum or using different cooking techniques. The objective of this review is to provide detailed information about the formation of acrylamide, 5-hydroxymethylfurfural (HMF) and furan along with the mitigation strategies used to suppress the formation of these toxic reaction products in gluten-free bakery products. Additionally, a risk/benefit assessment was presented in order to assist in the development of new gluten-free bakery products. Since gluten-free products have a completely different composition than gluten-containing products and product composition directly affects the formation of these contaminants, it is of great importance, especially for the people suffering from Celiac disease, to investigate and reduce formation of these contaminants in gluten-free products.

Keywords
5-hydroxymethylfurfural, acrylamide, furan, Maillard reaction, mitigation

#70: Use of wild plants for the production of functional pasta

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According to a FAO definition, wild plants (WEPs) are "plants that grow spontaneously in self-maintaining populations in natural or semi-natural ecosystems and can exist independently of direct human action". In Italy, the use of alimurgical WEPs has always been a relevant feature of local cultures and they are widely spread in different traditional recipes. Increasing evidences suggest that WEPs may have great potential as sources of unusual colors and flavors and dietary supplements, mainly fiber, proteins and different minerals. Moreover, they provide high amounts of bioactive compounds, such as flavonoids, proanthocyanidins, flavonols, vitamin C, tocols (vitamin E), carotenes (vitamin A) and xanthophylls that, also due to their antioxidant activity, play a key role in reducing the risk to develop several degenerative diseases in humans. If food provides health benefits beyond basic nutrition it could be considered as a ''functional food''. In this context, pasta, due to its widespread use and popularity, is an ideal matrix for the incorporation of unconventional ingredients or raw materials so to realize a different innovative healthy food. The aim of this work was the production of pasta enriched with different wild and commercial leafy vegetables, considering their significant quantities of bioactive compounds. The nutritional and sensorial characteristics of the made final products were evaluated, with particular attention to the content of tocols and carotenoids. Using balanced formulations and appropriate technologies, leafy vegetables pastas proved to be a good alternative food, with high nutritional and sensorial quality and high healthy properties.

Keywords
wild plants, vegetables, pasta, tocols, carotenoids

#155: Use of benchtop Magnetic Resonance Imaging (MRI) to investigate the stability of functionalized tomato products

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Tomatoes and olives are indispensable ingredients of Mediterranean cuisine. However, the traditional recipes of tomatoes and olives need reformulation to meet the demand of today's consumers. There is an increasing demand for high-protein foods and plant proteins have become the major players to enrich food formulations. In this study, a functionalized tomato sauce has been produced using high pressures homogenization. The sauces were 'functionalized' using a specialized olive powder and plant protein powder. Plant proteins that were tested were rubisco and pea protein isolate. As tomato sauce is an acidic product and has a pH of around ~4.30; it is not an ideal environment for proteins as the pI of the proteins is close to the pH of the product. In addition, the formulation also contains salt which could be an additional triggering factor for protein aggregation. Although the tomato mix is subject to high-pressure homogenization, there are still aggregates observed in the formulation. In this study, we have used a benchtop Magnetic Imaging system to visualize the formation of the aggregates in the juices. Spin-spin (**T2**) and spin-lattice (**T1**) relaxation times and Self Diffusion Coefficients (**D**), were measured and T_2 weighted spin echo images were obtained to see the presence of protein aggregates better. Mn^{+2} was also used as a contrast agent and its effect on the proteins was also investigated.

Keywords
tomato sauce, plant protein, magnetic resonance imaging

Acknowledgements
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#166: Effects of legume enriched-wheat biscuits incorporated in an energy restrictive dietary plan on postprandial metabolic responses of overweight/obese women

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Snacks enriched with plant proteins have gained increased popularity, since they can modulate blood glucose and suppress appetite. We investigated whether the incorporation of a legume enriched biscuit in a restrictive diet plan in overweight/obese women influences weight loss and postprandial responses to a mixed meal.

Twenty-four women in reproductive age (38 y SD 8.9), with BMI=29.74, SD 3.65 kg/m2, participated in a 12-week randomized controlled trial. Subjects were randomized a control or to an intervention group and followed a calorie restrictive diet. They consumed daily 80 g of either a conventional wheat biscuit (CB) or a legume enriched wheat biscuit (LB). A mixed meal tolerance test was performed at the beginning and the end of intervention, where venous blood samples were collected before meal ingestion and at 30, 60, 90, 120, and 180 min postprandially. Glucose, Insulin and ghrelin were measured. Subjective appetite ratings were accessed by Visual Analogue Scales (hunger, fullness, desire to eat).

Decreases in body weight, fat mass, waist and hip circumference were observed in both groups ($p<0.05$). Participants in the LB group experienced greater weight loss while energy, carbohydrates and fat intake were significantly lower after 12 weeks at LB compared to CB group ($p<0.05$). Fasting insulin levels were lower at the LB than the CB group ($p<0.05$) at the end. Postprandial glycaemia and insulinaemia in mixed meal as measured by incremental area under the curve (iAUC), were similar between groups after 12-weeks while ghrelin response was higher in both groups reaching statistical significance at 90 min compared to baseline values ($p<0.05$). Fullness, as accessed by VAS, was significantly increased at every time point and the iAUC was higher in the group received the LB ($p<0.05$). Desire to eat was significantly reduced in both groups postprandially, at certain time points ($p<0.05$ compared to baseline).

Legume enriched biscuit as part of a restrictive diet in overweight/obese women seems to contribute to enhanced feelings of fulness and reduction in daily energy intake, resulting to a trend towards higher weight loss when compared to a common wheat biscuit. Postprandial glucose and insulin responses were not affected after the 12-week energy restricted dietary intervention.

Keywords

legume-enriched biscuit, overweight/obese women, mixed meal tolerance test, glycaemic, insulinaemic and ghrelin response, 12 week energy restricted dietary intervention

2.8. Animal and Marine based Foods

#114: Ultrafiltration and spray drying of a pork liver protein extract: effects on its techno-functional properties

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The circular economy is a new production model that guarantees sustainable growth over time. The valorisation of food by-products is a strategy that fully fits this concept. Pork liver has great potential for valorisation due to the large quantities produced daily in slaughterhouses, its high nutritional value and its low acceptance by Western consumers. This mismatch between the quantities generated and consumed means that a feasible alternative must be sought for industrial recovery. An interesting valorisation pathway involves the extraction of soluble proteins and their use as techno-functional ingredients. In previous studies, it was observed that at pH 6.0, the pig liver proteins were extracted in a relatively high percentage (around 50%) and that they presented good surface properties, particularly in relation to the foaming ones. However, it was not possible to determine whether their ability of forming heat-induced gels since, under the extraction conditions, the recovered extract had a too low protein content. However, the protein content of the recovered extract was too low to establish their potential as gelling agents. The dehydration of the extract by spray drying was the option chosen in order to subsequently be able to prepare protein solutions at concentrations that would allow gelation. However, the yield of the process was very low, which led to the need for a concentration stage prior to dehydration. In the present work, the effects of ultrafiltration concentration stage previous to the spray-drying on the techno-functional properties of the dehydrated extract were determined. For this purpose, the physicochemical and techno-functional properties of the initial extracts, the retentates recovered after ultrafiltration and the dehydrated retentates were determined. The obtained results indicated that heat-induced gels could be obtained from protein solutions prepared with dehydrated retentates but not using directly the retentates, although their textural properties and water-holding capacity were rather poor. Moreover, it was observed that ultrafiltration had no effects on the surface properties of the extracts, while spray-drying significantly improved the foaming properties, which could be very interesting due to the difficulty of finding substitute ingredients for egg white.

Keywords
meat by-product, pork liver, protein extract, spray-drying, techno-functional properties

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#67: Vitamin Vitamin D fortification of selected edible insect species through UVB-treatment

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In recent years the EU has approved the use of a couple of edible insect species (*Tenebrio molitor*, *Locusta migratoria*, *Acheta domesticus*) for food applications in dried and powdered form. All three insect species have been shown to be able to synthesize vitamin D as living organisms. But there are no studies to date, that have analyzed their potential fortification with vitamin D, when treated with UVB-light as a ready to use powder, as it has been demonstrated in several edible mushroom species.

Samples of the three species were freeze-dried, ground and subjected to artificial UVB-light (280-315 nm) until a dose of 1.5 J/cm^2 was reached. Untreated insect powder was used as control. Both UV-treated and untreated samples were saponified over night and subsequently extracted with n-hexane. Extracts were dried under vacuum, resolubilized in tetrahydrofuran, and measured via HPLC. Identity of vitamin D in the analyzed samples was verified through both standard addition and spectrum analysis.

Untreated control samples showed no quantifiable vitamin D, regardless of insect species. Of the samples treated with UVB-light only *Tenebrio molitor* (13 to 17 µg/g dry sample matter) and *Acheta domesticus* (2 to 4 µg/g dry sample matter) showed quantifiable vitamin D contents, while samples of *Locusta migratoria* produced no identifiable vitamin D after UVB-treatment.

Treatment with UVB-light is an effective approach for fortifying powdered *Tenebrio molitor* and *Acheta domesticus* with vitamin D. Even modest serving sizes of 1-10 grams would be sufficient to supply the recommended daily intake of 20 µg vitamin D, making these already interesting novel foods even more interesting for food manufacturers, who wish to create fortified foods and value-added products.

Keywords
vitamin D, edible insects, food fortification, UV-treatment

#75: Evaluation of physicochemical, texture, sensory and microbiological properties of fresh Sarrajão (*Sarda sarda*) fillets during storage time

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Portugal is one of the major fish consumers in Europe and the World. Fish is an essential source of nutrients, as it is low in fat content and high level of protein, vitamins, and minerals. In recent decades, this food group's consumption has increased and became available to consumers far from coastal areas.

The aim of this study was to evaluate the physicochemical, texture, sensorial and microbiological properties of fresh Sarrajão (*Sarda sarda*) fillets during 8 days under refrigeration storage at 4 ºC.

Protein, lipids, carbohydrates, chlorides, fibre, ash, moisture content and water activity were determined. A quantitative descriptive analysis (QDA®) was carried out with a panel of six semi-trained panellists. A texture profile analysis (TPA) of the fillets and the firmness of the whole fish and colour analysis were also performed. A microbiological analysis was made using Regulation 2073/2005 and the guidelines defined by the Health Protection Agency (HPA). The analysis of variance (ANOVA) and the Tukey test were used to determine which mean values were statistically different at a significant level of $p<0.05$.

No significant differences were observed in lipids, carbohydrates, fibre, ash and moisture content during storage time at 4 ºC. On the contrary, protein content decreased and chloride content increased 2-fold after 8 days at 4 °C. Texture results showed that fillets hardness and gumminess decreased after 8 days of storage. However, cohesiveness and adhesiveness parameters showed no significant differences over storage time. Concerning colour parameters luminosity, a* and b* parameters showed significant differences over time. It was concluded that Sarrajão fillets presented satisfactory microbiological quality regarding the parameters analysed (moulds and yeasts, *Salmonella spp*., *Escherichia coli*, *Enterobacteriaceae*, *Coagulase staphylococci* (+) and *Listeria monocytogenes*) with the exception of microorganisms at 30 ºC and *Pseudomonas* which, despite being increased, were still satisfactory.

It was possible to conclude that Sarrajão fillets can be stored during 8 days under refrigeration at 4 ºC keeping their physicochemical, microbiological, and sensory characteristics while assuring a high-quality product to consumers and enabling higher efficiency to the fish industry.

Keywords

Sarrajão storage, sensory analysis, nutritional properties, texture profile, microbiological analysis.

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2.9. New Omics an Integrative Approach for Food Quality Assessment and Manufacturing

#29: Inference of flavor compound profiles during cheese making processes from microbial gene expression profiles

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Cheese is one of the most consumed dairy products in the world. The overall appeal of every cheese variety is related to its quality and (off)_flavors. These (off)_flavors result from the metabolic functions of the different microbial species participating in cheese fermentation and ripening, therefore, the gene expression profiles of these microbes can be used as a proxy to assess and monitor the (off)_flavor outcomes during cheese making. In this work, we used a machine learning approach to infer the amounts of six important classes of flavor compounds in an experimental surface-ripened cheese composed of nine microbial species based only on transcriptomics data. The predictive models were tested on three independent data sets and the prediction accuracy ranged from 60 to 90 %.

To our knowledge, existing prediction models are based on (meta)genomics data which detect microorganisms that may be dead, while (meta)transcriptomics detects actual gene/enzyme activity. Our results provide a step towards characterizing cheese production aromatic outcomes from transcriptomics data of microorganism population involved in the process, helping to identify key factors and pathways.

Keywords
machine learning, metabolomics, transcriptomics, flavor compounds, cheese-making, microbial community

#71: Flavoromic: an integrative approach for food sensory quality assessment

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Flavoromic approach is a systematic and holistic procedure for decoding molecular profiles of food and beverages and finding a correlation between their aroma volatile composition and sensory properties. It might be efficiently employed to establish a correlation among food sensory quality, consumer preference, and therefore food choice.

Flavoromic approach has been applied to several food products as bakery products, cookies, packaged bread, ready-to-eat vegetables, and dried spices. Instrumental analysis of volatile aroma compounds, analytical and hedonic Sensory analyses, and Consumer acceptability test have been applied. Multivariate data analysis and the use of Preference Mapping allowed flavoromic approach to combine instrumental information, consumer preferences and expert panel descriptions. The data obtained on the food products above reported, demonstrated the importance of the flavoromic approach to orientate food product development playing an important role in the food industry that is required to develop new sustainable and healthy foods that meet consumers' demands.

Keywords
flavoromics, aroma compounds, sensory analysis, consumer's preference, preference mapping

#133: Metataxonomic mapping of the microbial diversity of cheeses as a geographical origin authentication tool

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Microbial diversity in cheese is among the fundamental contributors to sensorial and qualitative characteristics. However, knowledge regarding the existence of microbial patterns associated with regional production practices in ripened cheeses remains limited. Using metagenomic analysis of fermented products is recently reported as a tool for food origin and processes authentication. In this work we compared Irish *versus* Eastern Mediterranean cheeses—namely Greek and Cypriot—using High Throughput Sequencing (HTS). The study identified a significantly distinct separation among cheeses originating from the three different countries, in terms of the total microbial community composition. The use of machine learning and biomarkers discovery algorithms defined key microbes that differentiate each geographic region. Additionally, interaction networks were developed revealing that the key species developed mostly negative interactions with the other members of the communities, highlighting their dominance in the community. The present work demonstrates that cheeses metabarcoding can be used as a tool for geographical origin authentication while providing insightful information for the microbial dynamics in ripened cheeses.

Keywords
metabarcoding, metagenome, microbial diversity, food authentication, high throughput sequencing

#144: Exploration of viral diversity in fermented foods of plant origin

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Fermented food constitutes 30% of the human diet in average. The study of fermented foods of plant origin responds to industrial and economic issues. Indeed, fermentation failure is responsible for important economic losses and can lead to the production of food waste. Furthermore, the upcoming transition in our diet with the reduction of meat consumption and the increase of vegetable consumption leads to the great return of fermentation, a simple and energy energy-efficient food preservation process that generates tasty products with high nutritional value.

The bacterial and fungal communities of fermented foods of plant origin (wine, cabbage, carrot, turnip) are well known, which is not the case for phage communities (i.e. bacterial viruses). The scientific challenges of our project are therefore to provide a detailed description of their composition and to better understand their role in this peculiar type of microbial ecosystems.

The objective of the present study was to evaluate the impact of phages on the microbial dynamics of two different types of fermented foods of plant origin: sauerkraut (solid food) and wine (beverage).

The viral fraction of the food products collected at different time points during the fermentation process was purified by a specific method relying on the removal of microbial cells by centrifugation and filtration followed by viral particles' concentration using polyethylene glycol. Viruses were quantified by epifluorescence microscopy and the composition of viral communities was determined through a viral metagenomics approach involving nucleic acids extraction, DNA and RNA amplification and high throughput sequencing.

Based on epifluorescence microscopy, we estimated the concentration of viruses at 5 x 10^7 particles/g of sauerkraut after fermentation and 10^7 particles/L of wine. Viral metagenomics analysis revealed that the most abundant viral contigs shared some sequence homology with phages known to infect the principal bacteria responsible for fermentation in the studied systems, for example *Leuconostoc mesenteroides* and *Lactiplantibacillus plantarum* in sauerkraut. Interestingly, few contigs slightly related to RNA phage genomes were detected for the first time in this type of ecosystem, shedding light onto potentially new viruses to be further characterized.

Keywords
bacteriophages, fermented food, metagenomic, epifluorescence microscopy

#241: Vitamin-enrichment of kefir by propioni- and lactic acid bacteria with possible improvement via Omics

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In South Africa malnutrition due to inadequate dietary intake of micronutrients is one of the major causes of vitamin deficiencies, leading to disease. The cost of the treatment of malnutrition fuels the need to develop an affordable fortified dairy product, prompting this study aimed at using a "naturally" fortified kefir beverage with vitamin B12 and folate.

Propionibacterium freudenreichii and *Streptococcus thermophilus* are good producers of vitamin B12 and folate, respectively, and propionibacteria grow symbiotically in the presence of lactic acid bacteria. Hence, *P. freudenreichii* J19 (PAB) and *S. thermophilus* ATCC 19258 (LAB) were selected due to their ability to produce high levels of vitamin B12 and folate, respectively. The inclusion of the PAB and LAB in the study was conducted using three different forms of inoculum, namely broth, freeze-dried and direct cultures.

Broth and freeze-dried culture of PAB, followed by inoculation with LAB cultures, were used in multiple treatments (two treatments each); while the direct culture of PAB and LAB was inoculated once with the kefir grains. Multiple treatments of PAB with kefir grains showed an increase in vitamin B12 and folate on par with a %NRV, thus achieving the objective of the study.

DNA and PCR assays confirmed *P. freudenreichii* retention after fermentation. Sensory evaluators preferred the kefir beverage after 1 d fermentation based on sour and overall taste. Hence, PAB and PAB-LAB inclusion into kefir grains was successful and has the potential to improve the functionality of a food product by using food-grade bacteria to increase B-vitamin levels, promote and sustain human health.

Implementing the findings of this study has potential to reduce B-vitamin malnutrition, but will require a systems biology approach for a well-defined culture and process. A suitable strategy will include a comprehensive study of the multispecies and multiorganism food ecosystem (kefir), interaction with the environment and with each other (i.e., the process) entailing: amplicon sequencing (accurate identification of microbial composition); metagenomics (gene content), metatranscriptomics (gene function); metaproteomics (functional activity); and meta-metabolomics (metabolism/metabolites). The potential of PAB as cell factories will also be mentioned.

Keywords
biofortification, propionibacteria, kefir, B-vitamins, omics

2.10. Innovation and consumers' acceptance

#40: Improved chemical and structural properties of black soldier fly larva protein isolate conjugated with glucose through Maillard reaction

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The increasing global population and consumer demand for protein will render the provision of protein a serious future challenge, thus placing substantial pressure on the food industry to provide for the human population. The lower environmental impact of insect farming makes the consumption of insects such as Black soldier fly larvae (BSFL) an appealing solution, although consumers in developed countries often respond to the idea of eating insects with disgust. One approach to adapt consumers to insects as part of their diet is through application of making insect-based products in an unrecognised form. Black soldier fly has been proposed as an alternative protein source sustainable for both food and feed due to its nutritional composition. This study focused on the structural analysis of black soldier fly larvae (BSFL) protein and conjugates. The protein was extracted using the alkaline-acid extraction technique. The protein extract was then conjugated with glucose by Maillard reaction. The protein and glucose were mixed at (2:1 w/w, pH 9), incubated for 30, 60, 90, and 120 at 90 °C. The products obtained were then characterised and compared. The changes were confirmed by universal attenuated total reflectance Fourier-transform infrared spectroscopy (UATR-FTIR), scanning electron microscopy, thermal gravimetric analysis, and differential scanning calorimetry. UATR-FTIR combined with principal component analysis monitored the protein-sugar conjugates, to show the structural difference among heated proteins and conjugates. The heating treatments resulted in the unfolding and reduction of the protein molecule aggregation. The conjugates showed a significant decrease in the lysine content as the heating time increased to 120 min. FTIR indicated that the amide I and II bands of the protein were altered by the MR. The increased T max (the temperature at which decomposition is completed) demonstrated that the conjugation of the protein with glucose improved the thermal stability, remarkably. These results suggested that MR with glucose can be a promising way to improve the thermal properties of BSFL protein.

Keywords
insect protein, black soldier fly, Maillard reaction, structural analysis, nutrition

#54: Consumers' willingness to pay for food products from circular economy: Results of a choice experiment in Italy

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In Europe, the concern about sustainability topics, is growing as well as the need of shifting from a linear model to a circular one that can significantly reduce the negative pressures on the environment. The European Commission (EC) highlights that to fulfill the ambitious target of climate neutrality by 2050, the Union needs to accelerate the transition towards a regenerative growth model. In this respect, the EC is particularly concerned about the agri-food sector, responsible for 11 per cent of the EU greenhouse gas emissions and that involves the overuse of natural resources and contributes to a very high percentage of agricultural food waste. In this context, there is growing consensus about the fact that the transition to a Circular Economy offers many opportunities for the entire agri-food system. Accordingly, governments, businesses, research institutes and non-governmental organizations (NGOs) are exploring new ways to reuse products. At the same time, food products obtained through circular and thus sustainable processes could offer new competitiveness opportunities. However, notwithstanding some certifications attesting the circularity of the processes are currently adopted by companies (i.e. UNI/TS 11820 and AFNOR XP X30-901 standards), to the best of our knowledge, a European food quality scheme aiming to inform and guarantee consumers on this specific attribute still lacks. In this scenario, the study aims to investigate the consumer's willingness to pay for certified food products obtained by circular production systems. We conduct a choice experiment on Italian consumers of food products, where circular economy-certified attributes are compared with others sustainability attributes (e.g. organic, origin certification, animal wellness, *etc.*). This model, consistent with consumer theory, focuses on the attribute-based theory of value and permits to discriminate the specific "circular economy" attribute from other sustainability attributes. Results from this study could suggest interesting insights to both policy makers to support new strategies for EU quality policies and to food companies to catch new competitiveness opportunities.

Keywords
buying behaviour, circular economy, circular economy-certified, willingness to pay, choice experiment

#232: Sensory evaluation as a tool to develop an insect-based sausage-type product with the incorporation of insect flour from different edible species

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Edible insects are increasingly considered a novel alternative source for protein production, either for direct human consumption or in reconstituted foods (with extracted protein from insects. This study aimed to emphasize the role of sensory evaluation in the development process of insect-based food products development. A sequential development process for a sausage-like product incorporating edible insect flour was implemented. A starting batch of sausages containing buffalo worm (*A. diaperinus*) hydrolysate flour was analysed with two preparation methods – boiled and grilled; (ii) a formulation with cricket (*A. domesticus*) flour was presented with two preparation methods – boiled and grilled; (iii) a formulation with cricket flour was lightly heated on the grill and wrapped in a traditional German currywurst sauce; and (iv) a combined formulation with cricket and buffalo hydrolysate flour was evaluated with ketchup as a side dish. Eighty consumers were invited to taste the different samples and rate their overall liking on a 9-point hedonic scale (ranging from 1-Dislike extremely to 9 – Like extremely). After this, each consumer was invited to do an open comment. All participants were selected based on their willingness to try products containing edible insects, after informed consent. After completing the evaluation, participants were characterized according to their degree of neophobia and disgust. Both questionnaires include five questions, and the answer scale ranges from one to seven, so the sum of responses on each could range from 5 to 35. The results show that across time, the liking of the different samples increase. From the first to the last study the liking increased almost 1,5 points. From the open comments analysis, it was possible to observe that the sample prepared with currywurst sauce presents an appealing appearance and pleasant taste and texture, in opposition to the first samples where a large number of negative comments were pointed out. The sample presented with ketchup made it possible to minimize the number of negative attributes relating to the sausage, however, there still are some references to the “bitter“ taste. This study reinforces the importance of sensory analysis incorporation earlier on the product development, demonstrating a good potential of this insect-based sausages.

Keywords

alternative proteins, insect-based products, open comments, overall liking

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#237: Impact of technology disclosure on consumer´s perception of horticultural crops: "vertical horticulture" vs "plant factories"

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Recently, more attention has been given to the environmental impact of food production, and as a result, an increasing number of consumers may be supporting alternative food production methods including organic and sustainable agriculture, within which plant factories will play a relevant role. Vertical farming (also called plant factories) has emerged in the last decade as a novel production system, combining the production of healthy food products in a more sustainable and resource use-efficient way. Bearing in mind that consumers make their food choices based on accessibility, as well as perceptions and beliefs, it is essential to pass on to consumers a positive concept about this production method. Little is known about the impact of consumer disclosure on vertical production systems. This work aims to: (i) study the consumer's perception of horticultural products produced in vertical farming systems, their beliefs and attitudes towards the system itself; and (ii) better understand how to positively communicate the advantages of these production systems for horticultural products. A questionnaire was applied in the Great Oporto area to 215 consumers, with participants being randomly allocated to two versions of the same questionnaire: one evaluating concepts, attitudes, and beliefs towards "vertical horticulture" and the other towards "plant factories". Results show that more than half of the participants are unfamiliar with this production system, with only 20% claiming to know the term "vertical horticulture" and knowing someone that has consumed products from it, including themselves, and 14% for "plant factories". Consumers exhibited a less positive perception of the system and a lower willingness to consume its products when referring to "plant factories", compared to "vertical horticulture". Attitudes have significantly increased after disclosure of the system characteristics, for both concepts. Lettuce produced in "vertical horticulture" was perceived as being significantly more natural, environmentally friendly, safe, with a pleasant taste, healthy, fresh, nutritious, supporting local production and with fewer additives than the one produced in "plant factories". Disclosure of technology as "vertical horticulture" is strongly advised in future communication with consumers.

Keywords
lettuce, plant factories, vertical horticulture, consumer perception, perceived quality

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#233: Evaluation of innovative plant-based *vs*. insect-based products by young couples during regular household meals

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The protein supply for feed and food is most critical and requires a transition to different protein sources, such as insects or plants. Currently, in the EU, edible insects are considered novel foods. Low consumer acceptance, due to disgust, neophobia or even poor-performing products, has reduced the successful marketing of insect-based food products. It has been proposed that more information could be provided, not only to increase awareness of the beneficial, ethical and health aspects of edible insects, while comparing it with other alternative protein sources, such as plant-based ones. This study aims to evaluate the integration of insects as part of Portuguese daily meals by testing in a natural household context six insect-based novel food products (meat-like sausage, cracker, falafel, umami-tomato paste, Dahl spice mix and minced meat-like preparation). Over 100 young couples were recruited to participate. To isolate the understanding of the consumer's perception of insect-based products, half of the couples were allocated to receive similar innovative plant-based products, already available in the market. Couples were randomly assigned an insect-based or a vegetable-based food basket. Each young couple were provided with one family portion of each of the six different products per fortnight, over a 6-week intervention. For both baskets, the couples were instructed to incorporate the food product into their family dinner. After preparing the meals, each participant and their partner were invited to evaluate overall liking. Finding from home exposure showed different effects on product liking. The plant-based sausages had a higher liking value. On a global view, the spice mix and umami paste had a higher liking value on the insect-based panel, while sausage and minced meat had a higher liking value on the plant-based group. For crackers and falafel, the overall liking score was similar between both groups. The intervention study revealed insights into insect-based product development and consumers' liking, different approaches to consumer response should be applied when the formulations were refined.

Keywords
alternative proteins, home usage intervention, insect-based products, overall liking, plant-based

Acknowledgements
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Session 2: Poster presentations

#3: Improved antioxidant and anti-melanogenic effects of pitaya fruit peel with membrane process

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In this study, a membrane process was carried out to separate and purify bioactive compounds of agricultural waste from red pitaya fruit peels for the potential application. The peel was pre-treated with NS-Max lactic acid bacteria at 40°C for 1 h and then centrifuged. Supernatant was further fractionated with either a microfiltration or one of four molecular weight cut-off ultrafiltration membrane into permeate and retentate fractions. The color parameters, antioxidant and anti-melanogenic capability, as well as the contents of bioactive compounds including total phenolic, betacyanin, and total flavonoid were determined when weight concentration ratio (WCR) reached 1.5 and 4. Our results showed that permeate treated with a 0.45 mm microfiltration membrane exhibited less fouling layer and specific resistance and thus had a higher permeate flux than treated with an ultrafiltration membranes. Membrane process particularly treated with a UK 10 ultrafiltration membrane raised L* values of permeate and bioactive compounds, antioxidant and whitening capabilities of retentate. In addition, a higher content of active compounds may explain higher antioxidant and anti-melanogenic capabilities of pitaya fruit peels.

Keywords
pitaya fruit, membrane process, antioxidant property, anti-melanogenic effect

#4: Protective effect of oolong tea extract and resveratrol against doxorubicin-induced cardiomyopathy targeting mitochondria

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Doxorubicin (DOX) is highly effective anticancer drug and has stayed in the mainstream cancer chemotherapy for decades. However, DOX treatment-associated cardiotoxicity side effect is also well documented and remains to be solved. There is growing evidence for the critical role of mitochondria in DOX-induced cardiac dysfunction. Cardiac mitochondria are potential therapeutic targets for DOX cardiotoxicity. Herein, the protective effect of resveratrol and Oolong tea extract against DOX cardiotoxicity was examined in H9c2 rodent cardiac myoblast model, focusing on mitochondrial modulation. The results indicated that DOX treatment caused remarkable loss in cell viability in concurrence with mitochondrial injury determined by the alterations of mitochondrial mass, morphology dynamic, membrane potential, reactive oxygen species (ROS) production, apoptosis, and autophagy. Supplementation with either Oolong tea extract or Resveratrol prevented the loss of cell viability caused by DOX, while only Oolong tea extract prevented the DOX-induced mitochondrial injury in cardiac myoblasts. Oolong tea extract preserved mitochondrial membrane potential and hindered cell apoptosis induced by DOX. The results suggested that Resveratrol and Oolong tea extract had distinct protection mechanisms against DOX cardiotoxicity. Furthermore, cardiac mitochondria were targets for DOX toxicity and thus phytochemicals with mitochondrial modulating activity, such as Oolong tea extract, may be useful for future application as dietary supplements or therapeutic adjuvants for the cancer treatment with DOX targeting mitochondria.

Keywords
doxorubicin cardiotoxicity, mitochondria, oolong tea, resveratrol.

#11: Application of pectinase from a novel yeast strain, *Yarrowia phangngaensis* XB3 grown on banana waste in fruit juice clarification

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Pectinases are important enzymes used in several industries, especially food and beverage. Pectinase production from yeasts is advantageous for their high specific growth rate, ease of culture, and inability to emit pectin methyl esterase, enabling juice clarification without methanol generation. *Yarrowia phangngaensis*, a novel oleaginous yeast capable of producing multiple enzymes, including pectinases, needs to be better studied. The current study investigated its ability to produce copious pectinase using agro-wastes as substrates. *Y. phangngaensis*, earlier isolated from soil, was resuscitated in a medium containing pectin. Pectinase production was achieved using a mineral medium containing inorganic nitrogen sources and agro-based wastes as carbon and organic nitrogen sources. Optimization of process parameters (pH, carbon source concentration, inoculum size, and incubation time) was by the one variable at a time (OVAT) approach, followed by partial purification by ethanol precipitation. The optimum pH and temperature for the pectinase activity were studied, and the suitable parameters for apple juice clarification were determined. Culture optimization remarkably influenced pectinase production by *Yarrowia phangngaensis*. Banana peels elicited the highest pectinase production compared to potato, pawpaw, orange, and lemon peels. Yeast extract and ammonium sulphate proved best for pectinase synthesis. The optimum condition for pectinase production was 5 % banana peel, pH 7.5, 1.4 x 10^4 cells ml^{-1} and incubation for 36 h. Culture optimization increased the pectinase yield by 182%. Ethanol precipitation (50%) resulted in a 5.31-fold increase in the specific activity of the pectinase. The pectinase was optimally active at 50^{o}C and pH 5. The optimum juice clarification was achieved by treating 10 ml apple juice with 7.03 IU ml^{-1} pectinase for 120 minutes. The turbidity and clarity reduction percentages were 39.33 % and 59.84 %, respectively. The pectinase from *Yarrowia phangngaensis* is applicable in food and other industries.

Keywords
pectinase, agricultural waste, *Yarrowia*, juice clarification, *Yarrowia phangngaensis*

#12: Valorization of fish discards and fish by-products through microbial fermentation to produce a novel protein-rich fish sauce

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In modern days, fish discard practices are still quite frequent in the fishing industry and fish by-products represent a huge everyday-waste-generation due to the fish processing, finally turning into a great loss of valuable marine resources. The present work aimed the valorization of various fish discards (*Stromateus brasiliensis, Micromesistius poutassou* and *Argentina sphyraena*) and several fish by-products (hake and monkfish viscera and blackbelly rosefish heads) generated in the Galician fleet to produce a cost-effective fish sauce through different fermentation processes for human consumption. On the one hand, a traditional approach mixing fish and salt in a 4 to 1 ratio (w/w) was carried out to produce fish sauces. The mush was fermented at 30˚ C for a long period of time (1 year). Protein content in every fish sauce increased with time, from less than 10 g/L at the beginning of the process up to more than 15 g/L at the end. Alternatively, koji mold (*Aspergillus oryzae*) and high temperatures (60˚ C) were used to carry out a novel fermentation approach, reducing not only time (80 days), but also salt content (10% w/w). In this case, the fish sauces achieved a similar protein content (15 g/L) in a quarter of time, even though the amino content, a measure of protein hydrolysis, was lower than that of the traditional fermentation. The microbial community was also studied through next generation sequencing, showing that lactic acid bacteria (*Latilactobacillus* spp.) and halotolerant microbes (*Halanaerobium* spp.) were the most important populations. Finally, for every ended product, sensorial analyses are currently being conducted.

Keywords
fermentation, fish sauce, fish waste, valorization

#16: The effects of Kakadu plum fruit (*Terminalia ferdinandiana*) as bio-preservative in raw processed meats

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The effects of Kakadu plum powder (KPP) as a candidate plant-based preservative in raw processed meat was evaluated. Beef patties were treated with either 0 additive (negative control), or 450 ppm of sodium metabisulphite, or KPP at incremental concentration in the recipe (0.2%, 0.4%, 0.6%, and 0.8%). Beef patties samples were packaged under modified atmospheric conditions and stored at 4 ±1°C for 20 days. Lipid oxidation was significantly ($p < 0.05$) delayed during the storage period for KPP treated samples compared to both the negative control and sodium metabisulphite treated samples. The inclusion of KPP in beef patties at levels of 0.2% and 0.4% was efficient in slowing down the growth of microorganisms compared to the negative control; however, sodium metabisulphite had a higher ($p < 0.05$) antimicrobial activity. At the end of the storage period on day 20, there was no difference between the samples in terms of L*, a*, b*, H* and C* colour ordinates. A significant correlation ($r = -0.66$) was noted between the addition of KPP (treatments) in the beef patties and lipid oxidation, but there was no correlation ($r = -0.006$) between the treatments and microbial growth. This study showed that Kakadu plum fruit powder could be used as a plant-based preservative to extend shelf life of processed meat.

Keywords
natural antioxidant, natural antimicrobial, processed meat, kakadu plum, bio-preservative

#17: Plant based phytochemicals: Review on advanced health benefits based on extraction methods

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Recent scientific studies have established the relationship between the consumption of phytochemicals like carotenoids, polyphenols, isoprenoids, phytosterols, saponins, dietary fibres, and polysaccharides, *etc.* with health benefits like prevention of diabetes, obesity, cancer, cardio-vascular diseases, *etc.* This has led to the popularization of phytochemicals. Nowadays, functional foods and nutraceuticals are used as a preventive measure or cure for many diseases. The health benefits of these phytochemicals depend on their purity and structural stability. The yield, purity, and structural stability of extracted phytochemicals depend on the matrix in which the phyto-chemical is present, the method of extraction, the solvent used, the temperature, and the time of extraction. There are several extraction methods have been used to isolate and concentrate these phytochemicals, which are used in dietary supplements or as functional food ingredients.

1. Supercritical fluid extraction (SFE): High pressure and temperature are applied throughout the process, which converts CO2 into a supercritical fluid with special solvent characteristics. Environmentally friendly.

2.Enzyme-assisted extraction: Enzymes are used in this technique to breakdown the plant cell walls and release phytochemicals. Environmentally friendly.

3. Microwave-assisted extraction (MAE): This technique extracts phytochemicals from plants by using microwave radiation. Radiation heats the plant material and releases the bioactive compounds.

4. Ultrasound-assisted extraction (UAE): Ultrasound waves are used to create cavitation bubbles, which rupture the cell walls and release the bioactive compounds.

5. Pressurized liquid extraction (PLE): Extracting phytochemicals using PLE from plants involves the use of solvents under high pressure and temperature to extract the phytochemicals from the plants.

In conclusion, phytochemicals derived from plants are bioactive substances that have been linked to a variety of health advantages. These phytochemicals can be concentrated and isolated using cutting-edge extraction techniques as supercritical fluid extraction, enzyme-assisted extraction, microwave-assisted extraction, ultrasound-assisted extraction, and pressurized liquid extraction.

Keywords
phytochemicals, bioactive compounds, functional foods, health benefits

#22: Innovative snacks with designed health-promoting properties enriched with minerals

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The aim of this work, which is an integral part of the HealthySnack Project, was to develop a concept and recipe for innovative gluten-free flavored snacks of the crunch and popcorn type, based on natural plant raw materials rich in minerals with targeted health-promoting effects, i.e. strengthening the immune system (enriched in zinc and copper) and supporting nervous system and cognitive functions (enriched in iron and magnesium), to a level that allows the use of Nutrition Claims and Health Claims attributed to these ingredients. The innovative snacks will be attractive in taste (fruit flavor, mildly sweet), but without added simple sugars or artificial sweeteners). The source of minerals enriching the snacks will be vegetable raw materials (including seeds or oilseeds of flax, sunflower, pumpkin, chia, quinoa). The presentation will include the project concept, sample recipes and the results of laboratory trials of innovative snack prototypes. The project was funded under the Subtask 2.3.2. INNOVATION VOUCHERS FOR SME OPERATIONAL PROGRAM SMART GROWTH, 2014-2020, granted on the basis of the decision of the Polish Agency for Enterprise Development, number POIR.02.03.02.-22-0009/20-00

Keywords
snack, fortification, minerals, health-promoting effect

#25: Comparison of the elemental composition of selected vegan products to their traditional counterparts

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Vegan diets have been gaining popularity in recent years due to increased consumer awareness of animal rights and their impact on the environment. A plant-based diet has been proven to have less impact on environmental pollution and the use of natural resources for food production than conventional diets. It is believed that a properly balanced vegetarian diet is one of the healthier dietary models and is beneficial in reducing the risk of many diseases. Manufacturers respond to increased consumer interest in vegan products, so the availability of plant-based analogs of animal products has increased significantly in recent years. There are still concerns about the nutritional value of plant-based foods.

Therefore, a comparative analysis of the content of selected minerals (Ca, Mg, Fe, Zn, and Cu) in vegan products and their conventional counterparts from the Polish market was conducted. Fourteen products (7 vegan and 7 of their traditional counterparts) were analyzed for elemental composition. The contents of elements were determined by the atomic absorption spectrometry method (AAS).

Based on the obtained results, the advantage of one of these food groups in terms of the content of the minerals studied cannot be unequivocally stated, it depended on the type of product analyzed. However, from a broader perspective, it is necessary to consider not only the content of minerals but also their bioavailability from these products.

Keywords
vegan diet, vegan products, traditional counterparts, minerals

#28: Converting potato peel waste into bioactive extracts: reduction of residual pesticides through classic and novel pretreatments

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Potato peel, the main constituent of potato processing waste, is an excellent source of bioactive compounds making it an attractive source for developing antioxidant extracts. However, pesticide residues are, as well, concentrated in potato peel and thus, their content should be reduced before further processing. The objective of this study aimed to reduce pesticide content of potato peel using ultrasound (US), liquid nitrogen immersion (LN) and pulsed electric field (PEF) pretreatment processes and to test the final total phenolic content. Chlorpropham, Spirotetramat, Azoxystrobin, Propiconazole and Captan pesticides were diluted in water and spiked on potato peel samples (dimensions 20x10x1 mm). Then, US (power 136W, 200 ml volume, 1:4 sample to water ratio, 1 to 5 min duration at 30°C), LN (1 to 4 cycles of 1 min), and PEF (1: 4 sample to water ratio, 12 to 50 pulses at 3 kV/cm) pretreatments were applied to spiked potato peel samples, while immersion in water was used as control (similar sample to water ratio). Pesticide residues were extracted with QuEChERS method, followed by GC-FID, and total phenolic content was estimated with the Folin-Ciocalteu assay. Ultrasound was the most effective pretreatment to reduce pesticide content (up to 100% reduction for Captan), followed by PEF (up to 80%) and finally, LN with just 20% efficacity. Removing residual pesticides from potato peel could be related to their physicochemical characteristics such as water solubility and octanol-water partition coefficient. Also, total phenolic content retention was higher after US pretreatment (88%) compared to PEF (54%). Overall, ultrasound pretreatment seemed to be the best process to reduce pesticides of hydrophilic nature (Spirotetramat, Azoxystrobin, and Captan, in this study) in potato peel, with a significant retention in total phenolics.

Keywords
potato peel waste, pesticide residues, ultrasound, pulsed electric field, antioxidant retention

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#30: Complex characterization of indigenous yeast strains isolated from spontaneously fermented dairy products

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An efficient alternative for improvement of microbial biotechnological processes from the food industry is represented by starter cultures based on strains isolated from different ecological niches, harboring naturally acquired phenotypic characteristics. This approach is also important for preserving and capitalizing artisanal food products.

Our work deals with the characterization of eight yeast strains from spontaneously fermented dairy products (sour crème, yogurt, fermented milk) from different regions of Romania. Taxonomical identification using conventional and molecular techniques (RFLP-PCR, sequencing of ITS1-5.8SrDNA-ITS2 region) revealed their belonging to *Ogataea*, *Saccharomyces*, *Candida,* and *Pichia* genera. The antimicrobial activity was determined against frequently encountered food pathogens. Optimal growth conditions studies and qualitative assays for evaluation of antibacterial potential were performed using *Staphylococcus aureus* ATCC 6538, *Listeria monocytogenes* CMGB333, *Bacillus cereus* CMGB 53-100, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853 and *Salmonella typhimurium* ATCC 14028. The yeast strains showed good capacity to inhibit *E. coli*, *P. aeruginosa* and *S. typhimurium*. We also determined the presence of virulence and pathogenicity factors (hydrolytic enzymes production, adherence to inert substratum, genetic dimorphism) and the effect on probiotic microbial strains (*Streptococcus salivarius* ssp *thermophylus* ATCC 19258; *Lactobacillus acidophilus* ATCC 4356; *S. boulardii* CMGB-S; *K. lactis* CMGB 112; *K. marxianus* CMGB 159). Our strains did not present pathogenic characteristics and had no inhibitory effect on the growth of probiotic microorganisms. Moreover, all the strains showed high potential for crop plants protection applications and prevention of contamination with phytopathogenic fungi, inhibiting *B. cinereea*, *R. solani*, *A. ochraceus* and *A. flavus* strains, with best results for *P. membraniefaciens* CMGB-MT26 which also inhibited ochratoxin A production.

In conclusion, the present work allowed the identification and characterization of eight new indigenous yeast strains as promising microbial resources for food industry with important antimicrobial abilities.

Keywords
antimicrobial activity, food protection, food industry, dairy fermented products

#31: Kluyveromyces marxianus CMGB-P16- a new yeast strain with probiotic potential

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Kluyveromyces marxianus represents one of the main yeast species from dairy products, with a beneficial impact on human health.

The present work deals with the characterization of the probiotic potential of a new yeast strain *Kluyveromyces marxianus* CMGB-P16 isolated from traditional dairy products (Ialomita County, Romania). The yeast cultures showed good growth at pH values ranging from 4.0 to 8.5, temperatures: 20 to 42^{o}C and NaCl concentrations: 0.5% to 8%, suggesting the ability to adapt to conditions characteristic to the gastrointestinal environment. The killer activity of *K. marxianus* CMGB-P16 was tested against 12 *Candida* strains (seven from hospital infections). Best results were obtained against *C. famata* M and *C. famata* CMGB14 after 48 hours of incubation. The crude and [17X] concentrated killer toxins were stable over seven days, with best activity against *C. famata* CMGB14, at 28^{o}C, 37^{o}C and pH 6.2. The pH 4.7, [8.5X] killer toxin inhibited the growth of *C. famata* CMGB14 culture in the first 24 hours (27.82%) and had the highest anti adherent activity against biofilm formation (38.59%). Both, the crude and pH 4.7, [8.5X] killer toxins inhibited hyphal formation of *C. famata* CMGB14 in high percentage (72, respectively, 79%). Moreover, the toxins had good impact on synthesis of siderophore-like compounds and gelatinase in *C. famata* CMGB14.

Our strain *K. marxianus* CMGB-P16 was able to synthesize stable esterases under pH and temperature variations, degrading tributyrin into butyric acid, an important compound in regulation of the gut metabolism and immune system.

In order to establish the molecular marker for a rapid separation of *K. marxianus* CMGB-P16 from other yeast species and strains from dairy products, we performed PCR-RAPD using OPA03 and M13 primers. Both primers can be successfully used for determination of interspecific and intergeneric polymorphism for yeast strains/species from the same or similar ecological niches. The primer M13 also generated the best polymorphic profile for intraspecific identification.

In conclusion, the strain *K. marxianus* CMGB-P16 has promising potential for use in obtaining probiotic compounds.

Further studies aim to broaden the range of interactions with pathogenic yeast and bacterial strains and to elucidate the mechanism of antimicrobial action.

Keywords
Kluyveromyces marxianus, probiotic, esterase, killer activity, anti adherence

#32: Diversity of bacterial communities on fresh salmon when preserved by refrigeration or superchilling

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Superchilling, or ultra-chilling, is a technology used to preserve food products by partial ice crystallization (about 30% of ice volume fraction) and storage at 1 or 2°C below their initial freezing temperature. This technology uses temperatures in between those of refrigeration and freezing. It is considered to extend the shelf life of food products compared to refrigeration and to better preserve organoleptic properties (texture, colour, water retention capacity, *etc.*) compared to freezing.

In this study, we aimed at assessing the impact of this technology on the evolution of pathogenic and spoilage microorganisms in fresh salmon. To do so, we characterized the diversity of the bacterial microbiota of fresh salmon after different storage conditions using 16S rRNA gene metabarcoding.

Salmon samples were bought in a local supermarket 8 days after slaughtering (Time 0). As preliminary setting-up, we first compared three commercial kits for gDNA extraction on fish microbiota collected at time 0 to select the most relevant one kit in term of extraction efficiency. The resulting gDNA extracts were then PCR amplified to construct a library targeting the V3-V4 variable regions of the 16S RNA gene. After library sequencing, the commercial extraction kit has been selected according community richness and evenness and been used for the following experiments. Salmon samples were stored for two weeks by refrigeration at 2°C or by superchilling at 1°C below the freezing temperature. Whole microbiota was collected from 10g at time 0 and after storage in both conditions. gDNA of the bacterial communities was extracted in the collected samples. The diversity and dynamic of bacterial communities were then evaluated as a function of the storage using 16rRNA metabarcoding.

Keywords
refrigeration, superchilling, food preservation, food microbiota

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#33: Effect of different pectin sources and structures on the stability of cyanidin-3-O-glucoside (C3G)

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The global demand for high-quality and fresh mixed fruit and vegetable juices is constantly increasing. Mixed cloudy juices containing functional substances, including dietary fiber (e.g., pectin) and bioactive compounds (e.g., anthocyanins) that are related to health benefits to consumers are of special interest. Apple and peach, widely grown popular juice processing raw materials, were chosen for obtaining different pectin fractions (Water-soluble fraction (WSF), chelator soluble fraction (CSF) and sodium carbonate soluble fraction (NSF)). Cyanidin-3-O-glucoside (C3G) is the most abundant and widely distributed anthocyanin, found widely in fruits and vegetables such as blueberry, purple potato, and elderberry. The stability of C3G is influenced by several factors such as light, temperature, oxygen, and pH which might lead to its degradation during processing and storage of the juices which limits the health benefits of the juices. Fortunately, the interaction between plant cell wall polysaccharides and C3G could enhance the physicochemical stability of C3G in the juice system. It has been found that pectin could stabilize anthocyanins during processing and storage. The effects of pectin structure on this stabilization is unknown. Therefore, the stability of C3G were investigated after binding with pectin from different sources (apple and peach) and different fractions (WSF, CSF, and NSF). The maximum binding percentage was obtained at pH 2.0 for apple pectin (AP) (46%~50%) and at pH 3.5 for peach pectin (PP) (50%~54%). Binding with both pectin increased the color stability of C3G under pH 2.0. Pectin with high degree of esterification increased C3G light stability, and all pectin fractions reduced the thermal degradation rate of C3G, thus exhibiting a protective effect.

Keywords
cyanidin-3-O-glucoside, pectin, color, degradation, stability

#37: Proximate, Physicochemical, and sensory properties of biscuits formulated with *Macrotermes subhyalinus* flour

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In recent years, the high nutritional value of edible insects has attracted researchers and the food industry's attention as a potential source of food with enhanced nutrition. In this study, *Macrotermes subhyalinus* flour was added to wheat flour with a view to obtaining a biscuit that is nutritionally enhanced and acceptable to consumers. The edible insect's nutritional, physicochemical and sensory properties were determined and compared with wheat flour. Moisture content of the composite flour ranged from 6.83 to 7.76%, while the moisture of the biscuits ranged from 2.86 to 7.90%. A notable significant difference ($p < 0.05$) was observed in the protein content of the composite flour and biscuits as the flour concentration increased, ranging from 15.03 to 21.52% and 17.38 to 20.63%, respectively. The lightness of the composite flours decreased significantly ($p <0.05$) with an increase in edible insect flour addition, while the colour attributes of redness and yellowness did not exhibit any statistical differences ($p > 0.05$). Biscuits generally showed substantially lower L*, indicating that they were darker in colour than the corresponding composite flours. The water activity of the biscuits ranged from 0.44 to 0.67. According to the results obtained, the added concentration of insect flour did not significantly ($p > 0.05$) influence the hardness of the biscuits. MZ-5 was the most liked insect-enriched biscuit in terms of colour, taste and pleasant aroma attributes. In this study, more than 70% of consumers indicated a willingness to consume biscuits enriched with edible insects.

Keywords
composite flour, biscuit, nutritional value, sensory evaluation, *Macrotermes subyalinus*

#41: Survival and growth of foodborne pathogens in falafel paste at different storage temperatures

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Contamination of fried falafel (fried paste of chickpeas) with foodborne pathogens have been linked to foodborne outbreaks. The objective of the current study was to investigate the behavior pattern of E. coli O157:H7, *Shigella flexneri* and *Staphylococcus aureus* in falafel paste at different storage temperatures. Falafel paste was divided into 50 g samples which were inoculated with 5.0-6.0 log CFU/g of E. coli O157:H7, *S. flexneri* and S. aureus and stored at 4, 10 and 25°C for 14 days. Samples were taken at different time intervals and analyzed for viability of pathogens. E. coli O157:H7, *S. flexneri* and *S. aureus* survived well in falafel paste stored at 4 and 10 °C till the end of storage period with < 1.6 log CFU/g reductions except for *S. flexneri* at 10°C where the numbers increased by 3.5 log CFU/g. At 25°C, numbers of E. coli O157:H7, *S. flexneri* and S. aureus sharply increased by 4.0, 3.6, and 2.5 log CFU/g, respectively, at day 1 and then gradually decreased to reach 8.1, 8.6 and 4.7 log CFU/g, respectively, at 14 d. The initial pH value of falafel paste was 6.4; and remained constant at 4°C until the end of storage period. However, the pH was reduced to a range of 4.3-5.0 at 10 and 4.9-5.6 at 25°C. E. coli O157:H7, *S. flexneri* and *S. aureus* grew or survived well in falafel paste under different storage temperatures which indicates the necessity of preventing the contamination of falafel paste to reduce the potential the risk associated with foodborne pathogens.

Keywords
foodborne pathogens, *Staphylococcus aureus*, *Shigella flexneri*, *E. coli* O157:H7, falafel (fried paste of chickpeas)

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#42: Fermentation, health aspects and future prospects of kombucha

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Kombucha is prepared with black or green tea with the addition of some sugar. The mixture is then inoculated with the mother culture (symbiotic culture of bacteria and yeast, or SCOBY). The bacteria and yeasts in the SCOBY synthesize polysaccharide, and the liquid part is the fermented tea. The content of the fermented tea mostly depends on the quality and microbiota of the SCOBY. Furthermore, kombucha fermentation is affected by numerous parameters such as the hardness of water, carbon source, substrate, concentration of tea, microbial and nutrition composition, fermentation temperature and length, surface area. Kombucha has a symbiotic, diverse microbiota and metabolites. *Acetobacter* spp., *Gluconobacter* spp., and yeasts are present in kombucha. Kombucha fermentation produces several vitamins, including vitamin B_1 (anti-aging), vitamin B_2 (prevents arthritis and allergies), vitamin B_6 (helps the body fight depression, stabilizes mood, and improves concentration, prevents stroke and obesity), vitamin B_{12} (aids memory loss), and vitamin C (suppresses cortisol release). Tea polyphenols, which are active substances and powerful antioxidants, are found in Kombucha. The tea is well-known for its antioxidant properties. Antioxidants help to prevent a variety of diseases, including cancer, neurodegenerative disease, and cardiovascular disease. However, the vast majority of the health benefits have yet to be scientifically proven in human models. Currently, research on kombucha tea and SCOBY is gaining popularity due to their remarkable properties. The polysaccharide component of the SCOBY is a valuable product of the kombucha tea fermentation process, with potential applications in the food industry, cosmetics, textile and biotechnology fields. Kombucha is traditionally brewed at home and is also available commercially. This beverage could be used as a dietary probiotic and prebiotic supplement because it is high in bioactive compounds and antioxidants.

Keywords
kombucha, SCOBY, health benefits, bioactive substances

#43: Use of persimmon fruits as a health-promoting substrates in water kefir fermentation

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Water kefir is a fermented beverage using non-dairy substrates and water kefir grain grains with potential health benefits. Persimmon (*Diospyros kaki*) has nutrients and important bioactive components. The research aimed to investigate the use of persimmon in water kefir fermentation and determine the final product's microbial, chemical, and sensory properties. Water kefir grains containing lactic acid bacteria and yeasts were inoculated into sterile water with persimmon and fermented at 25 °C for 24 h. The pH decreased during persimmon water kefir fermentation. Persimmon water kefir samples contained 8.16 log CFU/g *Lactobacillus* spp., 7.84 log CFU/g *Lactococcus* spp., and 6.17 log CFU/g yeasts. The microbiota efficiently utilized the sugars in the persimmon during water kefir fermentation, and metabolites such as lactic acid content increased. Notably, the persimmon water kefir samples' acetic and malic acid content were high. Persimmon water kefir had a substantial amount of total antioxidant activity. The total phenolic contents of persimmon water kefir samples were 49.30±2.36 mg/L, respectively. TEAC and DPPH values of samples were determined as 9.44±0.31 mM and 2.29±0.28 mM, respectively. The persimmon water kefir samples had high scores for sensory properties. In conclusion, the persimmon water kefir would significantly benefit vegans and allergic individuals. This study obtained plant-based water kefir beverage with high content of lactic acid bacteria and antioxidant activity.

Keywords
water kefir grains, vegan, persimmon, antioxidant activity, fermentation

#45: Effect of feeding systems on goat milk composition

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Small ruminants have been milked before cows for thousands of years and have been raised for milk and meat. They have a wide range of genetic potential, distribution, and production and are naturally renewable resources. Goat feeding systems vary greatly over the world, especially in the Mediterranean countries. They could be highly extensive and based on natural grasslands or rangelands, or they can be very intensive and dependent on feeding and natural grazing. Usually, systems that are based mostly on pasture *vs*. indoors are being compared. The aim of this review is to present the key components of goat milk product composition as well as the impact of feeding systems on chemical composition and quality characteristics of those products. Due to the multispecies composition and climatic conditions, grazed forage naturally contains various bioactive compounds with antioxidant and anti-inflammatory characteristics, including as bioflavonoids and phytosterols, which are transferred to milk and dairy products. The majority of browse species, including fodder trees, shrubs, and herbaceous plants, have significant polyphenol contents and many of them contain bioactive components of the forage selected by goats. This milk is rich in phenolic compounds, volatile compounds, and minerals, all of which are beneficial for nutrition and overall health. Goat milk from pasture is naturally enriched in natural elements such as phenolic compounds, fat-soluble vitamins, flavonoids, bioactive lipid components, unsaturated fatty acids, and medium-chain fatty acids in compared to goat milk from typical concentrate-forage diets. A large number of traditional specialty products, primarily from extensive goat farming systems, should be produced and marketed in accordance with consumer demands and expectations, with authenticity due to animal breeds, natural feed resources used by these animals, and specific processing. Because goat milk has beneficial properties, it is recommended because it reduces the risk factor of such illness.

Keywords
goat milk, extensive feeding, bioactive components, health

#48: Unraveling the role of oleic acid in *Listeria monocytogenes* cold adaptation by transcriptomic analysis

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Listeria monocytogenes is one of the main microbiological hazards to be considered in refrigerated ready-to-eat foods. Low temperature preserves food safety by reducing pathogen growth. However, *L. monocytogenes* is able to grow at low temperature by changing its membrane lipid composition. We have recently shown that *L. monocytogenes* grows faster at low temperatures when the medium is supplemented with exogenous unsaturated fatty acids (eUFA) which are incorporated into the bacterial membrane. No significant differences in growth rate were observed at 37°C. A transcriptomic analysis on 4 culture conditions with or without oleic acid at 5°C or 37°C was performed to understand the involvement of oleic acid in cold adaptation of *L. monocytogenes* at molecular level. Differential gene expression analysis was performed using R-studio. 1164 genes were differentially up- or down- regulated (Log2 Fold Change >1 or <-1). The clusters of Gene Ontology with the most differentially expressed genes were inorganic ion transport and metabolism, chemotaxis and cell motility, fatty acid synthesis, amino acid synthesis, plasma membrane proteins and transport proteins. Several genes involved in fatty acid metabolism (*fabK*, propionate CoA transferase) or transport (ABC transporters) are upregulated when oleic acid is present at 5°C but not at 37°C and downregulated at 5°C without oleic acid. In contrast, genes involved in the synthesis of branched fatty acid precursors (*ilv* and *leu* genes) and in the initiation module of the fatty acid synthesis (*acc* genes) were only upregulated at 5°C but no significant differences were observed with or without oleic acid. Chemotaxis and flagellar genes are upregulated in the presence of oleic acid at 5°C but not at 37°C. Hence, the upregulation of the large operon starting with *cheAY*, a two-component system, implies that *L. monocytogenes* could sense an oleic acid related stimulus at 5°C. Besides, genes involved in iron metabolism (*fhuC*, *tatA*, ...) are downregulated when oleic acid is present at 5°C but not at 37°C and upregulated at 5°C without oleic acid. Overall, oleic acid could counterbalance the effect of low temperature on the expression of these genes. These results will be shortly deepened by RT-qPCR with other eUFA and further studies will be implemented to understand this regulatory mechanism.

Keywords
Listeria monocytogenes, low temperature, oleic acid, transcriptomic analysis

Acknowledgements
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#49: Valorization of organic biomass to produce active caseinate composite films

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The horticultural commodities produce a significant number of crops residues, by-products of agro-industrial transformations, and additional unmarketable products that represent an important potential source of organic matter to reuse in the productive cycle as compost. For instance, common agro-products i.e., fennel or waste of coffee production are often rich of bioactive molecules and can be used effectively to design novel food packaging formulations due to their ability as anti-microbials and antioxidants. In a sustainability context, this work was aimed at extracting humic substances (HS) from green compost of coffee husk (COF) and fennel waste (FEN). The HS were then used to develop biopolymeric films using casein as base biopolymer through solution casting. The developed film samples were evaluated structurally by NMR. The mechanical, barrier, optical, antioxidant and antimicrobial properties of the films were analyzed. The NMR results suggested a faster relaxation time (t1rH) in polymeric films whose values were significantly lower in respect to those of isolated single components. The active film (F-COF) contained more hydrophilic groups than film (F-FEN) as confirmed by NMR and 3 times more water vapor permeability. The optical properties of the films were influenced by the presence of aromatic rings in the extracts. The softening of the active film structure due to reduced interactions between the polymeric chains led to significantly lower ($p < 0.05$) elastic modulus (EM) as compared to neat films. The active films containing fennel extract displayed better antioxidant and anti-microbial potential as compared to neat and film with coffee husk extract. Thus, the use of coffee husk and fennel waste is promising for the development of environmentally friendly packaging to be used for food preservation.

Keywords
recycling biomass, fennel, coffee husk, biobased film, active film

#51: Recovery of compounds of interest from broccoli by-product using green techniques and functional food development

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There is a growing interest in the development of initiatives for the treatment of food by-products and the recovery of compounds of interest from them, due to the double advantage that they present, since apart from reducing the volume of waste and minimizing the costs involved in waste management, it is possible to recover a product or obtain a new one that can be marketed, with the consequent benefit from the economic point of view. Broccoli by-products are potential sources of compounds of interest, including phenolic compounds, edible fiber, proteins and sugars, of great interest to the food, cosmetic and pharmaceutical industries. For the extraction of compounds of interest in broccoli by-products, different alternative methodologies to the use of organic solvents have been used, including thermal and enzymatic treatment, ultrasound, subcritical water, obtaining extracts rich in edible fiber with antioxidant capacity. Functional foods have been developed with the broccoli extracts obtained to replace it with modified starch because these extracts have thickening power.

Keywords

by-product, green extractions, functional food, compounds of interest

#52: Recovery of compounds of interest from grape by-product using green techniques and functional food development

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There is a growing interest in the development of initiatives for the treatment of food by-products and the recovery of compounds of interest from them, due to the double advantage that they present, since apart from reducing the volume of waste and minimizing the costs involved in waste management, it is possible to recover a product or obtain a new one that can be marketed, with the consequent benefit from the economic point of view. Grape by-products are potential sources of bioactive compounds, including phenolic compounds, of great interest to the food, cosmetic and pharmaceutical industries. Different alternative methodologies to the use of organic solvents have been used for the extraction of compounds of interest in lemon by-products, including thermal and enzymatic treatment, ultrasound, subcritical water, obtaining extracts rich in phenolic compounds, edible fiber and sugars. Functional foods have been developed with the grape extracts obtained to replace it with chemical pectins, as these extracts have gelling power.

Keywords
grape by-product, functional food, compounds of interest, green extractions

#53: Chutneys formulation with strawberry tree fruits (*Arbutus unedo* L.) pulp

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Chutney is a spicy or savory condiment, made from fruits, vegetables and/or aromatic herbs, with vinegar, sugar, and spices. The main objective of this work was to develop formulations of chutneys using strawberry tree fruits (*Arbutus unedo* L.) as raw material. These fruits were crushed and their seeds and sclereids removed by physical separation to obtain a smooth pulp. In a first step, the development of six chutney formulations was carried out, all consisting of those pulp, and including different raw materials, such as tomato (CH1), raisin and honey (CH2), apple (CH3), pumpkin (CH4), pineapple (CH5) and beetroot (CH6). The six chutneys were sensory evaluated and physical-chemical and colour analyzes (L*a*b* system) were also carried out. Comparing the overall sensory appreciation, the following sequence was established: most appreciated CH5>CH2>CH6>CH3>CH1>CH4 least appreciated. For pH, the lowest mean value was presented by CH5 (4.12) and the highest by CH2 (4.65). From the literature, a low pH level in the chutney is crucial for its stability and shelf life extend. By this, a second step was taken to optimize the three previous most appreciated formulations by the increase of vinegar content in each formulation which allowed the pH reduction for average values lower than 3.50. Moreover, the overall acceptability and the purchase intention results for the three reformulated chutneys were positive, suggesting that the three chutneys have potential to become commercial products in the future.

Keywords
chutney, strawberry tree fruit, innovation, food industry, sensory analysis

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#56: Functional Finger Foods: a promising strategy to increase the proteins intake of older people

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In developed countries, the elderly population can suffer from undernutrition, particularly in frail and hospitalized people. In France, 2 millions of older people are at risk of undernutrition. Sarcopenia, that is recognized as an hallmark of undernutrition, is defined as the progressive and generalized loss of skeletal muscle mass and strength. Although difficult to determine, the sarcopenia could reach 20% of people 60 years old. The loss of appetite and/or food intake in old age can worsen the age-related sarcopenia. The deleterious self-perpetuating vicious circle between undernutrition and sarcopenia precipitates the entry of elderly people into dependence and increases the risk of infection and mortality (1). In France, the daily recommended protein intake is 1g/kg for adults aged over 65 years, whereas it is 0.8g/kg for younger adults(2). For the elderly, the protein requirement increases while their spontaneous intake decreases, due to loss of appetite, individual's disability and disgust for the meat. In collaboration with cookers working for a long time in a nursing home, we have designed finger foods, rich in proteins and easy to grab and chew. These finger foods are small sugary bites of 10g and contain 1g animal proteins. Different recipes (n=16) of finger foods were distributed to 60 people in 5 different French nursing houses for 10 days. Participants evaluated the finger foods on a categorical scale, with pictograms as described in Sulmont-Rossé (3). We observed that the level of consumption depends on the taste and the involvement of the nursing team to accompany, explain and support this new proposal. The number of finger foods preferentially consumed per day was 10, thus providing 10g of proteins. Distribution of finger foods three or four times a day, is a promising strategy to increase the food consumption all along the day with small portions and to better fulfill the daily recommended protein intake.

1 Saint-Criq V, Lugo-Villarino G, Thomas M. Ageing Res Rev. 66 (2021)

2 Experts PA (2007) Protein Intake: Dietary Intake, Quality, Requirements and Recommendations. ANSES reports. https://www.anses.fr/fr/system/files/NUT-Sy-ProteinesEN. pdf.

3 Sulmont-Rossé C, Symoneaux R, Feyen V, Maître I. Vol 2 1st Edition, Elsevier, 478 p., 2018. ffhal-02791415

Keywords
finger food, elderly, protein, sarcopenia, undernutrition

#59: Evaluation of UVC-light and High Intensity Light Pulses (HILP) as technologies for sanitization of seeds for sprouting

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Sprouted seeds are natural foods, abundant in vitamins, minerals, amino acids, fiber, flavonoids and phenolic components, which are gaining popularity among consumers. However, despite their benefits, they have been the cause of important foodborne outbreaks related to *Salmonella spp*. and *Escherichia coli*, among others. Although the FDA has recommended the use of 20,000 ppm of free chlorine to disinfect these seeds, several outbreaks continue to be reported due to the consumption of these. However, this method cannot be used for some seeds as chia since the adsorption of these chlorine solution within the mucilage is difficult to wash away, and could be toxic for human consumption and detrimental for sprouting. For this reason, research is needed in technological alternatives that ensure adequate disinfection of seeds. Among these technologies are UVC-light and high intensity light pulses (HILP). Both technologies have proven to be successful at inactivating a wide range of pathogens in different foods (juices, dairy, egg-shells, poultry, cheese, sesame seeds, radish, *etc.*); however, there is not enough information about its application in seeds for sprouts.

This study evaluates the effectiveness of the application of UVC-light and HILP, as alternatives to improve the microbiological quality of sprout seeds. Different treatment doses of UVC-light and HILP were tested to inactivate the population of native mesophilic bacteria and S. Typhimurium inoculated in alfalfa, wheat and chia seeds. The results showed that the native microbiota in the analyzed seeds was in the range of $10^2 – 10^3$ CFU/g. With both technologies, the native microbiota population was completely inactivated in chia seeds, while in alfalfa and wheat seeds, 10^2 CFU/g reductions were achieved. Regards the total inactivation of S. Typhimurium, it was achieved with HILP when applied in alfalfa and chia seeds. The effectiveness of HILP compared with UVC-light treatments is attributed to the synergy among the photochemical (DNA damage) and photothermal effects. Additionally, the effectiveness of both technologies is strongly related to the physical characteristics of the seeds (size and surface roughness). Further research is needed to optimize the application of these technologies on seeds.

Keywords
sprouts, high-intensity light pulses, UVC-light, seed disinfection

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#61: Steaming is the best cooking technique for phenolics and sensory acceptance of the cauliflower

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Cooking vegetables affects thermo-labile nutritional compounds such as phenolics and vitamins in addition to their palatability. Brassicaceae family of plants are known for their high content of phenolic compounds including Cauliflower. A comprehensive study including frying, stir-frying, grilling, air-frying techniques, other than boiling, steaming, baking and sous-vide, and microwaving, has not been studied for effect on total phenolic content (TPC) and sensory properties (appearance, odor, taste, and texture) yet.

This research investigated how various cooking methods with different process parameters (time and temperature) affect TPC and sensory profile of cauliflower. TPC was analyzed using Folin-Ciocalteu method. A descriptive sensory analysis was conducted on selected samples based on higher TPC and assessable sensory attributes. 15 semi-trained sensory panelists evaluated the sensorial attributes using 9 point hedonic scale.

Higher the cooking temperature higher the TPC values. This phenomenon is due to cleavage of bound-phenolic compounds by degradation of cell wall of the cauliflower and disruption of phenol-protein complexes, and phenolic compounds produced by Maillard reaction. Both facts were mostly effective in steam cooking (12 min) and baking in oven (180°C-20 min), respectively. Although increasing cooking time is beneficial for these reactions, increase in boiling time increases the loss of phenolics through boiling water.

Sous vide samples were very light and had uniform color in spite of less palatability. Sulfur odor and taste were only detected in low moisture cooking methods (frying and baking). TPC highly affected the bitterness. The highest TPC and bitterness were obtained in steaming and baking in 180°C for 20 min cooking. Both bitterness and sweetness were the lowest in boiling due to loss of related compounds in boiling water. Steaming and frying provided the highest cooked cauliflower taste. The baking and sous-vide resulted in higher firmness and difficulty in chewing and swallowing. Overall acceptability in boiling, steaming, and frying was higher than in baking and sous-vide.

Finally, steaming was chosen as the best technique regarding both TPC and sensorial affects. Further studies can be focused on different parameters with various sauces as a cover medium.

Keywords
cauliflower, total phenolics, cooking techniques, sensory analysis, steaming

Acknowledgements
Analyzes were performed in Central Research Laboratory of Altınbaş University.

#63: Thermal gelation of protein isolates from legumes: A comparative study

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The rapidly growing world population is challenging the food industry to foster the transformation to a sustainable food system. Thus, the need for plant-based food solutions is increasing and requires the development of new functional food ingredients. Building a profound knowledge of the gelation of plant proteins bears great potential to establish a next generation of foods. In the field of plant protein gels, hydrophobic groups - naturally buried within the globular structure of most of the plant proteins - are crucial for network stabilization. During a thermal denaturation process, water can be irreversibly trapped inside a newly formed network via the reorganization of the molecular conformation during the cooling process. Legume proteins differ in amino acid composition, which in turn affects secondary, ternary and quaternary protein structures and thus the accessibility of hydrophobic groups. To compare the gel-forming properties of different legume sources, multiple commercially available protein isolates, such as pea, soy and lupin protein ingredients, were investigated. For this purpose, the gelling temperature, minimal gelling concentration and viscoelastic properties were assessed. Substantial differences of gel quality were observed in dependence of the legume source, e.g. minimal gelling concentrations varied from 14% to higher than 20%. Even within the same legume source, differences in gelation temperature and minimal gelation concentration were found, suggesting a strong influence of processing conditions during extraction, isolation and drying. Overall, all investigated legume proteins showed insufficient gel qualities when compared to traditionally used ingredients such as gelatin or pectin. Currently, physico-chemical modification strategies are examined to obtain promising food ingredients for substitution of animal proteins in gelled products.

Keywords
plant protein, alternative protein, techno-functionality, heat-induced gelation, hydrogel

#68: Influence of artificial UV-light treatment or sun-drying on the Vitamin B2 (riboflavin) content of selected edible mushrooms

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Objective: In the last decade numerous studies have shown that treating mushrooms with artificial UV-light or traditional sun-drying drastically increases their vitamin D_2 contents. Thus, recommendations to employ either method, to meet dietary vitamin D requirements, have their merits. However, the fact that mushrooms are a good source of the photo-sensitive B-vitamin riboflavin (0.2-0.4 mg/100 g), comparable to more familiar riboflavin sources like dairy, is often overlooked. Thus, there is only limited data, if UV-treated mushrooms have decreased riboflavin contents. The aim of this study was to close this data gap.

Methods: Button, oyster and shiitake mushrooms, were chosen for this study, due to being the three economically and nutritionally most important mushroom species. Each analyzed mushroom species was divided in two groups i) sliced fruit bodies (3-5mm) treated with artificial UVB-light until a dose of 3 J/cm2 was reached and then freeze-dried, or ii) sliced fruit bodies (3-5mm) that were sun-dried. For each batch and mushroom species untreated samples were used as controls. Riboflavin contents were analyzed via HPLC. All experiments were repeated for 3 different batches of each mushroom species.

Results: Button, oyster and shiitake mushrooms treated with artificial UVB-light had a mean riboflavin content of 0.35 mg, 0.16 mg and 0.17 mg per 100 g fresh weight, showing little to no reduction compared to controls which contained 0.37 mg, 0.16 mg and 0.15 mg per 100 g. Sun-dried button mushrooms however showed a remarkable reduction in riboflavin, having a mean riboflavin content of 0.14 mg per 100 g. Oyster (0.11 mg per 100 g) and shiitake (0.12 mg per 100 g) mushrooms also showed a stronger reduction in riboflavin, compared to the other treatment groups but losses were overall much lower.

Conclusions: The results of this study indicate that the mushroom matrix can inhibit riboflavin degradation by artificial UV-B light, while sun-light, which consists mostly of UVA-light, causes a stronger reduction of riboflavin especially in button mushrooms. Therefore, treatment with artificial UV-B light is to be recommended for vitamin D2 fortification of mushrooms to simultaneously ensure preservation of their riboflavin.

Keywords
mushrooms, riboflavin, UV-treatment, sun-drying

#69: Advanced maize ogi characterisation for the design of high quality and healthy akpan, a plant-based yoghurt-like food from Benin

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Microorganisms in fermented foods can contribute to consumer health by prebiotic and probiotic properties. Traditionally fermented foods, mainly obtained through fermentation by lactic acid bacteria, are particularly known for these functional roles. In south Benin, a survey was conducted on fermented maize starch, called *ogi*, which is used for preparing *akpan*, i.e., a traditional plant-based food potentially promoting human health by stimulating species of *Bifidobacterium* in consumer gut microbiota. Current *ogi* processing technologies used by two socio-cultural groups, namely the Fon and the Goun, and the quality of the fermented starches were studied as a basis for formulating best production practices since spontaneous fermentation sometimes causes product failure. Four processing technologies were identified, two from the Goun (G1, G2) and two from the Fon (F1, F2). The main difference between the technologies was the steeping procedure where maize grains and water are heated together in Goun technologies, while the water is boiled then added to the grains in Fon technologies. Differences related to the processing technologies were found between *ogi* samples when ready for *akpan* production. For example, *Lactobacillus* and *Cladosporium* spp. were significantly more abundant in Goun *ogi* than Fon *ogi*, while *Kurtzmaniella* spp. were significantly lower. Fon samples collected in Abomey were particularly rich in volatile organic compounds and free essential amino acids. However, when traditional ready-to-use maize *ogi* sharing similar metabolic profiles clustered, the proportions of the main bacterial genera (e.g., *Lactobacillus*, *Limosilactobacillus*, *Streptococcus* and *Weissella*) and fungal genera (e.g., *Diutina*, *Pichia*, *Kluyveromyces*, *Lachancea*) dominating the microbiota of the samples were quite variable. Our results suggest that beyond using Fon or Goun procedures for steeping maize grains, other practices (e.g., steeping duration, fermentation time) in *ogi* processing technologies may impact the characteristics of the fermented maize starch. In follow-up research, we will evaluate the effect of fermentation on the microbial composition in maize *ogi* and the connections with residual metabolites.

Keywords

cereal processing, starch fermentation, microbiota, metabolite, food security

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#74: Study on the application of agricultural by-products in developing functional yogurt: physicochemical and sensory properties

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The demand for functional foods of vegetal origin has been growing among consumers, driven by concerns about health and wellness, as well as ethical and environmental considerations. In this study, the addition of two vegetable by-products (cocoa bean shell and beer spent grains) to stirred yogurt was investigated at three different concentrations (2%, 4%, and 6%). The functionalized yogurt was evaluated for its microbiological, sensory, and physiochemical characteristics, such as pH, acidity, syneresis, color, total phenolic content, and radical scavenging activity, at the time of production and after 7, 14, and 21 days of storage. The results indicated that the addition of the by-products did not significantly alter the load of lactic acid bacteria, pH and titratable acidity. However, other parameters, including syneresis, CIELab values, total phenolic content, radical scavenging capacity, and texture, were significantly impacted by the fortification. These changes on the result were directly correlated to the percentage of fortification. The sensory analysis revealed that all the functionalized yogurts were well-accepted by the panelists, with the highest preference scores observed for the yogurt containing 2% of the powders. The results of this study provide insights into the potential of incorporating agricultural by-products into functional yogurts and contribute to the development of new, sustainable food products that meet the evolving demands of consumers.

Keywords
functional yogurt, byproducts, sustainable food

#80: Colorimetric aptasensor for detection of *Bacillus cytotoxicus* spores in milk and ready-to-use food

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High incidence of foodborne diseases caused by pathogenic bacteria raises concerns worldwide and imposes considerable public health care challenges. This is especially observed with dormant spores of Bacilli, which are present in different foods and environments. Spores can often survive treatments used by the food industry to kill growing bacteria. The early and rapid detection of bacterial spores is essential to ensure food safety. Commercial availability of such a test will present a high potential for the food sector. To this aspect, we developed for the first time a point-of-need colorimetric assay for detection of *Bacillus cytotoxicus* spores in food. The detection principle is based on spore-enhanced peroxidase-like catalytic activity of gold nanoparticles. The sensing platform was a microtube containing gold nanoparticles (AuNPs) and magnetic particles (MPs) both conjugated with specific aptamer BAS6R that recognize *B. cytotoxicus* spores. Upon the addition of the sample, spores were evidenced through the oxidation of tetramethylbenidine (TMB) with H_2O_2 by the enhanced color change of the solution. The assay was evaluated by the naked eye (on/off) and quantitatively with use of a spectrophotometer. BAS6R@AuNPs aptasensor coupled to BAS6R@MPs proved to be highly sensitive, achieving the naked-eye limit of detection as low as 10^2 cfu/mL in water and milk and 10^4 cfu/mL in mashed potatoes. Moreover, discrimination between spores of *B. cytotoxicus* and *B. subtilis* as well as bacterial vegetative cells was achieved in contaminated food samples, providing a good selectivity. We constructed an affordable strategy for the simple and rapid detection of *B. cytotoxicus* spores in food matrices based on the use of enhanced peroxidase-like activity of AuNPs. This work provides a promising proof of concept for the development of instrument-free, low-cost and rapid assay for *Bacillus cytotoxicus* spore detection, which is able to compete in sensitivity with conventional costly and time-consuming laboratory analyses.

Keywords
enzyme-free, colorimetry, gold nanoparticles, magnetic particles, *B. cereus* spores

#83: Influence of hydrocolloid type on rheological properties, printability, and deformation of 3D-printed gluten-free snacks

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Due to their thickening and gelling properties, hydrocolloids have the potential to improve the print quality of food inks, gluten-free in particular. Therefore, we investigated the effects of adding 1 % (flour blend basis) of xanthan (X,) guar gum (GG,) microcrystalline cellulose (MCC), and sodium alginate (NaA), on the ink rheology, print quality, and deformation of gluten-free snacks.

Rheological properties (storage and loss modulus (G', G''), loss factor (tan δ) and complex viscosity (η*)) were determined with frequency sweep test (1-30 Hz, 30°C), with the MCR 92 rheometer with a 25 mm plate system and a shear gap width 1 mm. Foodbot D2 printed a 24 layer shape of the letter "K" in a circle, through a nozzle 0.84 mm in diameter, in five replicates. The printer settings were: 30 °C, 1 mm layer height, and 20 mm/s printing speed. Printed shapes were baked for 60 min at 120°C. Sample height and diameter were measured, and area, printing precision, shrinkage in baking calculated using photographs and Image J software.

Under the lowest frequency, the highest η* (6435 Pa s), tan δ (0.255) and G' and G'' (39167 and 10039 Pa, respectively) were recorded in NaA, followed by X, GG and MCC samples, while being the lowest in the control batter (2300 Pa s; 0.212; 14137 and 2997 Pa, respectively). The type of hydrocolloid significantly affected printing precision, baking loss and shrinkage in baking. Printed line precision of control (55%) was improved with addition of X, GG or NaA (from 58 to 61 %), but not with MCC. It was also positively correlated with tan δ ($r=0.929$; $p<0.05$).

Shape diameter and height printing precisions, relative to the diameter and height given by the G-code, were improved with all hydrocolloids compared to the control. Highest precision (94 %) was achieved with X addition, followed by NaA (92 %), while being lowest for GG sample (91 %).

Control was shrunk by 34% in baking, resulting in reduction of weight, height, diameter and area of shape. Addition of NaA or MCC resulted in the lowest extent of shrinkage (26 %). Due to the biggest improvement of printing precision and reduction of shape deformation, NaA could be recommended for 3D printing of gluten-free dough. Nevertheless, the amount of used hydrocolloid or other additional pre-processing techniques should be investigated to achieve even better precision and lower shrinkage.

Keywords
3D-printing, gluten-free snack, hydrocolloids, rheology

Acknowledgements
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#84: Effect of hydrocolloid addition level on quality of 3D-printed gluten-free snacks

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This study investigated the extent to which different amounts of hydrocolloids (xanthan gum - X, microcrystalline cellulose - MCC, and sodium alginate - NaA) affect the printability and stability of 3D-printed gluten-free snacks, made from corn, millet, and sweet potato flours.

Prior to printing, batters containing 0 (CTRL), 1, 2, or 3% hydrocolloids (on flour basis), were treated in an ultrasonic bath at 860 W, 35 kHz, and 30 °C for 15 min. Rheological properties were analyzed using a frequency sweep test (1-30 Hz, 30 °C) on the MCR 92 rheometer, with a 25-mm plate system and a shear gap of 1 mm, to determine the loss factor (tan δ) and complex viscosity (η*). The printed letter "K" in a circle with 24 layers, height 2.5 cm, diameter 4.125 cm, was produced using the Foodbot D2, under the following parameters: nozzle diameter 0.84 mm, 30 °C, 1 mm layer height, 20 mm/s printing speed. Printed shapes were baked at 120 °C for 60 min. Printing precision and shape deformation in baking were determined using image analysis (Image J). The results were statistically analyzed using factorial ANOVA and Tukey post hoc test ($p< 0.05$).

The type and amount of hydrocolloids, as well as their interaction, had a significant effect on η* and tan δ, which increased with higher levels of hydrocolloids, especially with the addition of 3% NaA. Nevertheless, 3% NaA showed the lowest line (43%) and object height precision (46%), being 120% higher than the designed height. The best improvement of line precision (10 and 15%) compared to CTRL was achieved with addition of 3% X and 1% NaA, respectively. For X and MCC, the height precision was similar regardless of the addition level. Diameter printing precision was higher than 85% for all samples, and the best at 3% NaA (96%). The lowest shape shrinkage in baking, 19 and 22%, was observed in the samples with 1 and 2% NaA addition, respectively, which is an improvement of 27 and 16% compared to CTRL.

In general, the quality of printed raw objects and final products was significantly affected by the hydrocolloid type, addition level and their interaction, and the effect of level addition was most pronounced in the case of NaA, although that effect was not necessarily positive. Overall, the addition of X and NaA in an amount of 1 or 2% was most beneficial for improving the overall quality of the 3D printed gluten-free snacks.

Keywords
hydrocolloids, gluten-free snack, 3D printing

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#88: Selective Greek herbs and traditional, Mediterranean food by-products as sources of natural antioxidants and polyphenols for novel foods development: an *in vitro* study

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Numerous studies demonstrate the potential bioactivity of some medicinal plant extracts and traditional food by-products, containing in the Mediterranean diet, as important sources of bio-functional compounds. The purpose of the present study was to evaluate the total antioxidant capacity and the total phenolic content of selected Greek herbs and traditional, Mediterranean foods by-products. Greek herbs: oregano (Origanum vulgare), thyme (Thymus vulgaris), mountain tea (*Sideritis raeseri*), mint (*Mentha spicata*), sage (*Salvia officinalis*), achillea (*Achillea millefolium*) and labdanum (*Cistus incanus*), as well as selective by-products: olive leaves (Olea europaea) and pistachio red hulls & leaves (Pistacia vera), were evaluated. Aqueous extracts were prepared by adding 2 g of herbs/10 g of olive leaves to 100 mL of dH2O and 3 g of pistachio by-products to 100 mL of aqueous ethanol solution (50%), employing ultrasound assisted extraction (80 Hz, 70 °C, 1h). The total antioxidant capacity was determined via the established Ferric Reducing Antioxidant Power (FRAP) method the total phenolic content was measured according to Folin-Ciocalteu method. The results were processed with the statistical program SPSS 17, performing one-way Anova analysis and Bonferroni tests, in separate, aqueous and aqueous ethanol extract groups. The total antioxidant activity was highest in achillea and thyme (3.6 & 3.05 mmol FeSO4/L, respectively) and pistachio red hull (111.54 mmol FeSO4/L), among aqueous and aqueous ethanol extracts. The highest total phenolic content was shown by achillea (0.29 mg GA/L) and oregano (0.27 mg GA/L), among aqueous group, and also by pistachio leaves (3.32 mg GA/L) in aqueous ethanol group. The results showed that Greek herbs achillea, thyme and oregano, as well as pistachio hull & leaves (by-products) extracts are promising sources of natural antioxidants and phenolic compounds, for the development of innovative, functional foods, while their use could enhance Mediterranean diet principles.

Keywords
Mediterranean diet, Greek herbs, traditional food by-products, antioxidant activity, phenolic content

Acknowledgements
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#94: Production of air-dried Oyster mushrooms applying hurdle technology principles, based on the sustainable use of *Rosa damascena* distillation by-products combined with an osmotic dehydration step

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Oyster mushrooms (*Pleurotus ostreatus*) are widely cultivated around the world and recently they have become very popular due to their superior nutritional content. Due to their high amount of water their shelf life is short (up to 7 days at 4°C), limiting their commercial value. Osmotic dehydration (OD) a mild, non-thermal process, involves the immersion of a food sample in a hypertonic solution, leading to foods of intermediate moisture content. On the other hand, air drying aims at lowering water activity to a level that guarantees food stability, causing quality reduction.

The aim of this work was to study the air-drying kinetics of oyster mushrooms and investigate the effect of a prior osmotic dehydration step while also addressing the sustainable exploitation of *Rosa damascena* distillation wastewater, which are rich in phenolic compounds. In this context, mushroom samples were impregnated in hypertonic solutions including *Rosa damascena* wastewater, glycerol, salt and calcium carbonate. Fresh (Control), osmotically dehydrated (OD) and OD samples including wastewater (ODR) were further air-dehydrated at different temperatures (40, 55, 70°C) and mass transfer, color and texture kinetics were investigated. A first-order reaction kinetic model was successfully used to describe drying kinetics and predict the drying rate, with the rate constant being a function of the process temperature. Results showed that this pre-treatment significantly reduced the required drying time and thus, the overall energy required. Based on model predictions, the time required to reach a final moisture content <10% wb, characteristic of air-dried products, was reduced by a factor of more than two when control samples and OD/ODR counterparts were compared. This time reduction was more pronounced at the drying temperature of 70°C, where the drying time was reduced from 4.8 h (control) to 3.8 h (OD) and 3.3 h (ODR). Moreover, quality-wise OD and ODR samples retained their texture and color much better than the control samples, with ODR samples being additionally enriched with bioactive compounds. Overall, results show that osmotic dehydration using by-products rich in bioactive compounds, prior to drying helps to minimize degradation of color and texture, achieving the goal of less energy consumption and a shorter drying time.

Keywords
hurdle technology, drying kinetics, osmotic dehydration, oyster mushroom, by-products utilization

#95: The study of recyclable packaging materials for Gouda cheese ripening

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With an increase of the greenhouse gas effect, there is an upcoming need to reduce the emissions by reducing packaging waste. Different materials are used for cheese packaging as well as ripening due to the specific requirements in order to maintain product quality. The aim of the study was to establish appropriate recyclable packaging material for Gouda cheese quality maintenance during the ripening.

The sustainable commercially produced recyclable packaging materials are selected for the study: BOPP Propafilm P2GAF (Innovia), CERAMIS® polylactic acid biopolymer with SiO2 coating (Amcor), cellulose-based material (Formaticum), polylactic acid biopolymer with NatureFlex coating (Mixpack), PropaFresh P2GAF (Innovia), and DECOLINE®DCL-BD polyolefin (PolPak) shrinking film, as well as Cryovac® BK 3550 BAG conventional multilayer (EVA/PE/EPC/PVDC) packaging material (Sealed Air) was used as a control.

Unripened Gouda type cheese (produced by SC Smiltenes piens, Latvia) was selected for the study. The cheese surface was not treated with antifungal preservatives prior to ripening. Cheese samples were packed in the selected materials and ripened at 12oC in a relative humidity of 80-85%. pH, yeasts and molds, cheese hardness, lactic acid bacteria, cheese weight loss were tested throughout 45 days of cheese ripening and samples were analysed on the 1st, 15th, 30th and 45th days of ripening.

The growth of yeasts and molds was established on the surface of cheese samples using BOPP Propafilm P2GAF, cellulose-based material, and polylactic acid biopolymer with Nature Flex coating. The results indicated that CERAMIS polylactic acid biopolymer with SiO2 coating, PropaFresh P2GAF film, and DECOLINE DCL-BD polyolefin (POLPAK) shrinking film decreased the weight loss and minimized the microbiological spoilage by controlling fungal growth and oxygen barrier which resulted in the same quality cheese comparing with conventionally packed.

Keywords
recyclable materials, cheese, quality, packaging, microbiology

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#99: Electrospun nanocellulose/poly(vinyl alcohol) (PVA) fibers: evaluation of cellulose nanocrystals orientation on multilayer food packaging properties

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The harmful impact of single-use plastics on the environment encourages the development of new materials in multiple industries, particularly in the food packaging industry which is the main single-use plastics generator. Designing new bio-based and biodegradable food packaging is hence essential. Previous work highlighted the potential of nanocelluloses as a bio-based and renewable polymer, with high gas barrier properties, for food packaging applications[1]. Their high sensitivity to water vapor requires the use of a second bio-based polymer with good water barrier properties, such as poly(lactic acid) (PLA). Different architectures combining nanocelluloses and PLA have been studied and better preservation of nanocelluloses properties was observed with a multilayer structure[2]. We hypothesized that it was possible to improve the film properties by orienting cellulose nanocrystals (CNC) to create a dense and highly barrier network. In this work, a specific coating process was studied: electrospinning, used to deposit nanofibers of CNC/poly(vinyl alcohol) (PVA) solution on a PLA layer. The electrospinning coating process was optimized to obtain the most oriented electrospun fibers, through the use of an adhesive layer and a rotative drum collector. A second type of samples, unoriented, were prepared with a bar-coated deposition of CNC/PVA solution on PLA to serve as control group. Samples prepared with both coating processes were characterized and compared to evaluate the effect of CNC orientation on the film properties.

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Keywords
electrospinning, nanocelluloses, barrier properties, multilayer films, food packaging

#101: Mechanical properties of hydrogels based on gelatin and chitosan as affected by pH

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Hydrogels are three-dimensional polymer networks that absorb and retain large amounts of water. Gelatin, as a commonly used natural hydrogel matrix, is a protein that is produced from collagen by acid or alkaline hydrolysis, as type A or type B gelatin, respectively. The chitosan is a cationic polysaccharide obtained from chitin by deacetylation in presence of an alkali. Particularly, gelatin and chitosan are non-toxic, edible, biodegradable, biocompatible and which have a good film-forming property. They are also used together, forming a blended matrix with improved physical properties. The objective of this study was to evaluate the mechanical properties of hydrogels formed by two types of gelatins [Type A (GeA) and type B (GeB)] and chitosan (CH) as affected by pH (3.5 to 6.0). The hydrogels were prepared from the blend of two solutions: (I) 6.5% (w/w) of GeA or GeB, and (II) 1.5% (w/w) of chitosan. Briefly, these solutions were mixed at a ratio of 4.3:1 (w/w, Ge:CH), (2 h/50 °C). Then, their pH was adjusted to 3.5–6.0, and these solutions were put in cylindrical molds (20 x 20 mm) and stored at 5 °C for 24 h to set the hydrogels. The hydrogels were submitted to mechanical characterizations by uniaxial compression tests (1 mm-1, 90% of strain) and stress relaxation (1 mm-1; 20% of strain), using a Texture Analyser (TA.XT2i, Stable Micro Systems, Surrey, England UK). According to the uniaxial compression tests results, the break stress for GeA:CH gels increased linearly with pH (2 to 16 kPa), while for GeB:CH, two regions were observed: linear increase between pH 3.5 and 5.5 and a jump from 13 to 37 kPa, when the pH went from 5.5 to 6.0. The same behavior was observed for Young Modulus, with a linear increase from 7 to 20 kPa for GeA:CH, and two regions for GeB:CH (20 to 30 kPa at pH 3.5-5.5 and a jump to 40 kPa at pH 5.5 to 6.0). The strain at break varied at the same interval for both types of hydrogels (50 to 70%). This behavior may be associated with the change in intensity of interactions at pH above the GeB pI. For the stress relaxation tests, the Maxwell model was applied (R^2>0.9) and it was observed that the pH influenced both the relaxation modulus and relaxation time, but without a well-defined behavior. Thus, it can be concluded that the pH and the type of gelatin influence the mechanical behavior of the GeA:CH and GeB:CH hydrogels.

Keywords

food packaging, biopolymer blend, uniaxial compression, stress relaxation

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#103: Revisiting the design of a multi-stage reverse osmosis process for the treatment and recycling of an agri-food industry wastewater

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Food industry largely depends on water use for processing, cleaning and washing operations, and heat and mass transfer (boilers, cooling circuits, refrigeration…). In the context of increasing water scarcity and price, the French program ANR MINIMEAU (ANR-17-CE10-0015, https://minimeau.fr) developed tools to help factories minimize water consumption by implementing the reuse (without treatment) and recycling (after treatment) of wastewater.

Amongst them, a new filtration module was developed in the ProSimPlus software (ProSim SA, France) for the simulation of reverse osmosis (RO) and tight nanofiltration processes, which led to revisit the design rules of multi-stage systems. It is based on the solution-diffusion model, considers concentration polarization and osmotic effects, and requires the preliminary determination of the membrane permeability: for water and for the targeted pollution parameters to remove from the effluent.

Pilot-scale experiments were run to obtain the required data for a previously selected RO membrane (ESPA4-LD from Hydranautics, Nitto Denko) and two process water streams of a French vegetable plant, the organic contaminants of which were studied: COD, total nitrogen, sugars (sucrose, glucose, fructose) and organic acids (lactic and acetic) (Garnier et al. 2020; Garnier et al. 2022). Considering the effluent flowrate, the desired range for the conversion rate and the hydraulic requirements, simple rules were used to develop different design options for multi-stage systems. Their treatment performances could be calculated and compared using the ProSimPlus software, highlighting key parameters for the design.

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Garnier, C.; Guiga, W., Lameloise; M.-L., Degrand, L.; Fargues, C., Treatment of cauliflower processing wastewater by nanofiltration and reverse osmosis in view of recycling. Journal of Food Engineering, 2022, 317, 110863.

Keywords

wastewater, reverse osmosis, recycling, design, modeling

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#105: Optimization of a novel gluten-free bread formulation fortified with pulse crops, chickpea, lentils, lupin and locust bean germ: texture, physicochemical, antioxidant and sensory characteristics

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Coeliac disease (CD) is an autoimmune disease triggered by gluten ingestion in genetically predisposed individuals. Apart from CD-diagnosed individuals, an additional percentage of population has non-celiac wheat/gluten sensitivity, making them experiencing symptoms similar to CD after consuming gluten-containing food products. For this population group, exclusion of wheat/gluten from their diet is recommended. Bread is one of the cereal products that is composed mainly of wheat flour. The rapid increase in gluten-related diseases has led to a growing demand for gluten-free (GF) products in the market. Most GF products (especially bread), which are typically produced from GF flours and starches and devoid of gluten proteins, have poor sensory, textural and nutritional properties. The enrichment of GF bread with dietary fiber comes as a necessity as it has been reported that coeliac patients generally have low fiber intakes due to their gluten-free diet.

This study aimed to develop a nutritious, GF bread with high quality characteristics using pulse crops of chickpeas, beans, lentils, locust bean germ and lupin flours added to a gluten-free bread formulation, and to analyse their effect on texture, physicochemical, antioxidant and sensory properties. Each formulation contained a mixture of gluten-free flours (cassava, buckwheat and rice) and 4% (w/w) of a pulse crop. An ANOVA with Tukey test was used to investigate significant differences ($p<0.05$) in the analysed parameters.

Results showed that pulse crops flours, with the exception of locust bean, decreased crumb hardness. The same results were found with the sensory analysis, in which the panel scored GF bread with locust bean flour as the hardest. The partial replacement (4%) of rice flour by pulse crop flour induced a significant increase in fiber, protein and ash contents of bread when compared with control. GF bread with lentil and chickpea flours showed lower EC50 value, that is, higher antioxidant activity than the others.

From this work it was concluded that pulse crops of chickpeas, beans, lentils, locust bean germ and lupin flours can be added to GF bread with positive impact on its nutritional, antioxidant and texture properties and can be a good alternative to obtain fortified GF products, with a commercial added value.

Keywords
gluten-free, bread, fortified, pulse crops, texture, physicochemical, antioxidant and sensory characteristics

#107: Valorization of orange by-products for packaging films production

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Oranges are one of the most extensively cultivated fruits in the world (1), with Spain being one of the largest producers worldwide (2). However, the culture generates a lot of by-products which have so far not many applications. This project aims at the valorization of orange peels for food packaging applications, using a green, low-impact process. The interest in pectin (one of the main components of orange peel) for food packaging (3) is known, notably for edible food packaging. However, orange peel contains many more components such as phenolic compounds, terpenes, vitamin C and so forth with interesting properties such as antioxidant activity.

In this project, we are comparing two by-products of orange production: the orange peel flour (ground orange peel, washed) and orange peel pectin, extracted from the latter with a low-impact process (room temperature and a weak acid as a solvent, citric acid) intensified by the application of power-ultrasounds. Those products were used to form films or to coat packaging paper. The mechanical and rheological properties were optimized when necessary, by adding a plasticizer (glycerol) or mixing with another polysaccharide (chitosan or alginate). Oxygen and water vapour barrier properties of all the formulations were measured and proved the interest of orange peel by-products for food packaging applications. Besides, antioxidant activity was also studied. All these results were compared with the corresponding values for commercially available pectin, which is obtained through a much longer and more complex process.

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Keywords
packaging, by-products, oranges, pectin, films

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#116: Microbial quality of dried spices (cinnamon and pepper) commercially available in the Southern Portuguese retail market

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Dried spices are minor condiments widely used in the food industry and added to processed foods and dishes in order to enhance aroma and flavor of the base ingredients. Despite their plant origin and low water activity, during pre and post-harvesting stages of the food chain, including transport and storage, these food ingredients can become a target for microbial contamination. Pathogenic and toxigenic microorganisms have been recovered from those food products and aflatoxins have been found in a significant number of samples. Adding these ingredients to ready-to-eat food products or meals can pose a health public hazard since foodborne outbreaks have already been associated to contaminated dried spices. This study was conducted to determine the microbiological quality/safety of dried spices such as cinnamon and pepper commercially available in the Portuguese retail market. The analysis covered twenty-seven samples of pepper (powder black pepper, four berries red pepper, red pepper flakes, powder white pepper, ground white pepper) and ten samples of cinnamon (powder cinnamon and stick cinnamon). Samples were assayed for total count of aerobic mesophilic bacteria (TAMB), *Salmonella* spp., *Escherichia coli*, coagulase-positive staphylococci and also filamentous fungi. The highest levels of TAMB ($\geq 10^6$ cfu/g) were found in respectively 28% and 20% of ground white and powder black pepper. No samples were positive for *Salmonella* spp., *Escherichia coli* and coagulase-positive staphylococci and also the fungi count regarded as unacceptable ($>10^3$ cfu/g level) was only found in one of the tested samples. Although data are in compliance with European Commission criteria, the enumeration of high counts of TAMB alerts to a requirement for permanent surveillance regarding their microbial hygiene and safety. Results suggest that dried spices can contain microorganisms at different levels which can in turn contaminate meals, deteriorate products and infect humans, causing foodborne outbreaks and food recalls. Public health issues regarding this kind of food product are of relevance and application of good hygienic and manufacturing practices along with implementation of HACCP guidelines are crucial to provide the global consumer market with a safe and good quality product.

Keywords
dried spices, low moisture foods, microbiological quality, total count of microorganism, foodborne pathogens

#117: Assessing the fatigue stress behavior of starch biodegradable films with montmorillonite using accelerated survival test methods

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A destructive degradation model was applied on biodegradable packaging films made from different compositions of starch, glycerol and nanoclay concentration using varying elongation levels as a stress variable at different stress times and the logarithm of the quotient of tensile strength *versus* break cycle (log[ts/bc]) as the response variable. The film elongation level ranged between 5% and 45%, exerted at three stress break cycles of 1, 3 and 6 repetitions. The log[ts/bc] was increased 2-fold and the log exact break time reduced significantly at the higher elongation levels of 20-45%. The sample consisting of 7 %wt starch, 35 %wt on dry starch basis glycerol and 10.5 %wt on dry starch basis montmorillonite proved to be the most resistant to stress conditions and most versatile to the varying elongation levels. More specifically, this sample required comparatively highest log[ts/bc] at the lower levels of exact break time, while the sample containing 4% starch, 50% on dry starch basis glycerol and 1% on dry starch basis montmorillonite manifested the lowest log[ts/bc] at higher levels of exact break time (> 213 s). Break cycle governed mostly the stress conditions in the degradation model explaining 51.6% of the total variation, the sample ID explained 16.2% and the log exact break time 5.7%. Next, 120 film units comprised of 7 %wt starch, 35 %wt on dry starch basis glycerol and 10.5 %wt on dry starch basis montmorillonite, were subjected to 5 levels of increasing elongation (5, 12, 16, 18 and 23%). After fitting the lognormal distribution to the data, a generally decreasing trend of the film exact break time when increasing the elongation level was observed. The simple linear model provided the best fit as compared to those with different regression lines b and different parameters a, permitting also the estimation of the elongation as acceleration factor providing also a low AIC value (1047.58). Thus, an acceleration value of 18.6-fold was obtained when comparing the 18% elongation level with the 5% elongation level. Comparatively, at elongation level 12% the failure rate of film units reached 86.49% and at elongation level 23% almost completed (98.67%). At the same level a maximum hazard rate equal to 0.07% per second of action of the strain factor was observed, i.e. about 4 times higher compared to the 5% use level.

Keywords
starch biodegradable films, montmorillonite, accelerated life testing (ALT), food packaging, acceleration factor

Acknowledgements
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#121: Radio frequency de-crystallization of honey: Computational model development for process efficiency

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Industrial de-crystallization of honey is carried out by using hot water at 60 °C or higher temperatures with the cost of energy and long process times. Radiofrequency (RF) process, with its longer penetration depth and volumetric heating feature, might also be used for process efficiency. Therefore, the objectives of this study were to apply RF processing for the de-crystallization of honey and develop a mathematical model to determine the temperature changes during RF processing.

For this purpose, honey samples were processed in a 10 kW - 27.12 MHz RF system, and experimental temperature data was used for validating the developed computational model. For model development, a finite element based multi-physics software (Comsol V6.0, Comsol AB, Stockholm, Sweden) was used, the electromagnetic field and temperature distribution within the honey samples were determined. Following the validation of the model with the experimental data, the results were also compared with conventional water heating, and the RF processing was demonstrated to lead to a 60% reduction in the required process time. This indicated that RF processing might be accepted to be an efficient and sustainable processing for honey de-crystallization process. The further use of the developed model for industrial processing conditions is expected to lead to scale-up studies for RF system and process design purposes.

Keywords
honey, de-crystallization, thermal processing, radio frequency heating, mathematical modelling

Acknowledgements
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#124: Effect of increasing salinity on the microbiological characteristics of halophytes cultivated in a soilless technique

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The objective of the present study was to evaluate the influence of salinity (35, 200, and 465 mM of NaCl) on the microbial quality of the halophytes *Disphyma crassifolium*, *Inula crithmoides*, *Mesembryanthemum nodiflorum* and *Suaeda maritima*, cultivated using a soilless technique by the company RiaFresh®. The microbial quality was evaluated through the counting of aerobic microorganisms at 30 °C and 6.5 °C, filamentous fungi and yeasts, *Escherichia coli*, and *Staphylococcus aureus*. The increase in salinity of the nutritive solution resulted in a concentration-dependent accumulation of salt in the plants which caused a general rise in the microbial populations studied namely the total aerobic and filamentous fungi on *D. crassifolium* ($p<0.05$) and *I. crithmoides* and the psychrotrophic population on *S. maritima* ($p<0.05$). The psychrotrophic population was less abundant when compared to the values of the mesophylls. The highest numbers of aerobic microorganisms were enumerated in *I. crithmoides* (4.54, 5.18, 5.38 Log CFU/g in the 35, 200, and 465 mM of NaCl, respectively) and the lowest numbers of filamentous fungi on *M. nodiflorum* (2.15, 1.24, 2.30 Log CFU/g in the three concentrations, respectively). The yeast population, *E. coli*, and *S. aureus* were not detected on the halophytes in any growing conditions. Based on the Portuguese guidelines, the plants cultivated in the presence of the highest salinity (465 mM) showed a level of filamentous fungi higher than 3 Log CFU/g, which is classified as "unsatisfactory" for a "ready to eat" food, except for *M. nodiflorum*. However, in regard to aerobes, the halophytes studied presented a satisfactory microbiological quality (<6 Log CFU/g) even when the plants were cultivated with the most concentrated nutritive solution (465 mM). Plants grown with low levels of salinity (35 mM) revealed better microbial quality, being classified as satisfactory when considering the aerobic microorganism grown at 30 °C, and acceptable, considering fungi. Results of the present study indicated that soilless cultures using low salinities produce plants adequate for consumption, considering their microbial quality.

Keywords

microbial quality, *Disphyma crassifolium*, *Inula crithmoides*, *Mesembryanthemum nodiflorum*, *Suaeda maritima*, soilless technique

#125: Creating organic brands through sustainable exploitation of local flora

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'The Land of Fagăraş', also known as the 'Land of Olt', is a historic erosion depression of 1000 km2 situated in the South of the Transylvania Plateau in Romania. Since 2021, a partnership between the Forest District and the University of Agronomic Sciences and Veterinary Medicine from Bucharest was established at the local initiative. The management and rational exploitation of plants from the spontaneous flora of RTF LAG was carried out on three levels (botanical, biochemical, and economic) to identify the valuable plant species present in the grassland and analyze their quantitative and qualitative potential.

Fourteen observation areas located on the territory of the eight localities were evaluated to determine the summer appearance of beneficial flora. Another evaluation was carried out in the grassland of the subalpine and alpine floors.

The species identified in each observation area were listed. A series of essential characteristics were noted, respectively life span and biological form, possibilities of use: industrial, food, medicinal (human medicine, veterinary), cosmetic, tinctorial, beekeeping, the part of the plant that can be harvested and used for different purposes, the optimal period for harvesting, and the general distribution of the species in the territory to signal the possible presence of rare or endangered species in the respective communities.

Following the centralization of the results of observations and field determinations, more than 150 species were identified. After analyzing and selecting the plant species with an economic interest, together with the local community representatives, 56 species were chosen for their valorization and commercialization potential.

The results completed with the consumers' perception of local brands evaluated through a questionnaire were proposed to local communities to stimulate cooperation in creating local organic brands.

Keywords
local communities, assessing useful species, qualitative analyses

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Part of the Management and rational exploitation of plants from the spontaneous flora of RTF LAG project

#126: Bio-nanocomposite films based on whey protein concentrate with thyme essential oil and electrospun polylactic fibers

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Biodegradable packaging materials based on industrial by-products like whey, functionalized with active essential oils (EOs) represent a way of reconfiguration valuable dairy side-streams into new environmental-friendly packaging with enhanced bioactive properties.
The aim of this study was to obtain and characterize whey poly-composite films (WF) functionalized with thyme essential oil (TEO) and reinforced on one side by layers of electrospun polylactic acid (PLA) nanofibers.

The 8% whey protein thermally denatured solutions with 8% glycerol as plasticizing agent and 1.6% Tween 80, was, firstly functionalized with 3% TEO, and then casted, air dried and equilibrated at 50% RH. The films were further reinforced with electrospun PLA nanofibers layers (Tong Li Tech, China). The PLA nanofibers were electrospun at 25 kV, 0.5 mL/h flowrate and 15 cm, collecting distance. Different WFs covered on one side with PLA nanofibers were obtained by varying the collecting time: 90 min (WF/G1), 150 min (WF/G2), 210 min (WF/G3) with one spinneret and 210 min (WF/G4) with two spinnerets.

The bio-composite WFs displayed improved permeability to water vapors and gases, and better mechanical behavior due to the addition of the PLA fibers. The force at break was by 1.5, 1.6, 1.9 and 3.5-fold higher for the WF/G1, WF/G2, WF/G3 and WF/G4, respectively, compared to the control. Thymol was the main volatile (50-60%) identified by GC/Ms in all WFs formulae.

Tests showed that the volatile terpenes contained by the TEO have lower antimicrobial activity against Listeria monocytogenes compared to a stronger antimicrobial effect against *Bacillus subtilis, Geotrichum candidum* and *Rhodotorula glutinis* ($p<0.05\%$).

This study demonstrates that the WFs with PLA nanofibers displayed improved structural and mechanical properties compared with the monolayer films and have potential to be used in different food applications as alternative to conventional packaging.

Keywords
food film packaging, thyme essential oil, PLA nanofibers, electrospinning

#128: The advantage of sumac usage in meatball preparation on various quality criteria and heterocyclic aromatic amines formation

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Heterocyclic aromatic amines (HAAs) are mutagenic/carcinogenic compounds that can 18 be formed during cooking process of proteinaceous foods such as meat. Therefore, it is needed to 19 inhibit or reduce their formations in cooked meats. Hereby, the effects of sumac usage (0.5%, w/w) 20 in beef meatball preparation on HAAs formation and some quality parameters (water, pH, cooking 21 loss, and lipid oxidation values) of meatballs cooked at 150 and 250ºC were investigated. The sumac usage caused a reduction in pH ($p < 0.01$), cooking loss ($p < 0.05$), lipid oxidation level (TBARS, 23 $p < 0.01$), and total HAA amount ($p < 0.05$) of the samples. In addition, increasing of the cooking 24 temperature significantly decreased pH value ($p < 0.01$) and increased cooking loss ($p < 0.05$) of the 25 samples. Only one compound, 2-amino-3,8-dimethylimidazo[4,5-f]quinoxaline (MeIQx), from nine 26 different HAAs studied in this study, could be determined and the levels of the other HAAs studied were lower then their detection limits. On the other hand, MeIQx were not detected in the 28 samples cooked at 150ºC, it was determined only in the control group samples cooked at 250ºC. 29 The sumac usage completely inhibited MeIQx formation in the samples. Due to its positive effect 30 on cooking loss value, lipid oxidation level, and MeIQx formation, it can be suggested to use sumac 31 powder in meatball preparation.

Keywords
meatball, sumac, lipid oxidation, mutagenic, carcinogenic

#130: Multilayer films for coffee packaging: Characterization, delamination and chemical recycling

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Billions of tons of multilayered films are produced annually as food packaging, such as coffee packaging. Multiple layers of different materials are needed in order to preserve the physicochemical properties of the content and to avoid oxidation. However, their recycling is difficult because they contain multiple layers of different materials including several types of polymers and metals. Polymers used are usually immiscible and burdensome to traditional mechanical recycling operations. A possible solution, in accordance with the principles of circular economy, is the method of selective dissolution by finding the most suitable solvent for the delamination of different layers.

In this research, initially, multilayered films for coffee packaging were characterized using several analytical techniques including Scanning Electron Microscope (SEM), FT-IR spectroscopy and Differential Scanning Calorimetry (DSC). The film thickness was found at 100 ± 5 μm, and three layers were identified: two polymers (*i.e.* polyethylene, PE, and poly(ethylene terephthalate), PET) and one from aluminum. The PET/PE ratio was at 0.2±0.02 μm and the Al percentage was near 15%. Thermal degradation of the films using TGA started at 400 °C and was completed at 515 °C.

For the delamination, we used several solvents (*e.g.* acetone, acetic acid, ethanol, methanol, toluene, *etc.*) from the list of green chemicals, due to their less impact on the environment. The best solvent was found to be acetic acid. After this process, the different layers were characterized and the materials were identified. Finally, the recycling of the identified polymeric layers was carried out. Thus, PET recovered was recycled through chemical recycling by glycolysis and alkaline hydrolysis. The monomers terephthalic acid and ethylene glycol were recovered at relatively mild conditions.

Polyethylene was subjected to thermochemical recycling by pyrolysis and a series of hydrocarbons were obtained with a varying carbon number from 1 to nearly 30. Optimization of the conditions and/or addition of specific catalysts is needed to narrow the range of carbon numbers. In this way, several secondary value-added products can be obtained.

Keywords
multilayered film packaging, chemical recycling, coffee plastic packaging, circular economy

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#131: Is the Romanian consumer ready for innovative fruit products?

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The aim of this study is to present some innovative pawpaw (Asimina triloba) and kiwi (Actinidia deliciosa) products. The products prepared with fruit from the experimental field of the Faculty of Horticulture have been presented and tasted at two events within our university: Bucharest Horticulture Days and ”Bucharest horticulture Autumn”. Four varieties of ice cream and seven assortments of candies with pawpaw and kiwifruit were tasted for consumer acceptance by 26 respectively 89 people. General appearance, color, texture, taste and flavour with a 7- point Hedonic scale were evaluated. The obtained results showed that the products with new fruits were easily accepted by the consumers and very appreciated, especially all the ice cream and candies of pawpaw with a percentage over 90%, probably the kiwi products were less accepted (aprox 80%), because kiwi is a sweet-sour fruit, not being liked by all consumers. We considered that for these positive results, replacing the processed sugar with natural food ingredients, such as honey or sugar of jujube fruit, was a plus for all the products presented.

Keywords
candies, ice cream, kiwifruits, nutritional food, pawpaw

#134: A snapshot of culturable yeast microbiota from Cyprus honey mead

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Despite the excellent properties of honey, mead production faces several problems, namely, disastrous fermentations, lack of product uniformity, and production of yeast off-flavors, all of which are closely related to honey quality, treatment of the mead (water quality, addition of nutrients) and conditions during fermentation. In most mead-producing countries, alcoholic fermentation results from the growth of indigenous microorganisms naturally present in honey or the meadery environment while the use of starters is also possible. In the cases of autochthonous alcoholic fermentation, the result is likely unpredictable, and very often mead is entirely spoiled by contaminating mainly yeasts which makes it unacceptable. Additionally, the fermentation is often sluggish which also increases the chances of spoilage. Despite the use of starter cultures for honey-must inoculation, several problems also persist as the poor availability of nutrients creates an unfavorable environment for yeast growth. This study aimed to explore the existence of indigenous yeasts in Cypriot mead during autochthonous alcoholic fermentation from multiple honeys must samples collected in Cyprus and reveal for the first time the culturable microbiota of Cypriot mead. We performed a careful evaluation of our identified microorganisms and compared our findings with other mead and mead-like beverages in the literature. A total of 30 isolates clustered in 9 macroscopically and microscopically different isolates were isolated from fermenting mead samples on yeast malt agar, with chloramphenicol. ITS1-ITS4 region sequencing analysis revealed that these isolates mostly belonged to *Hanseniaspora uvarum*, *Pichia kluyveri*, *Suhomyces (Candida) xylopsoci*, *Candida glabatra*, *Debaryomyces hansenii*, and *Candida tropicalis*. Also, when compared to isolates from other mead and mead-like beverages, we found that some microorganisms were reported and tested elsewhere indicating their potential for use as starters. The present study, despite having given only a small insight into Cyprus' mead fermenting microbiota, is provoking more research to come into the evaluation of meads' fermenting and spoilage yeasts and mead fermentation improvements.

Keywords
honey, mead, fermentation, spoilage yeast, Cyprus

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#137: Effect of packaging material on the sensory characteristics of coffee beverages

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Sensory quality is an important attribute of coffee beverages, essentially based on flavor and aroma formed during roasting. Storage and packaging conditions severely affect the preservation of these characteristics. Proper packaging impermeable to O_2 and moisture will help delay sensory changes, mainly lipid oxidative degradation reactions accompanied by volatiles' loss, and preserve superior quality characteristics during coffee storage. Moreover, proper packaging means the use of materials that are environmentally friendly as dictated by the philosophy of sustainable design, circular economy and, in the European Union level, the Directive 2018/852 for a better management of packaging and packaging waste. In this direction, the development of coffee packaging bags made from polymers derived from renewable raw materials, that are also easily recoverable and recyclable, as opposed to traditional petroleum-based plastics, is of increasing scientific attention.

Based on the above, the aim of this study focused on the effect of a new eco-friendly, fully recyclable PE film, compared to a conventional non-recyclable multilayer PE/PET/ALU one, on the sensory characteristics of coffee beverages, made from medium roasted *C. arabica* beans, stored for a specific period, at constant temperature (20±2 ^{o}C) and relative humidity (45-50%) conditions. After a pre-selection process based on questionnaires, selected assessors followed a program of basic training. Proper sensory analysis was based on triangle tests applied to coffee beverages prepared from roasted beans stored for 20 days and 2 months, in the two packaging materials. No significant differences were observed between beverages from beans stored in the two materials for either 20 days or 2 months ($p<0.05$, $n=18$). Aromas in the toasty group like roasted coffee and smoke as well as nutty, used by the assessors to describe the products, were well preserved in the beverages prepared from beans stored in the new packaging material. Obtained results are discussed in relation to the volatile profile monitored by Headspace Solid Phase Microextraction–Gas Chromatography–Mass Spectrometry analysis.

Keywords

sensory analysis, triangle test, coffee, packaging material, storage time

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#138: Analysis of Vitamin B12 in Total Diet Study

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Vitamin B12 (cobalamin) plays an essential role in red blood cell formation, cell metabolism, nerve function, and the production of DNA, the molecules inside cells that carry genetic information. Food sources of Vitamin B12 include poultry, meat, fish, and dairy products. Analytical methods were used to analyze Vitamin B12 levels by extracting the samples with 0.2 M sodium acetate and sodium cyanide, and purifying them with an immunoaffinity column, followed by liquid chromatography tandem mass spectrometry (LC-MS/MS). Linearity was confirmed in the concentration range of (1.5~50) μg/kg, and the limits of detection and quantification were 0.5 μg/kg and 1.5 μg/kg, respectively. The method was validated for linearity, accuracy, limits of quantification, limits of detection, and precision for Vitamin B12. The recovery results of the National Institute of Standards and Technology (NIST) standard reference sample (SRM) 1849a ranged from 103.0% to 104.9%. To verify the analysis method, we participated in the FAPAS program (07174: baby food formula), an international proficiency program, and obtained a valid z-score value of -0.7. When analyzing Vitamin B12 levels in livestock products, aquatic products, and seaweed, we found that roasted seaweed had the highest concentration at 568.5 mg/kg, followed by clams, abalone, and oysters at 421.4 mg/kg, 133.8 mg/kg, and 151.4 mg/kg, respectively.

Keywords
total diet study, vitamin B12, LC-MS/MS

Acknowledgements
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#140: Stability assessment of *Hibiscus sabdariffa* and *Crocus sativus* aqueous extract based on their physicochemical characteristics

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The color and aroma of beverage products are among their most appreciated quality features appealing to the consumer's acceptability and need for pleasure. The preservation of these quality attributes during the shelf-life of the product is of paramount importance for industry because it defines its long-term commercial viability in the market. The edible parts of *Hibiscus sabdariffa* and *Crocus sativus* plants are rich in water-soluble red pigments (anthocyanins, carotenoids) and quite popular as herbal tea ingredients with medicinal properties. In the present study, the thermal stability of extracts with mineral water over a storage period of 7-20 days in the dark and at different temperature (4, 25, and 50^{o}C) was assessed by monitoring changes in coloring strength, opacity, and pH value. Control experiments with deionized water were also carried out to evaluate the contribution of inorganic salts. The results support the use of mineral water as an extraction solvent at low temperature and provide further insight into the role of metals for stabilization of the natural water-soluble pigments.

Keywords

stability, color, physicochemical characterization, *Hibiscus sabdariffa*, *Crocus sativus*

Acknowledgements

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#141: Characterization of spray dried starch molecular inclusion complexes of antioxidant and antimicrobial compounds

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Spray drying is a traditional high throughput, fast and simple drying technique widely used in the food, cosmetic and pharmaceutical industries for the drying and protection of heat sensitive bioactive compounds. In the present study starch molecular inclusion complexes of natural antioxidants were produced during spray drying and the effect of the drying process on the structural, morphological and physical characteristics of the starch complexes was investigated. Starch molecular inclusion complexes were prepared using different varieties of starch (lentil, chickpea, pea) and antioxidants (ascorbic acid, linalool, carvacrol). Starch complexes were formed and dried on a pilot scale spray dryer equipped with a centrifugal atomizer at 160 and 90 ^{o}C inlet and outlet temperatures respectively. X-ray analysis (XRD) verified the successful formation of the V-form complexed amylose with the characteristic peak at around 20o (2-theta). Light microscopy and Confocal Laser Scanning Microscopy (CLSM) revealed that the antioxidant molecules were uniformly distributed within the matrix of the starch systems. The moisture content of all powders was below 6%w/w. The Hausner ratio ranged from 1.2 to 1.4 while Car Index varied between 14 and 25%. Significant differences were recorded in the color parameters of spray dried powders. Overall, it is strongly believed that the spray drying technique could be used for the preparation of starch molecular inclusion complexes with desirable physical characteristics.

Keywords
spray drying, linalool, carvacrol, x-ray analysis

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#142: Sustainable application of aromatic plant distillation by-products for an alternative meat preservation approach

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Meat products, and especially sliced, traditional ones, are considered an added-value perishable food product, with increased commercial interest for some Mediterranean sites, such as Crete. The conventional use of preservatives, such as nitrates and nitrites, which are currently authorized as food additives within the EU, is known to enhance the colour and extend the shelf life of processed meats. Nonetheless, current consumer demand for a 'healthier' and more natural diet, along with recent evidence that these chemicals can become hazardous if they form nitrosamines (in case of elevated temperatures), has initialized a systematic study for proposing physical preservatives for processed meat. On the other hand, the industrial production of essential oils, based on popular Greek aromatic plants (such as *Rosa damascena*, lavender, rosemary *etc.*) generates significant amounts of wastes, characterized as hazardous for the environment; however, these residues are a rich but yet underexploited matrix of biologically active compounds and therefore their potential for alternative applications is highly underexplored.

The present study aimed at optimizing ultrasound-assisted extraction (UAE) using experimental design models, and at providing a detailed antimicrobial/antioxidant and phytochemical profile of those extracts, occurring after the hydro- or steam- distillation of specific aromatic plants, by the implementation of IR and LC-MS/MS methods. The ultimate purpose is to design a processing procedure to incorporate those extracts in some traditional Cretan meat products (such as 'apaki'), in an effort to replace the commonly used chemical preservatives. In order to assess the effectiveness of this alternative treatment, a systematic shelf life study is implemented, based on the principles of Accelerated Shelf Life Testing. The purpose of this assay is to evaluate the microbial spoilage, lipid oxidation and the quality/sensory deterioration of the 'novel' products, as compared to their traditionally produced counterparts. In this context, predictive mathematical models will be applied and validated under the dynamic conditions of the real meat chill chain.

Keywords
meat products, aromatic plant by products, natural extracts, shelf life, sustainability

#143: Valorization of agro-industrial wheat bran waste through Solid-State Fermentation and its utilization as a novel food ingredient

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The major by-product of flour milling industry is wheat bran, which makes up about 13-19% of the total wheat grain weight. Wheat bran is considered as an ideal source of dietary fibers, proteins with balanced amino acid content, and antioxidants. Being high in nutritional value, different efforts to incorporate wheat bran to improve the nutritional content of food products were explored. However, these resulted to negative effects on the food products' sensorial properties, shelf-life, and overall quality. As a consequence, wheat bran is not being utilized for human consumption, but is sold as animal feed instead. In Monde Nissin, we aspire to create sustainable solutions to address food security, and one of the emerging approaches in designing the next generation of foods is through food waste valorization. There are different approaches to food waste valorization and one of the most promising processes in the field of food technology is fermentation. Through solid-state fermentation, transformation of wheat bran into a higher-value and better quality food ingredient may be beneficial in addressing food security by means of reducing food waste. This study explored the potential of wheat bran as a substrate in solid-state fermentation, wherein the resulting biomass is evaluated as an alternative protein source with improved nutritional and sensorial properties. Different treatment groups consisting of fungi, bacteria, yeast, and co-culture of these microorganisms undergone fermentation, and the resulting fermented biomass showed an increase of as much as 42% protein in the co-culture fermentation. Moreover, the fermented biomass from different treatment groups exhibit interesting range of fermented notes, umami flavors, and improved texture compared to unfermented wheat bran. Incorporation of the fermented biomass in several food products were also explored, and the resulting end products showed promising qualities. Further optimization of fermentation parameters and product application formulation can be done to create breakthrough solution for the utilization of wheat bran waste as a novel food ingredient.

Keywords
wheat bran, food waste, solid-state fermentation, waste valorization, alternative protein

#146: Coffee packaging: New trends and recyclability

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The two major challenges of humanity today are the fight against the pandemic of COVID-19 and the protection of the environment. Concerning the latter, one of the great concerns is the successful management of plastic wastes and particularly plastic packaging. In 2015, the European Commission adopted the Circular Economy Action Plan, which included goals to increase the recycling of the packaging waste and to reduce the landfill by 2030. The main issues in plastics disposal include their short life cycle and low bio-degradability and therefore accumulation in the final recipients. To achieve the circular economy goals for plastics, zero landfilling is needed. The films used in the packaging of food in general, but also of coffee in particular, usually consist of multilayer materials with the aim of achieving a combination of properties for the food. For example, avoiding the penetration of oxygen and thus oxidation of the contents, combined with preserving the aroma and avoiding spoilage due to prolonged storage. Thus, the extended shelf life of the food is achieved. Although the combination of different polymeric layers extends the functionality and application area of plastic packaging, they make the recycling of multilayer packaging more complex. For example, during mechanical recycling, incompatibility issues may arise in the polymer blends such as PE and PET due to their difference in physico-chemical properties. Similarly, in thermochemical recycling heterogeneous polymers such as PET, polyamide (PA), polycarbonate (PC) contaminate polyolefinic plastic waste. Therefore, multilayer plastic film fractions are still mainly incinerated or landfilled to date. Recently, there is a growing interest towards single layer plastic films in order to eliminate those complexities encountered in multilayer packaging. In this research a new film for coffee packaging is investigated based only on polymeric material(s). Their properties are examined together with their potential recyclability using chemical recycling techniques, such as pyrolysis, for the production of secondary value-added products.

Keywords
coffee packaging, recyclability, polymeric materials

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#147: Development of polylactic acid polymeric matrix materials reinforced with coffee industry by-products for food packaging

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Bio-nanocomposite films based on polylactic acid (PLA) matrix reinforced with coffee silverskin (CS), were developed by using solution casting method. Coffee silverskin, which is a by-product of the coffee roasting process, used as reinforcing agents to obtain nanocomposites by addition at different concentrations (2.5–20 wt.%). Then, the effect of bleaching treatments was examined to silverskin. The results showed that good silverskin dispersion and distribution into PLA was achieved and that bleaching led to better interfacial interaction. The films were characterized by FTIR, Differential Scanning Calorimetry (DSC) and Scanning Electron Microscope (SEM). The addition of silverskin, in proportions from 2.5 to 20 wt.% to the polymer matrix did not affect the melting point and glass transition temperature of PLA. Also, the physico-chemical characterization of films followed, determining their water content, solubility and degree of swelling, as well as Gas and Water Transition Rate and antioxidant activity. The water vapor permeability as well as the antioxidant activity is increased gradually with increasing addition of coffee silverskin and good oxygen and carbon dioxide barrier properties were found for all nanocomposites. Hence, these bio-nanocomposite films can be considered for replacing the conventional synthetic non-biodegradable.

Keywords
coffee industry by-products, polymeric materials, food packaging, circular economy

#150: Roasted coffee beans aroma quality as affected by packaging material

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Roasted coffee beans can be considered, from a food safety approach, as a shelf-stable product. However, during storage, several changes may occur due to loss of volatile compounds as well as coffee oil oxidative degradation reactions, causing a negative impact on coffee's final quality. Proper packaging could significantly delay the development of these phenomena, contributing to the preservation of superior quality characteristics during coffee storage and extension of its shelf life.

Composite packages consisting of multiple layers of different materials, are widely used to provide a physical barrier to prevent moisture/oxygen/light-induced changes in coffee's flavor and nutritional characteristics. However, these materials can be viewed as a challenge for existing recycling systems, and they might be an obstacle to EU's Directive (EU) 2018/852 for packaging recycling and recovery, as well as to the fundamentals of circular economy and sustainability.

Considering the aforementioned, the present study aimed to examine whether the transition from a conventional composite package consisted of polymers and aluminum to a new eco-friendly one, would have a direct impact on roasted coffee quality during storage. To this direction, medium roasted *C. arabica* beans packed in two different packaging bags were stored for a specific period, at constant temperature conditions. Headspace Solid Phase Microextraction–Gas Chromatography–Mass Spectrometry analysis was carried out to monitor differences in volatiles' profile according to packaging materials. The obtained results were discussed on the basis of volatile compounds' loss and the evolution of specific oxidation products during coffee storage. The calculation of quality indices was also attempted to better understand the chemistry of coffee aroma changes during that period.

Keywords

aroma, coffee, eco-friendly packaging, HS-SPME-GCMS

Acknowledgements

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#151: A *Hibiscus sabdariffa* extract using sparkling natural mineral water of Souroti springs (Greece)

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Hydration of the human body is crucial for preserving good health. However, frequent consumption of high-in-sugar beverages is associated with chronic diseases, such as cardiovascular disorders, diabetes, and obesity. Nowadays, there is a constant increase in the demand for natural ones, especially flavored water products that address the consumer needs for new taste experiences and encourage healthy dietary habits. In this frame, the NyronYdor (NY) project aims at expanding the uses of the sparkling natural mineral water of Souroti springs (Souroti water, Thessaloniki, Greece), toward the extraction of flavoring and coloring constituents from local aromatic plant sources. The dehydrated flowers of *Hibiscus sabdariffa* are commonly used as herbal ingredient in tea preparations offering a vibrant red color and several health benefits due to their high content in anthocyanins. The present study aims at investigating the quality attributes of the extracts prepared with Souroti water and ultrasound-assisted technology at different raw material-to-solvent volume ratios. Differences in the color and aroma profile along with the content in total phenols and the profile of main anthocyanins are discussed considering the contribution of mineral composition of Souroti water. Control experiments with deionized water were also carried out for comparison reasons. Our findings are expected to progress our knowledge about using mineral water as an extraction solvent for *Hibiscus sabdariffa* dehydrated flowers and aid the development of new biofunctional water products.

Keywords

Hibiscus sabdariffa, anthocyanins, sparkling water, phenols, aroma

Acknowledgements

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#153: Enhancing the safety and quality of blueberry juice by thermosonication

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According to consumers' newest preferences, the juice segment is expanding in the market, especially using novel high technologies for processing. Ultrasound is an up-and-coming technology increasingly being applied in the food field since it can minimize the undesirable effects of thermal processing.

This study aimed to evaluate the influence of thermosonication on the inactivation kinetics of *L. innocua* 2030c, a non-pathogenic surrogate of *L. monocytogenes*, in blueberry juice. Thermal treatments were conducted as controls, and both processes' impact was assessed on some physicochemical attributes of the juice. Blueberry fruit was chosen since it is recognized as a superfruit due to its high content of health-promoting compounds.

Juice samples were prepared by defrosting frozen blueberries and using a domestic centrifuge. Freshly prepared juices were inoculated with *L. innocua* subculture (~10^9 CFU/mL). Thermosonication at two amplitude levels (60 and 100%) with a pulse duration of 10 sec on and 5 sec off was applied using a sonicator probe (700 W, 20 kHz). Thermosonication and thermal treatments were performed at 45 and 55 °C until a 5-log reduction was achieved. Physicochemical parameters of the juice (pH, total soluble solids, water activity, and color) were analyzed in fresh and treated samples. All treatments/analyses were performed in triplicate.

The Weibull model was successfully applied to fit *L. innocua* inactivation kinetic by regression analysis.

The processing times needed to achieve a 5-log reduction were, in the case of thermosonicated samples, much shorter (1 and 25 min) than the heated ones (10 and 60 min), showing the effectiveness of the synergistic effect of ultrasound and mild heating compared to heat treatment alone. For thermosonication treatments, the first decimal reduction time (δ) obtained at 55 °C was 5.13 ± 0.83 and 4.26 ± 0.36 min, respectively, for 100 and 60% amplitudes. At 45 °C, those values were reduced to 1.15 ± 0.49 and 0.51 ± 0.17 min. When thermal treatments were used, δ decreased to 1.18 ± 0.33 (55 HT) and 0.08 ± 0.09 min (45 HT), showing the δ dependence on temperature and process.

Thermosonication processes were more effective in microbial inactivation and retaining quality parameters than thermal procedures, with thermosonication at 45 °C the best treatment for blueberry juice.

Keywords

thermosonication, blueberry juice, thermal treatment, inactivation kinetics, *L. innocua*

Acknowledgements

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#154: Exploring non-edible parts of pineapples as fat replacers in cake formulations

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Non-edible parts of many fruits, such as peel and seeds, are sources of compounds with important nutritional properties. They are also rich in fibres, which gives them the potential to be used as functional ingredients since fibres may be fat replacers in many food formulations.

If these parts of fruits are properly transformed into edible forms, there will be potential reuse and recovery of food waste. In the case of pineapple, approximately 70% of the total weight of the fruit is not consumed, being rinds, core, and crown usually discarded.

This work aimed to transform pineapples' non-edible parts (rinds and crowns) into powders by freeze-drying with posterior micronization. The objective was to use the powders as fat replacers in a traditional cupcake recipe and assess the texture profile of the baked cakes.

Pineapples (*Ananas comosus* L.) rinds and crowns were removed, cut into small pieces, and freeze-dried. The dried samples were ground in a hammer mill to obtain powders/flours. They were characterized in terms of water activity, water and oil absorption capacity (WAC and OAC), proteins, and total dietary fibre content (on a dry basis, d.b.). These powders were used in a cupcake recipe (control), replacing the fat (butter) with the powders in different proportions: 25, 50, and 75%. Relevant textural parameters such as hardness, cohesiveness, chewiness, and springiness were assessed in the baked cupcakes. Water activity values of rind and crown powders were 0.36±0.02 and 0.49±0.03, respectively. Regarding functional properties, crown flours presented a considerably higher OAC (6.11±0.39 g oil/g d.b.) than the rind (2.45±0.47 g oil/g d.b.); WAC of both flours was similar, averaging 2.30±0.34 g water/g d.b.

Protein content was significantly higher in the crown (8.14±0.89 g/100 g d.b.) than in the rind flours (4.43±0.38 g/100 g d.b.). Dietary fibres were mainly insoluble; the crown had 18% and the skin 37%. The texture of cupcakes with 25% of both types of flour was similar to the control. However, as the proportions of the flours increased, texture differed mainly in crown-based recipes, becoming the cakes harder with springiness and adhesiveness decay.

These findings suggest that incorporating pineapple waste parts in a traditional cake recipe may serve as healthier ingredients with improved functional properties.

Keywords

fruit waste, proteins, dietary fibres, texture

Acknowledgements

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#157: Pea protein as alternative ingredients for plant-based food: understanding proteases' mechanisms for production of protein hydrolysates

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Food protein demand is increasing due to the world's population growth, nutritional aspects (consumers' specific / healthier diets) but it cannot be filled with animal proteins. Plant-based proteins are attracting more and more attention due to their contribution to food system sustainability and they are arising as an interesting alternative to their animal counterparts. Pulses like pea, lentil and chickpea appear as a promising source of proteins due to their well-balanced amino acid composition / bioavailability and their environmental benefits. With their low allergenicity, their non-transgenic status and they coming from a sustainable crop, pea proteins are given particular attention for food applications. However, their poor functional (low solubility, emulsification capacity, foaming) and sensory properties (beany flavour, bitterness) limit their application in food products formulation. Several authors suggested that enzymatic hydrolysis could highly improve their properties. In this context we studied the mechanisms of two commonly used food proteases: Alcalase (alkaline metallo aminopeptidase) and Flavourzyme (neutral serine endoprotease). We showed that Alcalase can be classified as a "one-by-one type" protease in the Linderstrom-Lang model (the molecules are broken one by one to peptides and no appreciable amounts of intermediary products are found in the system) whereas Flavourzyme can be classified as a "zipper type" protease (formation of a wide range of peptides with intermediate products). As a consequence, hydrolysates produced by each enzyme differ in size and properties. Alcalase and Flavourzyme were shown to be able to hydrolyse both water-soluble and water-insoluble pea proteins in controlled pH hydrolysis conditions but also in uncontrolled pH media (no alkali addition). According to that, enhanced solubility at neutral pH can be attributed to size reduction of the proteins but also because water-insoluble proteins are substrate of the enzyme. When enzymes are used in combination, the hydrolysis is not improved (no additive effect) but it could lead to an interesting mix of peptides as the action of one protease can create new cleavage sites for the other one. The controlled enzymatic generation of peptides is of great interest for food applications.

Keywords
protein hydrolysis, pea protein, protease mechanism, protein solubility

#159: Biodegradable spray dried starch-based films reinforced with silicon dioxide

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During the last few years, there has been an imperative need to reduce the use of plastics in food packaging due to justified environmental concerns over packaging pollution. Starch has gained an increasing interest due to its abundance in nature and simultaneously its ability to form biodegradable films. In the present study, starch-based films were prepared by casting using spray dried non-granular maize starch, glycerol (30% w/w) and silicon dioxide (SiO2, 3%w/w). Alongside the use of silicone dioxide, the effect of starch concentration (6.5 or 10% w/w) and ultrasound processing, applied during the preparation of the biodegradable starch-based films, on their mechanical and water barrier properties were investigated. Statistical analysis revealed that the thickness of the films was significantly increased with an increase of the starch concentration and the use of ultrasound. Maximum values of tensile strength, strain and young modulus of elasticity were recorded for the films prepared with 6.5% starch concentration. However, the mechanical properties of all starch films were not significantly affected by the use of ultrasound and starch concentration. The addition of SiO2 decreased the water absorption of the films. Ultrasound increased water vapour permeability rate (WVPR) of the films while SiO2 resulted to the opposite effect. Microscopic examination showed that ultrasound processing led to the elimination of air-bubbles within the film matrices indicating that the specific technology could potentially be employed for improving the optical properties of such biodegradable packaging materials.

Keywords
spray dried pregelatinized maize starch, biodegradable films, silicon dioxide

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#160: An integrate deep learning approach for accurate and reliable classification of different beer styles

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Micro brewers and artisanal beer market are growing fast. Beer classification is crucial for marketing, sales and customer acceptance. Recognizing a beer style from beer characteristics is easy for the experts but it can be challenging for beer consumers or amateur beer makers.

Machine learning algorithms can be used for classifying items based on chosen characteristics. Among these machine learning algorithms, Deep Neural Networks (DNNs) have been applied to different data sets. DNNs have been however often applied in isolation and no effort has been made to reuse and transfer the knowledge of different applications of DNNs. In this paper, we describe a training procedure capable of achieving a sufficient accuracy level within a limited training time.

In our study, first OG, FG, Abv%, IBU and SMV are used as characteristics distinguishing beer styles, which are then classified by using various classifiers in Classification Learner App of MATLAB. To select the best possible algorithm to classify different beer style we consider five different classes of classification algorithms, namely tree-based, discriminant-based, support vector machines, K-nearest neighbors, and ensemble mechanisms, and we consider several representatives for each of these classes. As a result, we apply 22 different classification algorithms coming from artificial intelligence resubstituting validation learning strategy, with the aim to individuate which the most suitable is for this data set.

After the model of classifier has been selected, resubstituting validation is used to set the training for the model.

The performance for each classifier is evaluated from the confusion matrix that was shown in the Classification Learner App. The model with highest accuracy in recognizing the beer style is selected, also evaluating its performance in terms of computing time.

In conclusion, Cubic SVM is selected as the best model in recognizing beer styles as it produced highest accuracy which is 98% compared to other classifiers.

Keywords
artificial intelligence, deep learning, classification learning, beer style

#161: Application of Taguchi methodology for the optimization of the aqueous extraction process of plant material under mild conditions

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The NyronYdor (NY) project aims to the development of naturally flavored sparkling water products using extracts from aromatic plants and the sparkling natural mineral water of Souroti springs (Souroti water) in the region of Thessaloniki, Central Macedonia, Greece as the extraction medium. Towards this direction, three herbal materials of local interest, but with wider culinary and medicinal interest, namely *Zingiber officinale* (rhizome), *Crocus sativus* (red stigmas) and *Hibiscus sabdariffa* (dehydrated flowers) were examined as sources of flavoring and/or coloring constituents.

Zingiber officinale is particularly favored for its characteristic spicy and pungent flavor. The *Crocus sativus* flower stigmas, commonly known as saffron is well known for its vibrant yellow color, characteristic flavor, and high content in antioxidants and bioactive ingredients. *Hibiscus sabdariffa* is highly appreciated for its bright red color and its special health benefits. To examine the potential of these materials for the preparation of aqueous extracts, Taguchi methodology, a well-established design-of-experiments (DoE) approach for extraction optimization, was used. Upon optimization, different set of parameters were introduced, namely the raw material-to-solvent volume (r, w/v %), ultrasound amplitude (A, %), extraction time (t, min), and extraction temperature (T, ^{o}C). The Doe led to a set of 18 (L18, 2-3) trials, and the evaluation relied on applying the "larger-the-better" criterion to the absorption intensity as the response in each parameter, elucidating the maximum extraction yield. Raw material-to-solvent volume (r) was strongly correlated with the extraction yield in all samples.

Keywords

Zingiber officinale, *Crocus sativus*, *Hibiscus sabdariffa*, Taguchi, aqueous extraction

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#163: Consumers' beliefs and attitudes towards entomophagy: Evidence from Greece

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Edible insects are considered among the most promising alternatives and sustainable sources of proteins to address the predicted deficiency of conventional food protein. Insects have high nutritional value, high feed-conversion efficiency, and low environmental impact. Due to their nutritional and environmental benefits, there is an increasing interest in entomophagy and the ways that insects could be part of the western diet. A limited number of studies have been conducted about the European consumers' willingness to consume insects as food, while nothing is known about Greek consumers' reactions to the habit of consuming insects as food. This study provides a first insight into Greek consumers' preferences for insect-based food products. The data was obtained by using an online questionnaire and convenience sampling (n=1,531). Two-step cluster analysis and categorical regression were respectively employed to classify the respondents in discernible clusters and to determine the relationship between their socioeconomic characteristics and their willingness to adopt insect-based food products. The results of the study indicated that food neophobia is the main factor that determines Greek consumers' unwillingness to accept insects as food. As expected, disgust and rejection were the main reactions to the theme of insects as food. However, it was also indicated that there is a potential for increasing acceptance of novel foods derived from edible insects by providing information about their positive effects, using familiar food products, and decreasing the degree of visibility of the insect, with the use of processed insects. Finally, this study provides information about insect protein-enriched food product categories (bakery, meat, snacks) that Greek consumers are more likely to consume. Such results may be useful to policymakers and entrepreneurs, who aim to promote strategies towards the consumption of insect-based products and the manufacture of sustainable novel foods.

Keywords

adoption theory, food neophobia, insect-based foods, multivariate statistics, willingness to consume

Acknowledgements

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#164: The nutritional potential of hemp leaves (*Cannabis sativa* L.)

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The aim of the study was to analyze leaves of *Cannabis sativa* L. as a source of nutrients (proteins, amino acids, lipids, phenols, flavonoids and vitamin E).

The average total protein content was 29% and it varied significantly depending on the level of leaves harvesting (21% in leaves collected from lower, 28% from middle, and 37% from upper part of plants). Analyze of leaves amino acid composition showed the highest amount of aspartic and glutamic acids and their amides. The content of three of analyzed amino acids in the upper leaves significantly exceed the content recommended by WHO/FAO. However, the protein digestibility of leaves was rather low. The highest 30% have upper leaves whereas the lower leaves have only 16,5%, which could result from noted inhibitory activity (which achieved up to ~50% trypsin inhibition capacity). It was also found that the average total content of tocochromanols in the leaves was 98.15 mg/ kg d.wt. The highest content, 76% of the total content of tocochromanols was found for the homologue alpha, whereas gamma-T 14%, PC-8 7.5%. Other tocochromanol homologs did not exceed 1% of the total content. Considering leaves harvesting level, the highest content of tocochromanols was found in samples taken from the middle sections of the plant (129.4 mg/kg d.wt.) comparing the lower, where only 62% of this value was noted. The polyphenolic compounds content depended also on the level of plant from which the leaves were collected, achieved up to 69,4 mg/100g d.wt. for flavonoids, and 7,53 mg/100g d.wt. for phenolic acids, with highest share related to ferulic acid, p-cumaric acid and vitexin.

Hemp leaves have been found to be a source of valuable ingredients the contents depend on position of the leaves on the plant. Younger leaves from upper part of the plant are richer in nutrients.

Keywords

hemp leaves, protein, flavonoids, tocochromanols, digestability

#168: Influence on ultraviolet light and ultrasound on microbiological quality of freshly squeezed apple juice

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In this work sonication and UVC technology were studied as alternative preservation techniques for fruit juice. Among the many undesirable effects that can occur during juice processing, microbial spoilage is the most important, as the presence of various bacteria can lead to significant health hazards. Traditional heat-based treatments are widely used because of their ability to inactivate/destroy pathogenic microorganisms and also inactivate versatile enzymes that have undesirable effects on product quality. However, the use of high temperatures for the above purposes significantly affects both the nutritional value and quality of the juices. In addition, the environmental impact of heat-based technologies is significant and, combined with the high economic cost, poses a problem that requires an alternative. Therefore, researchers are looking for alternative solutions and one of them is the application of so-called green technologies. More sustainable production, less heat waste and lower production costs are just some of the socio-economic and process benefits of green technologies. Some of these technologies are: Ultrasound, microwaves, high hydrostatic pressure, radio frequencies, cold plasma, and ultraviolet light. For the purpose of microbial quality, in this work, freshly squeezed apple juice (94%) with ginger (6%) was subjected to thermal treatment (at 80 °C/2 min), sonication in an ultrasonic bath (15, 30 and 60 min at 25 °C, 37 kHz frequency) and UV-C treatment (15, 30 and 60 s at 25 °C). In addition, a combination of sonication and UV-C treatment was also performed. The samples were processed and stored for 3 weeks. Then, they were analyzed for 5 different types of microorganisms according to the applicable regulations. The results were promising for both sonication and UV-C treatment. However, the best results were obtained with the combination of ultrasound and UV-C treatment. There is a need to further study the effects of UV-C-treatment on physicochemical characteristics of fruit juice.

Keywords
ultrasound, juices, ultraviolet light, microorganisms

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Project-Increasing the development of new products and services arising from research and development activities

#169: High-performance polymeric resins: Product, applications and circular bioeconomy, from ESG perspective

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Emerging demands for new materials have attracted the attention of researchers and technology-based companies. It has contributed to expanding proposals for studies related to scale and nanostructures, summed to functionalities and specific properties. The growing demand for materials, including biodegradable ones needs, feasibility and application studies, which demand an effective collaboration between Universities, Research Centers, and Industry. The present study presents a research instrument to complete a comprehensive development of high-performance polymeric resins, aiming at the development of innovative and technological products and processes, with multidisciplinary applications. The study involves reaction modelling of production stages, focusing on additive manufacturing and industrial applications. Complementary areas of science and engineering are included in the study, considering biodegradable nanocomposites, obtained from renewable vegetable raw materials (biomass and fibers, including those obtained from Acrocomia aculeata palm tree waste, after its edible oil processing). The project is guided by a partnership between the University and Industria-Startup, offering 3D printing technologies, taking into account environmental premises, based on elements of circular economy and ESG. The research will include structural and thermomechanical characterizations, as well as morphological properties, and biodegradability, permeating experimental design, evaluation of performance factors, physical-chemical tests, among others. Indeed, contemporary literature related to the nature of materials studied are extensive, as related 3D printing opens up avenues into 3D printable agents, recyclable printing resins, optically transparent printed parts, and even biomaterials with tunable thermomechanical and surface Properties. The aim is, through tuning the material composition and thermal curing profiles, to achieve the best thermomechanical properties for industrial applications while maintaining an ESG perspective. The study expands scientific, technological, and innovation areas, supporting the strengthening of the global scientific community, in addition to educational elements linked to the training of new researchers and new professionals.

Keywords
bioeconomy, polymeric resins, biomaterials, 3D printing

#170: Chickpea particle size influences postprandial glycaemia and appetite sensations in healthy subjects: A randomized crossover study

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Objective: Apart from nutrient composition of a food, its structure also plays an important role in postprandial glycemic response and appetite regulation. At cereals and legumes, starch is naturally encapsulated in their plant cell walls. Disruption of plant tissue structure by flour milling increases starch bioavailability, and as a result it becomes more digestible. The ingestion of bakery products produced solely with finely milled flours has been associated with higher postprandial glucose levels. Larger chickpea flour particle size has higher proportion of intact cotyledon cells, which contain starch less accessible to amylases.

In the present study the effect of two different whole meal wheat breads enriched with chickpea flour of varying particle size distribution on postprandial levels of glucose and subjective appetite ratings (hunger, fullness, desire to eat) was evaluated. At the first one, 30% of wheat flour was substituted with finely milled chickpea flour (LFB) and in the second the same proportion was substituted with chickpeas with larger particle sizes (CWB).

Methods: Fourteen healthy volunteers, 7 female/7 male with normal body weight and age 23.5±3.5 (SD) yeas participated in this randomized controlled crossover trial, where they consumed on two different occasions 126 g LFB and 136 g CWB. Venous blood samples were collected before consumption and after 30, 45, 60, 90, 120, 180 min. Subjective appetite ratings were accessed by Visual Analogue Scales (VAS).

Results: The incremental area under curve (iAUC) for LFB and CWB were calculated 2306±277.54 and 1815.04 ±264.52 mg*min/mL (SEM) respectively. Compared to LFB, CWB resulted in significantly lower glucose iAUC ($p<0.05$). Consumption of CWB resulted in statistically significant reduction in hunger ratings at 60 min postprandially ($p<0.05$) and elicited higher iAUC for fullness ($p<0.05$). Desire to eat was similar between LFB and CWB.

Conclusions: In the present study manipulating degree of chickpea flour milling has been shown to ameliorate glucose response and promote feeling of fullness over 180 min postprandially in healthy volunteers. Incorporation of chickpea flour of larger particle size in bread can be a strategy for controlling postprandial hyperglycaemia, promote satiety and potentially contribute to weight management.

Keywords
chickpeas, flour particle size, postprandial glycaemic response, subjective appetite ratings, legume-enriched wholemeal breads

#174: Fermentation of stout beer and its upgrade to imperial stout, by carob syrup addition, improving functional characteristics of the final product

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Carob tree (*Ceratonia siliqua* L.) is a xerophytic endemic species typical of the Mediterranean climate and its fruit is considered to be an important source of bioactive compounds and of high nutritional value. Stout beers originate from darker malts than the malts usually used to produce ale beers, therefore the final product is a darker beer with quintessential roasted flavors. Imperial stout is a stronger version of standard stout beer and their main difference is that imperial stout is a higher-octane beer, often several ticks higher on the ABV (Alcohol by Volume) spectrum. Producers add high sugar substrates to upgrade a regular stout beer to imperial. The study's aim was to produce an imperial stout beer with the addition of carob syrup and to determine the total phenolic content (TPC) of the final product. Initially, stout wort was produced at an original extract of 13,8° Plato and then it was separated in 3 batches. In the first batch stout wort remained unchanged and the expected ABV was 6%. In another batch 100g of carob syrup (produced in-house) was added in order the initial Plato to be increased to 18,8° and the expected ABV to 8%. Finally, higher concentration (222g) of carob syrup was added in a third batch which led to the initial Plato to reach 23.8° and final ABV to 10%. The wort was fermented at 18 °C with *S. cerevisiae* strain M42 (Mangrove Jack's). The analysis showed that standard beer stout (with no carob) had significantly lower total phenolic concentration than the other 2 beers, in which carob syrup had been added. In particular, the imperial stout 10% vol. beer had the highest total phenolic concentration (64% more than the standard stout), followed by the imperial stout 8% vol. beer (52% more than the standard stout). Furthermore, it was detected that at the beginning of the beers' fermentation all of the 3 samples had slightly higher total phenolic concentrations in comparison with the same samples at the end of the first fermentation. Finally, it was confirmed that the carob syrup used for the production of the imperial stout beers had a high polyphenol concentration (911.4mgGAE/100mL). Additional studies are needed to develop a product with the optimal organoleptic characteristics and antioxidant properties.

Keywords
imperial stout beer, carob syrup, saccharomyces cerevisiae, total phenolic content

Acknowledgements
Study has been supported by Food Science and Technology Department of the University of West Attica, Athens, Greece.

#175: Fermentation of carob syrup with *Saccharomyces cerevisiae* produces a fermented high-polyphenol alcoholic beverage

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Carob tree (*Ceratonia siliqua* L.) is an endemic xerophytic species, widely distributed in the Mediterranean area. It tolerates adverse conditions and is extremely tolerant to heat and dry atmosphere. The carob fruit is rich in sugars and bioactive compounds such as antioxidants, especially polyphenols. Hydromels (meads) are alcoholic beverages, considered to be consumed since ancient times, which are produced from the fermentation of honey with yeast and reach a high alcoholic content about 8%–18%. In addition to ethanol, hydromels contain many valuable compounds such as sugars, organic acids, vitamins, minerals and antioxidants. In this study, a novel hydromel-type fermented alcoholic beverage was produced by using only carob syrup as substrate with the addition of water and *Saccharomyces cerevisiae* strain US-05 (Fermentis). Three carob syrup meads were produced in the lab with the same concentration of both syrup and water, which had different final pH levels. The final samples produced had initial pH 5.14, 4.7 and 4.2. The aim of this study was to examine whether the pH parameter has an impact on the samples' total phenolic content (TPC). Total phenolics were assessed with the Folin-Ciocalteu method. The carob syrup meads were analyzed prior (time point: 0) and upon the completion of the fermentation (one month). In addition, meads from different honey species were analyzed (oak, chastetree and chestnut tree honey), compared to the carob syrup which was used to produce these meads. Our results showed that the total phenolic content of the three carob syrup meads with pH 5.14, 4.7 and 4.2 were on average 253 mgGAE/100mL at the beginning of the fermentation and had decreased to 204.8 mgGAE/100ml at the end of the fermentation (19% decrease). However, no statistically significant differences were found among the total phenolic content of samples with different pH. Furthermore, the carob syrup meads had remarkable higher concentrations (about 15 times more) of polyphenols than all the other compared meads which were produced by different honey types. This is due to the fact that the initial carob syrup used as sugar substrate has a high concentration of polyphenols (962.1mgGAE/100mL). Additional studies are needed in order to develop a product with the optimal organoleptic characteristics and antioxidant properties.

Keywords
hydromels (meads), saccharomyces cerevisiae, carob syrup, total phenolic content

Acknowledgements
Study has been supported by Food Science and Technology Department of the University of West Attica, Athens, Greece.

#182: Effects of cold atmospheric plasma treatments on decontamination of processing wash water, safety and quality of leafy vegetable products

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In order to ensure the microbial quality and safety of ready-to-eat vegetables, washing of fruits and vegetables is a critical step in the fresh produce processing industry. Washing contributes to the reduction in microbial contamination by spoilage and pathogenic bacteria, e.g. *Escherichia coli*, *Listeria monocytogenes* and *Salmonella*, as well as removal of traces of pesticides from the product surface. Adequate sanitizing treatments are required before wash waters are discarded or reused since they quickly accumulate solids, organic matter, and microbial contaminants. As recycled water used in food processing must satisfy the same standards as drinking water according to the EU legislation, decontamination of wash water is generally achieved through chemical or physical practices such as treatments with sodium hypochlorite, oxidizing agents, UV-C or ozone. Recent studies have shown that two emerging technologies, Cold Atmospheric Plasma and Plasma Activated Water (PAW), are successful against a variety of foodborne pathogens and spoilage bacteria in different food matrices. The aim of the study was to test the technology to evaluate its potential in decontaminating wash water. The performances of the plasma treatments were compared to the current industry standard procedure for water sanitation. Water quality (COD, BOD) and effectiveness in reducing viability of the main microbial spoilage populations were measured for different operational settings. Plasma-treated wash waters were also used to wash/rewash fresh leafy vegetables. Immediately after the treatments, the effects on natural spoilage microorganisms and product quality (pH, colour and total phenolic content) were evaluated. Overall, the results showed that plasma technologies can be a promising solution for the food industry to ensure safety and microbiological quality of both washing water and leafy vegetables, with the possibility of water sanitation, water reuse and water saving.

Keywords
plasma technology, microbial contamination, fresh produce, safety

Acknowledgements
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#187: Algae-enriched tomato juice as a potential superfood - EPR characterization

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In the biotechnology and food industry, the search for plant-based superfoods is at the top of the agenda. The tomato plays a key role in the Mediterranean diet (1) and has been recognized as an Intangible Cultural Heritage of Humanity by UNESCO. Tomato is being intensively researched to improve food quality and is also beneficial for human health. Microalgae are known as a sustainable and environmentally friendly marine source of bioactive ingredients such as fatty acids, lipids, proteins, and pigments, and could also serve as carrier systems (2,3). The aim of this study is to develop a protocol and characterize the properties of algae-enriched tomato juice. We will perform physicochemical characterization of algae-enriched tomato juice in terms of pH, dry content, color, total acidity, lycopene content, and antioxidant activity. Antioxidant activity via free radical inhibition, i.e. mainly oxidative stress, will be monitored by EPR spectroscopy. This initial study may help to improve our understanding of the development of plant superfoods with enhanced antioxidant properties.

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Keywords

algae, tomato, Mediterranean diet, marine source, algae-enriched tomato juice

Acknowledgements

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#188: Effect of atmospheric pressure cold plasma discharge on microbial load and physicochemical properties of whole wheat flour

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As a novel processing technology, atmospheric pressure cold plasma has the potential for microbial inactivation and modulation of physical surface properties. This study treated whole wheat flour with cold plasma (O2 or N2, 10 kV, 18 kHz) for 60 or 120 s. Treatment did not impact the total amylolytic activity and total antioxidant capacity. However, the decrease in the total aerobic bacterial count or mold count ranged from 0.4 to 0.7 log cfu/g as a result of treatment. Hydroperoxide value as an oxidation marker increased by around 0.1% with treatment time. Total proteins and wet gluten values were not significantly influenced by treatment. FTIR results indicated differences in the intensity of the peaks of prominent spectral bands containing general information on the molecular skeleton and functional groups of plasma-treated and non-treated flour samples. This study suggests that atmospheric pressure cold plasma could be used to decrease microbial load and modify flour functionality.

Keywords
atmospheric plasma, whole wheat flour, microbial inactivation, physicochemical modification

Acknowledgements
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#189: Effect of atmospheric cold plasma discharge on some physical properties of micellar casein and milk protein isolate powders

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In this study, the effect of atmospheric cold plasma jet treatment (10 kV, 18 kHz) on some physicochemical and functional properties of micellar casein (MC) powder and milk protein isolate (MPI) powder using oxygen or nitrogen gases was investigated. Powder samples were divided into fractions of 63-100 and 100-200 µm. Plasma treatment was applied to each fraction for 60 seconds using nitrogen (N2) and oxygen (O2) gases. It was determined that plasma application increased the solubility of MPI powder by around 10% for both size fractions, while there was no significant difference in the solubility of MC fractions. It was also determined that oxygen plasma was more effective than nitrogen in the solubility of MPI fractions. In addition, plasma treatment caused a decrease in BET surface area and particle porosity values. SEM images revealed that the microstructure of the particles remained unchanged after the treatment. Overall, atmospheric cold plasma treatment can be tailored to develop a plasma process with the potential to modify protein powders.

Keywords
atmospheric plasma, protein powder, protein solubility, physicochemical modification

Acknowledgements
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#192: Determination of fatty acid profile, total polyphenol content and antiradical activity of marine organisms *Petrosia ficiformis* and *Bugula neritina*

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The aim of this study was to determine the profile of fatty acids, total polyphenol content and antiradical activity in marine organisms from the Adriatic Sea *Petrosia ficiformis* and *Bugula neritina*. The sponge *P. ficiformis* was surfaced near the Rtina peninsula near the Paški bridge, and the bryozoa *B. neritina* was surfaced in the Luka cove, Dugi otok. The Folch method was used for the extraction of total lipids, and gas chromatography with flame-ionization detector was used for fatty acid identification. Total polyphenols were extracted using ultrasound, and polyphenol content was determined spectrophotometrically using the Folin-Ciocalteu reagent. The antiradical activity was determined by the DPPH method. Based on the obtained results, it was determined that cis- and trans- isomers of oleic acid (25.34 ± 0.26 %) are the most abundant in the sponge *P. ficiformis*, and palmitic acid (48.38 ± 0.44 %) dominates in bryozoan *B. neritina*. It was also observed that *P. ficiformis* (72.19 µg GAE/mL) has a higher content of total polyphenols than *B. neritina* (59.01 µg GAE/mL). By determining the antiradical activity by ultrasonic extraction, the highest values were obtained at 30 °C for *P. ficiformis* (93.57 ± 0.70 % DPPH) and for *B. neritina* (93.65 ± 0.51 % DPPH). Increasing the temperature decreased the antiradical activity for both samples.

Keywords
Petrosia ficiformis, *Bugula neritina*, fatty acids, total polyphenols, antiradical activity

Acknowledgements
The Scientific Centre of Excellence for Marine Bioprospecting – BioProCro

#194: Fatty acid profile of sea buckthorn pulp oil isolated by supercritical carbon dioxide extraction

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Sea buckthorn (*Hippophae rhamnoides* L.) pulp has recently been widely used as an ingredient in different food products, but is also being incorporated as a functional food, nutraceutical products and cosmetics. The pulp is mostly recognized for its oil content, comprising a unique fatty acid composition, fat-soluble vitamins, and plant sterols. The growing demand for this valuable lipid fraction has emerged the application of sustainable technologies for its isolation, such as supercritical carbon dioxide extraction (scCO2) in order to overcome the limitations and disadvantages of traditional isolation techniques. Therefore, the aim of this study was to evaluate the effect of temperature and pressure during scCO2 on the fatty acids profile in sea buckthorn lipid fraction using RSM. Obtained results showed that both content of total saturated fatty acids (SFA) and total mono- and poly-unsaturated fatty acids (MUFA+PUFA) was significantly affected by pressure during scCO2. Application of higher pressure resulted in higher proportion of SFA, while lower pressure provided the extraction of fraction rich in MUFA+PUFA. Thereby, optimal conditions for isolation of sea buckthorn lipid fraction rich in unsaturated fatty acids were set at temperature of 60℃ and pressure 80 bar, providing the fatty acid profile comprised of 68% of total unsaturated acids with cis-linoleic, oleic and trans-vaccenic acids being the most abundant. Obtained fraction presents a valuable material suitable for future application in a variety of food, nutraceutical and cosmetic products aimed for health and life-quality enhancement.

Keywords
sea buckthorn oil, fatty acids, supercritical carbon dioxide, optimization

#195: Investigation of the acrylamide and 5-Hydroxymethylfurfural (HMF) presence in breadsticks sold in local patisseries in terms of public health

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The objective of the current study was to determine the Turkish population exposure to acrylamide and 5-hydroxymethylfurfural (HMF) in breadsticks sold in local patisseries. Acrylamide and HMF are both known as toxic Maillard reaction products which are easily formed in bakery products processed at elevated temperatures. In this sense, breadsticks may also be considered among the risky product groups in terms of acrylamide and HMF formation in food safety worldwide. In the study, a total of 30 different breadsticks (plain, whole-grain and mixed-grain) were collected from local patisseries located in Aydın/Turkey. In addition to acrylamide and HMF contents, breadstick samples were also analyzed in terms of moisture content, ash content and color (L*, a* and b* values). Acrylamide content of the samples was determined using gas chromatography-mass spectrometry (GC-MS) after derivatization with a broming agent. HMF content, on the other side, was determined using high performance liquid chromatography (HPLC-DAD). Acrylamide analyses results were expressed in ppb, while HMF results were expressed in ppm. Results of the study showed that acrylamide content in breadsticks ranged from 7,98±1,00 ppb to 541,26±12,33 ppb, whereas HMF content changed between 6,61±0,25 and 28,36±0,83 ppm. The compositional parameters of plain, whole-grain and mixed-grain breadsticks were found to be different from each other. Considering the results, it was clearly seen that whole-grain breadsticks were more prone to acrylamide formation, while plain breadstick samples had a lower risk for the formation of acrylamide. Similarly, plain breadsticks posed less risk in terms of HMF formation, when compared to whole-grain and mixed-grain breadstick samples. Additionally, the exposure of acrylamide through breadstick samples was found as 0,64 µg/kg of body weight per day, while HMF exposure was determined as 0,06 mg/kg of body weight per day. The results presented herein may be useful in the development of novel food products that prioritize public health and healthy plant-based diets.

Keywords
acrylamide, breadsticks, exposure, health, HMF

#196: Impregnated polyethylene film as active food packaging via supercritical carbon dioxide

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Supercritical impregnation is one of the new technologies used to incorporate active ingredients in food packaging materials. The main advantages of using supercritical carbon dioxide as a solvent depending on the ability to operate at mild temperatures and thus to process thermo-sensitive active constituents. Meanwhile, pomegranate (*Punica granatum* L.) peel as a biowaste product has a higher total phenolic content and antioxidant activity than pulp. This study used supercritical impregnation to develop a polyethylene active packaging film with a pomegranate peel extract (PPE). Polyethylene film without PPE was used as a control film. The effects of different temperatures on films' functional and physical properties were determined. The results indicated that the thickness and weight of impregnated films augmented ($p<0.05$) as the temperature increased to 60 ºC. However, the diameter of impregnated films did not change as the temperature increased. The surface micrographs obtained by Scanning Electron Microscopy (SEM) showed that the films contained some bubbles, particularly in film at a higher temperature indicating the phenomenon of swelling during the impregnation process. For antioxidant activities, impregnation at 60 ºC was the most favourable condition, whereby impregnated films possessed higher antioxidant properties in DPPH and ABTS radical-scavenging activity tests, 93.85% and 88.74%, respectively. These results revealed that PPE could be used as an active agent in packaging film via supercritical impregnation and thus has the potential to prolong the quality and shelf life of foods.

Keywords
supercritical impregnation, active packaging, pomegranate peel, biowaste, antioxidant films

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#197: Starch-based biomaterials as key to the circular economy in the food packaging industry

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Concerns about natural resource conservation and climate change, as well as environmental protection, have driven science and industry worldwide to reduce dependence on and consumption of fossil fuels. A strong awareness of the need for a paradigm shift from a linear to a circular economy gives high priority to the development of biomaterials, especially in the packaging industry.

The study focuses on the production and investigation of sustainable and environmentally friendly packaging materials based on biodegradable blends, such as polylactic acid (PLA) and thermoplastic potato starch (TPS). Problems such as high interfacial tension due to incompatibility between the hydrophobic PLA and hydrophilic TPS have been attempted to be overcome in blends by using citric acid for starch esterification as a potential compatibilizer and plasticizer. Native potato starch and starch citrates were plasticized with glycerol and then several TPS/PLA blends were prepared in a laboratory Brabender mixer with the aim to evaluate the performance of citric acid as a compatibilizer. The prepared blends were subjected to extensive physicochemical characterization to clarify functional performance and demonstrate biodegradability. Consequently, the dynamic mechanical behavior, morphology, crystallization, barrier, and mechanical properties of the TPS/PLA blends were analyzed. In addition, the prepared blends were subjected to a 60-day biodegradation test.

The results showed that citric acid was able to promote esterification/transesterification reactions in TPS/PLA blends. The citric acid improved the interfacial adhesion due to the interaction between the carbonyl groups of citric acid and the active groups of TPS and the PLA phases, which was confirmed by FTIR analyses and adhesion parameters, as well as morphology analyses. The viscoelastic, thermal, and mechanical properties were improved by using starch citrates in TPS/PLA blends. In conclusion, the use of thermoplastic starch in PLA/TPS blends accelerates the biodegradation of polylactic acid, a slowly biodegradable polymer.

Keywords

biomaterials, starch, polylactic acid, blends, biodegradation

#198: Isolation of sea buckthorn oil volatiles: Effect of supercritical carbon dioxide extraction

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Both the leaves and the berries of sea buckthorn (*Hippophae rhamnoides* L.) have been anciently known for its use in traditional medicine and in food and feed production. The oil obtained after pressing the berries is a rich source of various non-polar bioactives such as phytosterols, unsaturated fatty acids, tocopherols, carotenoids, fat-soluble vitamins and volatiles, which provide numerous health benefits, making sea buckthorn oil a valuable material for use in a variety of cosmetic, pharmaceutical, and food products. In order to efficiently exploit these benefits and overcome the drawbacks of conventional extraction methods, "green" extraction techniques such as supercritical carbon dioxide extraction ($ScCO_2$) have been employed. On account of better extraction efficiency, environmentally friendly and safe status (GRAS), $ScCO_2$ has gained increasing attention. Therefore, this study aimed to evaluate the effects of $ScCO_2$ parameters on the isolation of volatiles in sea buckthorn oil. For this purpose, dry sea buckthorn berries were submitted to $ScCO_2$ according to a central-composite design, which included 13 experiments at different temperatures (35.9-64.1 °C) and pressures (78.6-361.4 bar). The results of sea buckthorn oil chemical composition showed the presence of terpenes, alcohols and esters, with esters being the most abundant volatiles. ANOVA revealed a significant effect of pressure on the yield of total alcohols and esters, showing an opposite trend: total alcohols yield was highest at lower pressure, while higher pressure applied yielded the highest amount of total esters. Given that esters were the most prevalent volatiles, RSM analysis defined 64.1 °C/361.4 bar as the optimal conditions for the extraction of 78.5% of these compounds.

Keywords
Hippophae rhamnoides L. oil, supercritical carbon dioxide, optimal parameters, esters, green extraction

#200: Exploring the impact of yeast fermentation on aroma changes in black currant pomace

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Following berry juice extraction, the solid residue, known as pomace, still contains substantial amounts of bioactive compounds and other nutrients. Depending on fruit species it may also contain reasonable amounts of fermentable sugars. Fermentation, utilizing various microorganisms and particularly various strains of yeast, has been shown to be an effective method for processing pomace in order to enhance both the nutritional value and the aroma profile of the resulting product. This study aimed at investigating the effects of anaerobic fermentation on the nutritional composition and aroma profile of mechanically pre-fractionated into the seeds and skins black currant pomace using 5 different yeast strains, namely *Saccharomyces cerevisiae, Saccharomyces bayanus, Kluyveromyces marxianus, Torulaspora delbrueckii*, and *Hanseniaspora uvarum*. Proximate composition of pomace fractions was determined by the standard methods, while sugars as well as their changes were monitored using the Megazym K-SUFRG protocol. Ethyl alcohol and other head space volatile compounds we collected by the solid phase microextraction and analysed by gas chromatography with time-of-flight mass spectrometry detector (HS–SPME–GC–TOF/MS). All applied yeast species fermented pomace, however, fermentation with *S. cerevisiae* led to a more rapid depletion of sugar levels and an increase in alcohol content, accompanied by the accumulation of various volatile organic acids. *S. bayanus*, on the other hand, produced more esters contributing to fruity and floral aromas. The non-*Saccharomyces* yeast strains fermented at a slower rate, but they synthesized a higher concentration of interesting aromatic compounds such as fruity esters, lactones, thiols, and terpenes. This study emphasizes the potential of black currant pomace fermentation as a sustainable approach to producing value-added products and reduce waste.

Keywords
black currant pomace, anaerobic fermentation, yeast strains, volatile compounds

#201: Optimization of pressurized liquid extraction of bioactive compounds from the defatted sour cherry pomace

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Sour cherries (*Prunus cerasus* L.) are popular stone fruits with high content of bioactive compounds, particularly polyphenolic antioxidants such as anthocyanins and proanthocyanidins. Therefore, cherry consumption has been linked to various health benefits, e.g. prevention of cardiovascular, Alzheimer and inflammatory diseases, lowering blood pressure and others. Sour cherries may be consumed as fresh fruits; however, due to a short shelf-life and sourness the major harvest fractions are used for the production of wine, juice, jam and other processed foods. Pressing cherry juice generates large amounts of pomace, most of which are currently discarded as a waste. Therefore, there is an urgent need of cherry pomace valorization studies for their conversion into the higher added value ingredients for foods and nutraceuticals. The aim of this study was to optimize the pressurized liquid extraction process (PLE) to recover polyphenolic-rich fractions from cherry pomace residues remaining after supercritical fluid extraction with CO_2, which is used to recover valuable lipophilic substances. A central composite design based response surface methodology was used to evaluate the effect of PLE time and temperature (the pressure was constant, 10.3 MPa). Ethanol mixture with water (70:30 v/v) was used as a solvent. The total extraction yield, total phenolic content (TPC) and antioxidant properties, based on a 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid radical cation ($ABTS^{\cdot+}$) scavenging capacity and oxygen radical absorbance capacity (ORAC), as well as proanthocyanidin content were chosen as the optimization responses. The highest yield (29.61%) was obtained at 120 °C and 3 extraction cycles, 15 min each, while the highest $ABTS^{\cdot+}$ scavenging (125.4 mg of trolox equivalents per g) and TPC (47.17 mg gallic acid equivalents per g) were obtained at 60 °C and 3×10 min. The highest content of proanthocyanidins was recovered at 90 °C and 3×10 min. Considering all observed responses, the extraction process was optimized and validated. Therefore, the results obtained in this study may be promising for the recovery of bioactive compounds from the defatted cherry pomace by PLE. Considering their health benefits, sour cherry pomace extracts may find applications in functional foods and nutraceuticals.

Keywords
sour cherry pomace, pressurized liquid extraction, antioxidant capacity, response surface methodology, optimization

#210: Production of a food package using carob fiber as a by-product

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The world's population began growing rapidly since the 1950s, and we have become a consumer society, where we produce and consume more and more and consequently generate more waste. There is an expanding market for carob (Ceratonia siliqua l.) syrup, but its production involves boiling the fruit to extract the sugars, leaving behind a waste rich in cellulose and lignin that can be used in food packaging. This work aimed at developing and optimizing a food packaging material in the shape of a bowl. In order to optimize the formula and process for producing this material, fixed quantities (previously established) of ground carob waste together with carob flour, glycerol, tween 20, distilled water and citric acid solution (50% w/v) were used. The effect of the composition of the two binding ingredients, apple pectin (AP and locust bean gum (LBG) and the effect of the heating time (Ht) and temperature (T) on the responses penetration force (PF), water activity (aw) and dry matter content (DMC) were studied using a combined Mixture-Factorial design and Response Surface Methodology. The results were then modeled mathematically, but only for PF a significant model was obtained, while for aw and DMC, the mean was a better estimator. An optimization was next performed having as main goal the maximization of PF. The optimized formulation had a final resistance of 20 kgf. Lastly, the bowl package was coated with a mixture of beeswax and carnauba wax to improve its water barrier.

Keywords
carob, waste, packaging, waxes, sustainability

#211: Validation study of a novel formula of functional tomato sauce base (TSB) with olive powder, pea protein, and dry tomato peel powder using Response Surface Methodology (RSM)

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Tomato-based products are widely consumed worldwide, making them a good matrix for supplying humans with essential and health-enhancing nutrients. A functional optimized tomato sauce base (TSB) was developed in this study using a mixture design with 4 components; tomato pulp from peeled tomatoes (x1), pea protein concentrate (x2) (which prevents hypertension and regulates intestinal flora activity), olive powder (x3) (which helps prevent cancer and cardiovascular disease), and tomato peel powder (x4) (which contains antioxidants including flavonoids, phenolic acids, and lycopene, helping to reduce the risk of chronic diseases). As methodology, Response Surface was used to find the best formulation. Responses, namely, color (Y1), aspect (Y2), aroma (Y3), viscosity (Y4), taste (Y5), and aftertaste (Y6), were evaluated by a sensory panel composed of 19 to 23 elements (males and females) with ages comprised between 18 and < 60. For each response, the polynomial models that best fitted the experimental results were then obtained. Numerical optimization was performed having as target (goal) for all responses, scores higher than 3 on a hedonic scale from 1-6 where 1 meant very bad and 6 very good. The optimized formulation contained 93.06% of tomato pulp, 1.82% of pea protein, 1.66% of olive powder, and 3.47% tomato peel powder. Total phenolic content, antioxidant activity (ABTS and FRAP), carotenoids, and lycopene contents were also determined. The TSB quality parameters were nearly identical to those of tomato fruit justifying the inclusion of the functional ingredients to make up for the loss observed when processing tomato fruits into pulp.

Keywords
tomato, functional food, response surface methodology, plant-based ingredients, health

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#212: Development of active packaging materials based on polylactic acid and application for the preservation of dehydrated fish powders

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Packaging of food provides protection against chemical, biological, and physical modifications during storage. The recent trends towards the reduction of the impact of plastic products on the environment has raised significant concerns about the sustainability of conventional polymers as food packaging materials. Polylactic acid (PLA) is a biopolymer obtained from renewable resources, with similar properties to several conventional synthetic polymers. However, its low gas and moisture barriers limit PLA applicability on sensitive products. Natural bioactive compounds, such as essential oils (EO), may be incorporated into the films to increase the preservative effect of the biopolymers on sensitive foods.

The objective of the study was to develop active PLA-based films with antioxidant properties and evaluate their applicability for the preservation of fish powders obtained from salmon by-products.

PLA films were produced using the TQC auto film applicator. Different concentrations (0-10%) of rosemary (Rosmarinus officinalis) EO were incorporated into the films, previously encapsulated into PLA pellets. The *in vitro* antimicrobial activity of active packaging materials was determined with a disk diffusion assay against selected bacteria, while DPPH free radical scavenging assay was used for screening the antioxidant activity of the active films. Water and oxygen permeability was determined using standard ASTM methods. Wettability of the film surface was evaluated based on the measurement of contact angle. The developed films were used for the preservation of salmon powders (obtained from fish processing by-products). PLA pouches (with 0-10% rosemary EO) with 10 g of salmon powder were stored at 25°C. Polyethylene films were evaluated as Control (conventional plastic films). Lipid oxidation was monitored via peroxide and anisidine value tests.

PLA films resulted in higher lipid oxidation rates in the packed fish powders, compared to polyethylene. The addition of rosemary EO resulted in inhibition of lipid oxidation, with the higher EO concentrations resulting in lower peroxide and anisidine values.

The results of the study show the potential of PLA-based active films with encapsulated rosemary essential oil for the preservation of dehydrated products, such as salmon powders.

Keywords

biodegradable packaging, biopolymers, lipid oxidation, dehydrated products

Acknowledgements

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#213: Sustainable recovery of ω-3 PUFA from fish processing effluents via Microwave-Assisted Extraction

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Fish side streams during processing can be up to 70% of the initial catch weight, raising economic and environmental concerns. Therefore, the disposal and recycling of these by-products is a main problem to be resolved. These materials are rich in valuable bioactive compounds such as polyunsaturated fatty acids (PUFA), which can be recovered and used as ingredients in added-value food products. Microwave-assisted extraction (MAE) can be used as an alternative to the Soxhlet extraction (SE) method for PUFAs recovery from fish by-products, aiming for high-quality extracts.

Seabass (*Dicentrarchus labrax*) filleting by-products were freeze-dried and lipid extraction was carried out. For SE method, a polar (ethanol) or a non-polar (hexane) solvent were used up to 6 h with solvent to solid ratio 60:1. MAE was carried out at 300-600 W using ethanol as solvent with solvent to solid ratios 10:1 and 30:1 at 30, 40, and 50°C for 5-10 min.

In order to evaluate the efficiency of the MAE method, MAE was compared with the SE in terms of the extraction yield of fish oil. Soxhlet extraction with ethanol achieved higher recovery yield, 40.8 g fish oil/100 g dry weight, compared to hexane (30.5 g fish oil/100 g dry weight) thus, ethanol was selected for MAE. MAE with ethanol at solvent to solid ratio 30:1 was able to extract 60% of the total lipid content within 5 min at 300 W and 50°C. Moreover, PUFA extracted from MAE were less oxidated compared to SE extracts; lower p-anisidine values.

Seabass side-streams are an ω-3 rich source suitable for further valorization. The application of MAE on process effluents could be a viable alternative to traditional extraction methods contributing to industry demands for sustainable development. Taking into account the thermal sensitivity of PUFA, extracted fish oil may have been degraded by Soxhlet method due to the high temperature and long extraction time. MAE method provides lower operating temperature, thus no thermal degradation of most of the unstable compounds and shorter extraction time leading to energy savings.

Keywords
microwave-assisted extraction, fish side streams, ω-3 fatty acids, PUFA recovery

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#214: Evaluation of the ability of smear-ripened cheese microbial communities to colonize pea-protein matrix

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Plant-based substitutes for dairy and meat products have been one of the key innovative drivers since the last decade due to concerns about sustainability, lifestyle, and dietary limitations. However, there are different challenges to developing these substitutes, including poor sensory properties and defects of these products. Fermentation and ripening processes may help enhance the texture, microbiological safety, nutritional value, and sensory characteristics of plant-based dairy and meat substitutes. However, assessing the growth conditions for various microbial species to produce the desired metabolites is challenging. The main objective of this study was to evaluate the ability of smear-ripened cheese microbial communities to colonize a pea-protein matrix.

In this study, 12 different cheese-rind microorganisms, including four Lactic Acid bacteria (LAB) strains belonging to three species, i.e., *Lactiplantibacillus plantarum, Lactococcus cremoris, L. lactis* S3+ and S3, five cheese ripening bacterial species, i.e., *Glutamicibacter arilaitensis, Brevibacterium aurantiacum, Staphyloccocus equorum, Corynebacterium casei, Hafnia alvei*, and three yeast species, i.e., *Geotrichum candidum, Debaryomyces hansenii*, and *Kluyveromyces lactis* were used. A pea protein matrix composed of 10% (w/w) pea protein isolate and 2.5% (w/v) glucose was inoculated with all twelve pure cultures for one week at 25°C. The control media were BHI broth for the cheese-ripening bacteria, PDB broth for the yeast species, and MRS broth for the LAB strains. The viable count (CFU/mL) and pH were assessed on day 0 and day 7 for both conditions.

The growth results showed that all smear-ripened cheese microorganisms colonized the pea protein matrix except for *B. aurantiacum*. Among LAB, *L. plantarum*, and *L. cremoris* showed a higher growth compared to L. lactis S3+ and S3 strains at day 7. The cheese ripening bacteria showed the ability to modify the initial pH with *H. alvei* and *C. casei* significantly reducing pH at Day 7 compared to the control.

Overall, most of the tested strains, mostly isolated from cheese, can grow in a pea-protein matrix. These results provide new insights into their technological capacities and are valuable for the design of microbial consortia for pea-protein and other plant protein-based fermented products.

Keywords
pea protein, smear ripened cheese microorganisms, plant protein fermentation, microbial growth, lactic acid bacteria

#216: Meat sausages production with maritime pine bark extracts: effects on lipid oxidation and antioxidant capacity

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Maritime pine bark (*Pinus pinaster* subsp. *atlantica*), a by-product of the timber industry, is a rich source of natural polyphenolic compounds with high bioactive potential, for preventing lipid oxidation by neutralizing free radicals. This study aims to evaluate the effectiveness of pine bark extracts in preventing lipid oxidation in ready-to-eat sausages.

Pine bark liquid extracts (PBE) were obtained by microwave-assisted extraction. Three batches of sausages were produced by a meat processing company: "STM", where PBE was added to the meat paste before casing and thermal processing; "STP", in which PBE was brushed onto the sausage's surface before packing; and "STC", which was produced without PBE. After vacuum-packing and 5 days of storage at 4 ºC samples were analyzed for TBARS, acid value (AV), peroxide value (PV), total phenolic compounds (TPC), and antioxidant capacity (ORAC and DPPH). Significant differences were set at $p<0.05$.

Acid values were statistically different ($p<0.05$) in all treated groups (STM 10.25±0.25%; STP 12.18±0.29%; STC 13.80±0.92). STM samples showed the lowest PV (81,63±7.39 meq/kg, $p<0.001$) and no differences were found for STP and STC samples, 249.83±11.86 and 273.90±15.20 meq/kg, respectively. DPPH values were higher in STP (0.520±0.006 mg. eq Trolox/g, $p<0.001$) when compared to other samples (0.461±0.005 and 0.487±0.002 mg. eq Trolox/g to STM and STC respectively). TPC was higher in STP (0.739±0.015 mg/g, $p<0,001$), but no significant differences between STC and STM were revealed, 0.544±0.006 and 0.558±0.033 mg/g, respectively. No relevant differences ($p>0.05$) were detected in TBARS and ORAC assays, regardless of the type of treatment.

PBE addition effectively postponed lipid oxidation in sausages when applied before thermal processing: STM samples revealed the lowest peroxide and acid values and, therefore, this method can be used to prolong the shelf life of these products. Alternatively, PBE application after thermal treatment, by brushing the sausage surface (STP sample), resulted in a greater quantity of TPC and a more pronounced antioxidant capacity as measured by DDPH assay. Thus, PBE addition to meat sausages is an opportunity to produce sustainable enriched foods adding value to forestry by-products.

Keywords

meat sausages, pine bark extracts, lipid oxidation, antioxidant capacity

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#219: The efficacy of indirect pulsed electric field application in marinating sardines

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Sardines (*Sardina pilchardus*) are valuable fish species with nutritional value and favorable taste. Processing sardines as marinades in brine provides a longer shelf life. However, the slow rate of salt diffusion is the main obstacle to be overcome. The pulsed electric field (PEF) is an innovative method that accelerates mass transfer by electroporation, increasing cell permeability. This study aims to understand the PEF effect on salt diffusion through sardine muscles and assess the PEF method as either pretreatment or continuous application.

PEF (6.36 kV/cm) was indirectly applied to sardines before and during marination when the electrodes were in contact with neither sample nor packaging material. Sample groups were composed of untreated (CS) sardines, PEF-applied sardines for 60 minutes at 4°C (CP), and PEF-applied sardines during storage (CPS) were kept in polypropylene food containers (11x12cm), including 18% brine (1:2) (w/v) for 24 hours at 4°C. Scanning electron microscope (SEM) images of fresh samples (C) and only PEF-applied samples (P) were evaluated during 12 and 24 hours of storage. The salt concentration, water activity, ash content, and pH values were also determined.

This study determined that PEF application was effective on the salt content of sardines kept in brine. The final salt concentration of PEF-treated samples was higher (18.17% - 18.22%) than the untreated samples (C) (16,32%). This situation can be explained by the deterioration of the integrity of the muscle cell membrane due to the mechanical damage caused by applying PEF in the microstructure of the fish muscle, and the increase in intercellular spaces and the formation of new channels facilitate the mass transfer. However, the difference between the PEF-applied samples was insignificant while ash content increased, and water activity value decreased in all samples due to salt absorption. No significant difference was observed between samples and storage periods when pH values were compared. The number and diameter of the pores increased due to the rise in application time in CPS and CP groups based on SEM images. The deformation of sardine tissues in CPS group was more pronounced than in other groups regarding salt diffusion.

In conclusion, PEF application could be used as a pretreatment to increase the salt diffusion rate in sardines.

Keywords
sardines, marination, pulsed electric field, salt diffusion rate

#220: Development of apple pomace enriched healthy wheat bread and evaluation of physicochemical, antioxidant and sensory properties

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Apple pomace is a by-product generated during the apple juice production. It consists of high amount of bioactive compounds and is an outstanding yet cheap source of fiber. Present day consumers do not fulfil the required amounts of bioactive compounds and fiber through their regular foods. This bread is made to solve both problems.

We used Design Experiment (DE) with study type Response Surface and subtype Randomized with 13 samples (from 0 to 25% dried apple pomace content) to develop the bread and evaluate the effect of different pomace concentrations on bread characteristics. We used BL-80 wheat flour to prepare the bread. The dough was kneaded for 7 minutes after that proofing was done at 35 °C for 30 minutes with 85% relative humidity and then baking was done at 200 °C for 20 minutes. To compare and evaluate the samples, we determined their total polyphenol content (TPC), antioxidant capacity (FRAP), color parameters (L*, a*, b*), fiber content and sensory properties.

The sample with 9% apple pomace produced the most likeable results having 4g/100g fiber, 7.4 overall sensory liking, 52 µg/100g TPC, 14 µg/100g FRAP with 59 L* color value. Bread without pomace had slightly higher overall sensory liking of 7.5 and it was brighter with L* color value of 63 but it had less fiber and much less TPC (29 µg/100g) and FRAP (7 µg/100g). In the sensory evaluation 9% pomace bread had better results in chewiness and appearance.

These results suggest that this bread could have high demand in public and could play key a role in making people healthier. Also, being made from a side stream this bread will help in circular economy and lower the burden on ever diminishing natural resources.

Keywords
apple pomace, design experiment, healthy bread, food processing waste, circular economy

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#222: Development of hops-based ingredients with enhanced techno-functionalities

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Currently, the food industry has started to decrease, eliminate or replace the use of synthetic additives with natural counterparts extracted from plants. Hop (Humulus Lupulus L.) represents a rich source of diverse secondary metabolites (e.g. bitter acids and polyphenols) of interest for both sensory and techno-functional properties. However, the instability of these compounds during storage and food processing has stimulated the use of different encapsulation techniques for their protection.

Aim of this study was the development of new hop-based ingredients with enhanced techno-functional properties and stability suitable for application in food products with improved functional and sensory properties. Hop extract was obtained from hop pellets using ultrasounds (100 Watt, 50 KHz) for 30 minutes. After solvent removal, the hop extract was formulated with maltodextrin (MD), gum Arabic (GA), a mixture of maltodextrin and β-cyclodextrin (βCD), and GA and βCD in the proportion 1:1 (w/w). Spray-drying (SD) was used as encapsulation technology at two different inlet temperatures (T_{inlet}) (120 °C and 150 °C). After SD the powdered hop extracts were characterized for their moisture content (Mc), water activity (a_w), solubility, hygroscopicity, water sorption isotherms, color, microstructure, bitter acids (BA), polyphenol content (TPC) and yield (TPC Y%), polyphenol encapsulation efficiency (TPC EE%), and antioxidant activity (AOA) by FRAP and ABTS assay. Results showed that the highest T_{inlet} enables the production of powders with lower Mc, aw, TPC, TPC Y%, AOA, and higher lightness, hygroscopicity, and TPC EE%. Samples encapsulated with MD compared to those encapsulated with GA showed a brighter and green-yellow colour and lower TPC EE%. Furthermore, GA and MD affected to different extent the other physical and chemical properties of the microencapsulated powders depending on the spray-drying T_{inlet}. The use of βCD as carrier in the formulation positively affected TPC, TPC Y%, bitter acids, and AOA but decreased the TPC EE%.

Keywords
hop extracts, food additives, bioactives, antioxidant activity, encapsulation

#223: Physical, physicochemical, physical, and microstructural properties of mascarpone and corresponding dessert creams

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The dairy-based, refrigerated or frozen, dairy desserts sector is increasing for importance in the market of the ready-to-eat products for their sensory properties and convenience. Their quality and sensory properties depend on diverse formulation and processing factors that, in turn, affect also their stability over storage time. While dairy-based ice-cream is a well-studied product for the main impact that frozen state has on its quality, very limited are the information related to the role of the main dairy ingredients and formulation on the physical, physico-chemical, microstructural and rheological properties of refrigerated dairy desserts. A well-known dairy-based dessert of Italian origin is the "tiramisu", whose cream component is mascarpone, a typical fat-rich, cream cheese that highly contributes to the peculiar qualitative and sensory properties of the product. However, so far no investigations have been carried out to comprehend the role of mascarpone and its properties on the dessert cream that could, in turn, affect its sensory acceptability.

Aim of this study was to evaluate the physical (rheology, dispersed colloidal state, thermal), physico-chemical (aw, colour), and microstructural (confocal laser scanning microscopy) properties of mascarpone, and of the corresponding dessert creams prepared thereof mimicking the well-known "tiramisu" recipe. Overall, the rheological, colorimetric and thermal analyses of the two different mascarpone cheese samples highlighted the complex colloidal properties of this fat-concentrated creamy cheese as affected by the specific processing conditions. Similarly, the corresponding dessert creams presented different viscoelastic properties depending on the initial mascarpone samples reflecting the microstructural properties and the dispersion state of the lipidic phase.

Results of this study will be used to optimise the formulations for modern and to design innovative dairy-and non-dairy dessert creams.

Keywords
dairy desserts, mascarpone, rheology, physical properties, microstructure

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#225: The impact of ingredient substitution on the sensory dynamic perception of strawberry sauce for dairy products incorporation

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Temporal Check-All-That-Apply (TCATA) is a sensory technique used to obtain a sensory dynamic characterization of food products. This study aimed to evaluate new innovative and clean-label formulations of industrial strawberry sauce and to compare them with a traditional recipe.

A panel of 10 semi-trained tasters evaluate ten strawberry sauce formulations (varying on ingredients affecting sweetness), using a TCATA approach. The list of attributes was previously defined based on a literature review, using seven attributes for texture and eight for taste. After the first bite, tasters dynamically selected the attributes that best described the product, during the whole 30-second tasting period, with a defined attribute fading time of 8 seconds. The process was repeated for each sensory dimension.

The dynamic sensory profile of the samples allowed the detection of different texture and flavour profiles between samples. Regarding the texture profile, typically, the samples have a creamy and soft initial texture, and, at the end of the 30-second period, they keep the softness and velvety attributes. At the end of the evaluation of the sample with yacon incorporation and 30% sugar reduction, the doughy attribute emerged. A similar sample with the incorporation of “A local cultivar/variety, 'Carapinheira' pear” revealed a grainy texture mainly in the first half of the evaluation. Regarding taste, analysis of the difference curves shows that the samples with yacon incorporation present a significant bitter taste when compared with the remaining formulations. Furthermore, intense and sweet taste are significantly more perceived in samples with oat incorporation and sugar reduction.

This research brought important aspects about these strawberry sauces with low sugar content, allowing for the characterisation of the dynamic sensory profile, giving insights for the product development process and for the use of ingredients with a clean label character.

Keywords

clean label ingredients, temporal measures, sugar reduction, semi-trained tasters

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#227: Biopolymer based antimicrobial packaging as a means to extent the shelf life of chicken meat

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Antimicrobial packaging materials can effectively control the microbial contamination of solid or semi-solid food products by inhibiting the growth of spoilage or pathogenic microorganisms on the surface of the food. E-polylysine (ε-PL) is a cationic homopolymer of 25–35 l-lysine units interlinked by a peptide bond between the carboxyl and ε-amino groups of l-lysine residues and exhibits a wide antimicrobial activity against Gram(+) and Gram(−) bacteria, yeasts and moulds.Antimicrobial films were prepared by incorporating different levels of ε-PL into sorbitol-plasticized whey protein isolate (WPI) and chitosan composite films. The effectiveness of the antimicrobial films against chicken breast meat spoilage flora during storage at 5 °C and the impact of the antimicrobial agents on the mechanical and physical properties of the films were examined. The moisture uptake behavior and the water vapor permeability (WVP) were only slightly affected by the addition of the antimicrobial agent at all concentrations. A decrease in maximum tensile strength (σmax), accompanied with an increase in elongation at break (%EB), was observed with increasing moisture content, highlighting the plasticizing effect of water. Additionaly, addition of ε-PL concentration affected the mechanical properties of the studied composite films. When evaluating the antimicrobial effect of the films it was shown that significant inhibition of growth of the total flora and pseudomonads was observed with the use of WPI/ chitosan composite films made containing 0,75% w/w ε-PL. These results pointed to the effectiveness of the antimicrobial films to extend the shelf life of chicken meat.

Keywords
biopolymer based packaging, composite films, ε-polylysine, antimicrobial packaging

Acknowledgements
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#234: Systematic review of edible insects' fractionation: extraction methods and characterization of chemical, techno-functional and biological properties

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The application of fractionation techniques on edible insects can be a promising strategy to not only increase consumer acceptance of insects as food but also to widen the range of possible applications of edible insects in the food and feed industries and in other fields. Besides assessing the characteristics of the main fractions (protein, lipid and chitin), it is also of utmost importance to understand how different extraction methods and conditions affect the efficiency and the characteristic of the obtained fractions. The search in the online databases PubMed/Medline, Scopus and Web of Science, lead to a total of 34,513 entries, from which 240 original papers were selected and included in this systematic review. An in-depth analysis of the different extraction methods and conditions was performed. Lipid extraction is considerably less studied than protein/chitin extraction. The most common extraction methods pertained to hexane-based extractions (lipid), alkaline solubilisation followed by acid/isoelectric point precipitation (protein concentrate), alcalase-hydrolysis (protein hydrolysates) and acid/alkali hydrolysis (chitin). The impact of different lipid extraction methods has been poorly characterized beyond yield and fatty acid profile. Regarding protein extracts, the focus should be given to improving efficiency and developing methods capable of being applied at an industrial level. Furthermore, it is imperative that obtained protein extracts can be incorporated into food products in order to assess their applicability beyond the lab. For protein hydrolysates, there is extensive information pertaining to common bioactive properties (antioxidant, antidiabetic and antihypertensive) and future studies should look beyond these characteristics. Lastly, for chitin extraction, there is a lack of application of green or alternative chitin extraction methods, which should be the focus of further studies as well as assessment of potential applications for chitosan. In addition, there is also a lack of studies performing complete fractionation of the insects and it is vital that developed extraction methods can be applied simultaneously and at an industrial level.

Keywords

entomophagy, chitin, lipid fraction, novel foods, protein extracts

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#238: Estimating a risk exposure on biogenic amines through surveys on the population and contents in foods and beverages

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This study indagates on biogenic amines (BAs) risk exposure in respect to consumers preferences in meal composition.

BAs are known bioactive compounds of which the controversial activity is recognized. For specific fish species and their derived products, limits for the histamine (a type of BA) are legally posed by EFSA in Europe and other authorities worldwide. In fact, histamine can be toxic and can lead to important health' symptoms and risks including the death. The action of histamine and of the other BAs are linked also to the distinctive characteristics of any subjects, their choices, and the meal composition.

Eating is a fundamental activity covering an important socio-economic part. Breakfast, lunch, and dinner are cardinal points in the daily routine, and very often people turn to any of these occasions to share their lives. Eating occasions also list happy hours/aperitivos, and snacks. Together with the "principal" meals these other two moments may shape the individual responsibility in respect to different aspects curbing our health state and our safety. In this specific frame this study tries to fit all the pieces of the larger puzzle of BAs safety through foods and beverages consumption.

A defined meal was elected considering its typicity in Italy and other Mediterranean countries. Happy our and/or aperitivos share common foods as fermented ones and others. By means of an on-line survey, voluntarily participants were asked about their habits in the aperitivo composition, their preferences about foods, their health status linked to the consumption of the goods present in the survey, and their knowledge about BAs.

Thanks to the collection of 424 replies to the survey, it was possible to determine BAs' risk exposure for selected classes of foods. Data used for probabilistic estimations were the contents of different BAs experimentally determined in samples, and quantities of same products eaten and drunk by respondents. A low risk to adverse effects of BAs from aperitivo was found for items indagated (fermented cold cuts, cheeses, beer, and wine). Nevertheless, the risk of experiencing any of the symptoms linked to BAs remains a possibility that foods and beverages choices can increase. In this scenario the population engagement and a better risk communication are required.

Keywords

biogenic amines, risk exposure, dietary habits, fermented foods

#239: Food hydrogels: Formulation of natural biopolymer-based, self-assembled starchy hydrogels.

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Hydrogels due to their unique properties have a wide range of uses and applications in a variety of fields including food, cosmetic and pharmaceutical industries and have been commonly used in encapsulation, drug delivery, food packaging and also in biosensor technologies. In terms of structure, hydrogels are three-dimensional polymer of cross-linked hydrophilic polymers, that can absorb water and hold it without disintegrating. They can be created through chemical or physical processes. Due of their safety, biocompatibility, and eco-friendly qualities, natural polymer-based hydrogels are favored over synthetic and unsustainable materials like petrochemicals. Among natural biopolymers, starch is one of the most prevalent biopolymers, a desirable option, since it is inexpensive, naturally biocompatible, biodegradable, nontoxic and renewable, all of which are prerequisites for sustainable development. Starch is composed of two main structural components, namely amylose (AM) and amylopectin (AP), and presents granules semi-crystalline organization. Gelatinization allows starch to dissolve in excess water. Then, a physical rearrangement network allowed for the retrogradation of the starch and water mixture to produce free-standing starch hydrogels. The most straightforward way to produce a hydrogel network that can be described as a self-assembled hydrogel is by this physical formation process.

In this study, we proposed a simple and facile one-step method to fabricate physically produced natural based hydrogels. The resultant hydrogels are presented for their behavior in order to better understand their structure as a hydrogel matrix. Corn starches with different amylose portions were elucidated on the physical crosslinking process used to create hydrogels. Characteristically, starch type and concentration levels (from 6% to 15% w/v) are examined and further characterized for their textural, rheological and morphological characteristics. The study elucidating the mechanisms of retrogradation in respect to storage time, to flourishing the knowledge on structural characterization of naturally formed hydrogels, due to their unique characteristics. All in all, our results are encouraging for the introduction of “eco-friendly” materials in the Food Industry.

Keywords
starch, hydrogels, self assembly, physical properties

#240: Green rooibos (*Aspalathus linearis*) extracts as natural antioxidants in apple slices in apple juice

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Prevention of non-enzymatic browning reactions during processing and storage are critical to the quality of canned fruits. In this context, beta-cyclodextrin (β-CD) assisted extracts of green rooibos (GRE) exhibited higher antioxidant activity than the aqueous extracts. Successful application in food required characterisation of their physicochemical properties. Green rooibos was extracted with water and β-CD at 40°C for 60 min resulting in freeze-dried extracts (GRE and β-GRE). The moisture content (MC), water activity (aw) and colour (L*a*b*) were analysed. Thermogravimetric analysis (TGA) and Fourier transform infrared (FTIR) were applied to confirm formation of inclusion complexes.

The MC of GRE and β-GRE at 3.29 and 2.45%, respectively did not differ significantly, but the aw of β-GRE was significantly ($p < 0.05$) lower at 0.11 than that of GRE at 0.18. β-CD-assisted extracts showed higher lightness (L*), lower redness (+a*) ($p < 0.05$), with no significant differences ($p > 0.05$) in the yellowness (+b*).

Thermograms showed that thermal degradation of β-CD was initiated between 100 – 120°C. Degradation occurred from 340 – 375°C. while that of GRE degraded from 180°C. The thermogram of β-GRE was a superposition of GRE and β-CD, confirming formation of inclusion complexes. Complexation resulted in a higher degradation temperature (260°C) for β-GRE. FTIR spectra further confirmed complexation.

GRE and β-GRE were applied as antioxidants in a model system (apple slices in apple juice) mimicking white fruit in fruit juice and processed to commercial sterility in plastic pouches. Overall, β-GRE samples showed superior inhibitory ($p < 0.05$) effects of anti-browning indices, as well as Hydroxymethyl furfural (HMF,) compared to GRE (59.55 – 67.33%). Inhibition of furfural was between 62.69 – 72.29%. Higher Ea further confirmed the browning inhibition capacity of β-GRE against colour development and HMF, but GRE was superior against furfural formation, a toxic compound.

The inclusion of GRE and β-GRE inhibited browning of the apple slices during storage. The mechanism of the browning was identified as the Maillard reaction, following degradation of ascorbic acid, the antioxidant system presently used in these products. The results, therefore, offer a potential solution for reducing food waste in this sector.

Keywords
natural antioxidants, green rooibos, non-enzymatic browning, Maillard Reaction

#244: Effect of commercial sugar and concentration of carob whole flour on the rheological behavior on an aqueous blend

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Currently, the production of carob pulp flour (CPF) is obtained by grinding the carob pulp after the separation of the seeds. From the seeds, locust bean gum (LBG) is obtained through a chemical process. CPF is already used in numerous cakes, puddings, and industrial production of chocolate-like bars, creams, and syrup. However, bioactive compounds such as polyphenols contained in interesting amounts in the seeds and bark, are lost in this process. The objective of the ALPHAMAIS Project was to produce whole carob flour (CWF) through an innovative sustainable milling process to reduce the size of pulp and seeds to a106 μm flour. Aqueous blends with different concentrations of CWF (25, 27.5, 30% w/w) with and without 10 % w/w commercial sugar (CS) were tested on the viscoelastic, pasting, and morphological characteristics. Results showed that the storage modulus (G'), loss modulus (G''), and apparent viscosity (μ_{app}) values of blends were enhanced with the addition of CS increasing with the CWF concentration. The time sweep test demonstrated time-independent viscoelastic behavior for all blends, except for 25% CWF without CS. Dynamic shear rheology tests revealed a weak gel behavior in all blends as (G'>G''), except for 25% CWF with no CS added, which showed a viscous behavior (G''>G'). For the weak gels, both G' and G'' moduli dependency on frequency (*f*) was evaluated using a Power Law model with $R^2 > 0.99$. A' and A'', the solid and viscous characteristics of the blends were evaluated, as well as *n*' and *n*'' that inform on the frequency dependency of G' and G''. The complex viscosity ($\mu*$) decreased with an increase in angular frequency, suggesting molecular disentanglement at higher angular frequencies. The tan(δ) values (0.16 to 0.3) for the blends with CS added suggested elasticity in nature.

Keywords
carob, whole flour, rheology, dynamic shear, time sweep, power law

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#245: Effect of *Lacticaseibacillus rhamnosus* OLXAL-1 and *Cistus albidus* extract in yoghurt high fat meal on postprandial oxidant and antioxidant status of healthy adults

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Purpose: Postprandial hyperlipemia evokes atherogenesis during the postprandial period, and a reasonable contributing mechanism could involve a postprandial increase in plasma lipid hydroperoxides (LPO). The purpose of the present study was to investigate the effects of a high-fat meal enriched with probiotic and antioxidant compounds on plasma postprandial antioxidant status and oxidative stress.

Methods: In a randomized, crossover, placebo-controlled design with three arms, 22 healthy participants were assigned to consume meal consisted of bread, butter, and either placebo yogurt product or enriched with a wild-type *Lacticaseibacillus rhamnosus* OLXAL-1 strain or enriched with both *L. rhamnosus* and *Cistus albidus* extract. Blood samples were collected before meal consumption and after 30, 90, and 180 minutes. The total antioxidant capacity (TAC), pro-oxidant status (dRom index), antioxidant potential (PAT index), and oxidative stress status (OSI index) were determined in EDTA plasma samples.

Results: TAC of plasma increased for the intervention of probiotic and antioxidant coexistence ($p<0.05$). However, no statistically significant differences were observed in the pro-oxidant status, antioxidant potential, and oxidative stress status between the intervention and placebo groups ($p>0.05$).

Conclusion: The enrichment of a high fat meal with probiotic and antioxidants increases the postprandial total antioxidant capacity within 3 hours of meal consumption without changes in oxidative stress. Further studies are needed to examine the effect of the intervention over time longer than 3 hours and to establish an effective dose treatment.

Keywords
probiotics, antioxidants, functional foods, antioxidant status

#251: Intensification of oleosomes aqueous extraction from *Camelina sativa* seeds: towards a sustainable and minimally processed natural ingredient

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Food and bioproduct emulsion-based products are generally produced from refined oils that are emulsified while adding emulsifiers and stabilizers. An alternative processing approach is to extract the natively stable oil-storing structures, oleosomes, and to use them as a natural ingredient for further applications.

This study aimed to develop a scalable minimal process for the recovery of oleosomes at high yield from Camelina sativa seeds and the preservation of their native structural and functional properties. Camelina sativa presents not only advantageous agronomical behavior but also seeds rich in ω-3 fatty acids compartmentally located in oleosomes (30–38% of the seed mass) and in soluble fibers (7–10% of the seed mass). Like for many oleaginous seeds, the outermost layer of Camelina seeds are surrounded by a mucilage that expands under hydration. This results in a thickening effect that hinders shear forces during mechanical treatments and interferes with oleosomes recovery. The process developed in this study includes several cascade steps that were designed to cope with this behavior, while seeking for high oleosome recovery yield and optimized energy and water consumptions. It includes: i) soaking (5% seeds w/w) in order to hydrate the mucilaginous network; ii) sonication using a continuous system equipped with a cascatrode and operating at 670 W for 30 s, completed by a fluidic recirculation (350 L/h) as an efficient pre-treatment for mucilage removal by iii) washing in a drum separator (0.5 mm sieve mesh); iv) demucilated seeds are then suspended in water (5 to 25% w/w) and grinded using a colloid mill set with a variable gap between rotor and stator devices and operated at 7990 rpm for 5 to 15 min. The final separation step is made by centrifugation. The operating parameters were combined in order to identify the best performing conditions in terms of oleosome recovery yield and quality. Samples were characterized by laser granulometry and confocal microscopy, proving the integrity of extracted structures. Energy consumption was evaluated throughout the processing steps. Water footprint minimization would be an interesting way to improve the environmental friendliness. The composition of mucilage suspension would be analyzed for further applications.

Keywords
plant oleosomes, *Camelina sativa*, aqueous extraction, minimal processing, process intensification

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#256: Antimicrobial effect of hemp flower extract from different extraction methods

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Over the past few years, there has been growing interest in the potential antimicrobial properties of hemp extracts. Specifically, cannabidiol (CBD), a non-psychoactive compound found in hemp, has been the focus of a number of studies exploring its potential as an antimicrobial agent.

In this research, the antimicrobial activity of hemp flower extracts was studied against Gram-positive bacteria (*Staphylococcus aureus, Bacillus subtilis, Enterococcus faecium* and *Listeria monocytogenes*), Gram-negative bacteria *(Pseudomonas aeruginosa, Escherichia coli* and *Salmonella enterica s. Typhimurium*), lactic acid bacteria (*Leuconostoc mesenteroides, Lactobacillus plantarum* and *Lactobacillus kimchii*) and yeasts (*Candida albicans, Candida utilis, Rhodotorula sp.*, and *Saccharomyces cerevisiae*) using the disc diffusion method.

Hemp extracts were made using ethanol and three different methods – ultrasound and microwave-assisted extraction and accelerated maceration with the help of magnetic stirring and temperature. All extracts were decarboxylated. Six different extracts from their extraction methods were used for antimicrobial activity – three before and three after decarboxylation.

Cannabinoids were determined using high pressure liquid chromatography (HPLC), with significant differences between the samples. The best antimicrobial activity was detected on Gram-positive bacteria, dominantly from ultrasound-assisted extract before decarboxylation. There was no antimicrobial effect on Gram-negative bacteria, lactic acid bacteria and yeasts.

Keywords
antimicrobial, CBD, ultrasound, microwave, hemp

#257: The effects of storage in vegetable oil on the proximate composition and microbiological quality of hot smoked South African black mussels (*Choromytilus meridionalis*)

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Commercial production of *Choromytilus* meridionalis (black mussel) and *Mytilus galloprovincialis* (Mediterranean mussel) contributes to half of the South African marine aquaculture production per year, however, limited ready-to-eat black mussel products are available. The most common use of the black mussel is its consumption among the coastal fishing communities. The black mussel is not available in any form of ready-to-eat processed product. The aim of the study was to investigate the effects of storage (15 days at room temperature) of ready-to-eat small-scale kitchen-based produced hot smoked black mussels in vegetable oil on the total viable counts (TVC), coliforms, proximate composition, and fat oxidation as thiobarbituric acid substances (TBARS). Three batches of black mussel meat were hot smoked at 80ºC for 15 minutes. Half of each batch were packaged in sterile glass bottles with heated (50ºC) vegetable oil and half without oil. Microbiological analyses were done at days 1, 3, 9 and 15. Proximate composition was determined at day 1 and TBARS at days 1 and 15. Coliforms for all samples throughout the storage period were undetected. Mussels stored without oil had no growth at days 1 to 5, but reached TVC >5 log10.g-1 at day 15. TVC for mussels in oil increased from 0 at day 1 to >5 log10.g-1 at day 3, and remained >5 log10.g-1. There was no significant difference ($P>0.05$) in moisture, protein, and ash, while significant differences ($P<0.001$) in total fat and carbohydrates in mussels with oil (10.27±2.10% and 6.80±2.22%) and without oil (5.05±1.49% and 10.59±3.00%) were detected. Differences were due to the presence of additional fats from the vegetable oil. TBARS at day 15 showed no significant difference ($P>0.05$) between mussels in oil and those without oil. There were no significant differences in TBARS from day 1 to 15 for both oil and without oil. Kitchen-scale produced smoked black mussels preserved without oil could be stored for up to 9 days at room temperature. It is recommended to investigate the potential shelf-life of a mussel pickle product, where heating of the oil together with spices and/or the mussel meat is to be a processing step, keeping in mind that the process should be applicable for small-scale kitchen based processing for potential adoption by low-income communities.

Keywords
mussels, small-scale production, hot smoking, storage, vegetable oil, TBARS, total viable counts

#262: EvoFIBER project: Sustainable solutions in dietary fiber from olive pomace

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Olive pomace, a by-product of olive oil production, holds immense biotechnological potential due to its high quality and nutritional value. Despite constituting 40% of all olive oil production, it remains largely unexplored. Moreover, the lack of exploration promotes disposal problems, leading to environmental issues. In recent years, Portugal has faced the collapse of its olive sector due to the limited processing capacity of olive pomace, resulting in high transportation costs to transfer it to other European countries without any added economic advantages. To address these challenges, the EvoFIBER project aims to develop sustainable solutions in dietary fibers by effectively managing and utilizing olive pomace. Initially, the project focuses on developing dietary fiber as an ingredient for the *B2B* market, following a circular bioeconomy model. Processed olive pomace contains approximately 60-65% dietary fibers, and over 70% unsaturated fatty acids (values equivalent to those found in olive oil). Moreover, it has demonstrated notable antioxidant activity and phenolic compounds. The innovation ecosystem of the project comprises three partners: Evowaste, the project's leading startup is responsible for ideation and biotechnological solutions; the University of Algarve, offering its facilities for pilot-scale product development and startup incubation; and the local olive oil producer, contributing raw materials for product development and serving as the main stakeholder in bagasse management services. This approach is expected to have a significant impact on sustainability and enhance the startup's competitiveness, particularly in the international market where there is a growing demand for high-quality solutions. The project aligns with the 2030 Agenda for sustainable development, specifically goals 9 (industry, innovation, and infrastructure) and 12 (sustainable production and consumption). The EvoFIBER project, with its innovative nature and overall objective of boosting the food sector in the Algarve region, is regarded as a catalyst for the local circular bioeconomy. Furthermore, our biorefinery concept can be adapted and replicated for other agri-food waste, extending its impact on various food sectors in search of innovative products.

Keywords
agri-food waste, dietary fiber, olive pomace, circular bioeconomy, biorefinery

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#263: Optimizing phycoerythrin extraction from *Porphyridium cruentum* for food films: pH and temperature effects and potential for intelligent packaging

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Porphyridium cruentum microalga is an abundant source of biologically valuable compounds, known for its nutritional and biological benefits, and produces phycoerythrin, a photosynthetic pigment responsible for its red color, normally used as a nutritional ingredient, fluorescent marker, or natural colorant. The main objective of this study was to study different extraction methods of phycoerythrin pigment obtained from *P. cruentum* and behavior in different pH and temperatures to be incorporated in food films. The microalgae biomass was separated by centrifugation from the supernatant, followed by lyophilization. An experimental design with three variables at three levels (time of extraction, ultrasound amplitude, and dilution) using water as solvent was employed, with phycoerythrin extraction as the response. The pigments were submitted in a buffer at pH 3, 7, and 12 and incubated at 4 and 25 °C. The ultrasound amplitude and sample dilution showed more influence on the pigment extracted, being recommended the maximum for these values (80%, 1:40 w v-1, respectively). However, the optimum condition tested without ultrasound presented less interference of other pigments, higher values of phycoerythrin extraction (7.65 and 9.05 mg g-1), and yield (19.13% and 22,63%). Both samples change color in different pH, being more noted when changing from neutral to acid conditions. This result was not observed when the temperature changed. The pigments were further used to make intelligent chitosan-based films where the pH difference in color was not achieved. Moreover, will be tested a pigment extraction with supercritical fluid looking to provide a pigment with a higher quality indicator to be incorporated into films.

Keywords

phycoerythrin, phycobiliproteins, ultrasound, extraction methods, smart packaging

#264: Assessing the viability of chitosan-based food packaging reinforced with cellulose nanofibers from *Salicornia ramosissima* agro-industrial waste for high-pressure processing

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This work aimed to evaluate and enhance the physical and mechanical performance of chitosan-based films reinforced with different loads of cellulose nanofibers (CNFs) obtained from *Salicornia ramosissima* agro-industrial waste, envisioning the development of sustainable food packaging (pouches). CNFs were obtained in a previous study, by an enzymatic method. The films were produced by solvent casting using different proportions of CNFs (1 and 2% w/w). As a control, chitosan-based film (without CNFs) was also prepared. Glycerol was used as a plasticizer. Subsequently, sealing tests were carried out to develop sustainable food packaging suitable for high-pressure processing (HPP). The increase in the CNFs levels reduced moisture content (46.5 ± 1.1% to 43.3 ± 0.6% and 36.7 ± 0.2%) and increased the solubility in an aqueous medium for control, CNF1% and CNF2% films (respectively) (17.4 ± 0.1% to 19.2 ± 0.1% and 18.6 ± 0.2%), and thickness (0.10 ± 0.02 mm to 0.18 ± 0.02 mm and 0.21 ± 0.03 mm). The control film was colorless and more transparent than the CNF-reinforced films. The increase in nanofiber levels increased tensile strength from 2.58 ± 0.27 MPa (control) to 3.27 ± 0.45 MPa (CNF1%) and 6.15 ± 0.17 MPa (CNF2%). The reinforced films also became stiffer than the control, increasing Young´s modulus from 0.10 ± 0.01 MPa (control) to 0.31 ± 0.03 MPa (CNF1%) and 0.58 ± 0.05 MPa (CNF2%). Meanwhile, the maximum elongation at rupture decreased from 26.3 ± 1.4% (control) to 10.5 ± 1.1%, and 10.8 ± 1.4% (CNF2%). SEM and TGA analysis of films showed that the reinforced films had a rougher surface. However, 1% of CNF was better incorporated into a chitosan-based matrix than 2%. ATR-FTIR spectra showed that CNF-reinforced films had a protective effect against UV-induced degradation. In the following steps, the behavior of the pouches and the interaction between packaging and food will be evaluated under HPP conditions of broad commercial interest for the food industry in the following conditions: 450 and 600 MPa, for 3 and 10 minutes at 5 and 25 °C. The work was successful in the recovery of the *S. ramosissima* ago-industrial waste. Furthermore, CNFs as a reinforcing agent improved the resistance of chitosan-based films, presenting good properties to turn them into sustainable food packaging suitable for HPP.

Keywords

food waste recovery, cellulose nanofibers, sustainable food packaging, high-pressure processing

Acknowledgements

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SESSION 3: SOCIETY ENGAGEMENT – SOCIETY AND FOOD INDUSTRY

Session 3: Oral presentations

FOODPathS towards sustainable outcomes

Hugo DE VRIES

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Globally, the United Nations Food Summit 2021 has underlined the need for jointly transforming food systems towards sustainable outcomes. In Europe, the Farm-to-Fork Strategy and the overarching Green Deal strive for reaching sustainable food systems in the coming decades. One of the new instruments is the Partnership in the current framework programme Horizon Europe. In the agrifood area, DG Research and Innovation of the European Commission – together with the Standing Committee on Agricultural Research (SCAR) Strategic Working Group Food Systems – are preparing the candidate Partnership Sustainable Food Systems (SFS)[1]. It's strategic research and innovation agenda (SRIA) will address (i) Change the way we eat, (ii) change the way we process and supply, (iii) change the way we connect and (iv) change the way we govern food systems of the future. Since the Partnership SFS is a very ambitious instrument, the European project FOODPathS develops the prototype Partnership thanks to 17 partners and 19 network organisations active in the public and private domains at local to global levels. Via inspiring case studies, the need for joint actions will be elucidated.

The SRIA will in particular be considered from sustainability-oriented food system approaches. Such approaches require deeper understanding of the complexity of diverse food systems (diversity, adaptability, circularity, scalability, *etc.*). Here, knowledge from complex systems sciences and principles from physics can be mobilized[2]. Even more, the use of such approaches supports the formulation of new research questions in the food science and technology (FST) domain. In addition, they allow linking FST with environmental, management, social and economic sciences. Examples will be discussed like the development of new circular business models for locally valorising and functionalizing bio-diverse co-products from the agri-food sector.

References:

[1]https://research-and-innovation.ec.europa.eu/system/files/2022-04/ec_rtd_he-partnership-sustainable-food-systems-april_2022.pdf

[2]See for example https://doi.org/10.1016/j.tifs.2022.03.027

Functional food and health: essentiality of human evidence

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Starting from 1980 when the term "functional food" was developed, research on the identification and on the role of food to modulate key aspects of body's physiology and to decrease risk factors for degenerative diseases increased exponentially. Accordingly, the term functional food has been object of a massive communication from media and social network, becoming widely popular for general audience, modifying dietary habits of consumer.

According to EFSA, the term functional food refers to "a food, which beneficially affects one or more target functions in the body, beyond adequate nutritional effects, in a way that is relevant to either an improved state of health and well-being and/or reduction of risk of disease". As for any diet or food item, the final target is the human being, with his complicated and fascinating physiology, aiming to optimize resistance to stressors and exogenous threat, preserving wellbeing.

The efficiency of a food strictly depends on the process of digestion, absorption, metabolization of the ingested molecules as well as the process of eating is tightly linked to human physiology and immunity for better or for worse. Last but not the least, a higher efficiency of functional foods take place when there is an alteration of the physiological homeostasis, such as in presence of oxidative/inflammatory stress, dysbiosis *etc.* In this picture is obvious how human studies, represents the optimal model to understand the functionality of a food and to deliver public health recommendations. The Lecture will focus on the importance of **strengthening human-based evidence** and on practical aspects of eating, the **"real life" settings,** to significantly improve scientific-based evidence about the association between diet and wellbeing. It will be emphasized the key role of modulating the oxidative and inflammatory post-prandial stress and the increasing importance of chrono-nutrition in order to avoid the raising of CVD risk factors. Accordingly, communication for non-scientific audience based on solid human evidences, will allow to deliver simple and scientific-based message to the consumer, for efficient and practical applications in real life, aiming to wellbeing and reducing the risk of degenerative disease in humans.

The 3 pillars of future protein production: Plant-based, cultivated, and fermentation-made meat, eggs and dairy

Stella CHILD

The Good Food Institute Europe ASBL, Brussels, Belgium

This talk will cover the need for alternative proteins to sustainably feed the world by 2050, and the key role of plant-based, fermentation-made, and cultivated meat to enable this transition. It will provide an overview of the present commercial and investment landscape in the alternative protein sector, including insights on trends and drivers. The talk will outline scientific and industrial challenges as identified through a market-shaping analysis, whitespace ideation, and interviews with more than 150 experts across the alternative protein field, and it will describe some high-leverage opportunities for innovation along the sustainable protein value chain. Finally, a potential path forward for research and training as a backbone for this growing industry will be proposed.

Keywords
innovation opportunities, plant-based, fermentation-made, cultivated meat, sustainable proteins

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Are you ready for the future of dairy alternatives?

Catherine BAYARD

Global product manager Plant Attitude Dairy, Givaudan Naturals, France

Global warming, pandemics, and economic and political crises have put strong pressure on world exchanges and the global food supply. In this dynamic environment, consumers are more conscious than ever that their food has a tremendous impact on their health, but also on the world that they will leave to their children and grandchildren.

At Givaudan, we're supporting food system transformation by working with our customers and partners to create more diverse food choices and in turn, to help drive the global transition to more mindful diets.

This transformation is already well underway. The global dairy-free market is expected to reach US 62 billion by 2030. In addition, more than 40% of non vegan consumers in the EU have stated that they would like to reduce their consumption of meat and dairy products and try alternatives.

Despite this strong consumer willingness, market adoption remains limited and fragmented. Although the global milk alternatives segment already represents 9% of the total milk market, it is only 0.5% for cheese analogues, for example.

The consumer experience with dairy-free products is critical, and current market products don't deliver on taste, texture or functionality requirements well enough to enable alternatives to dairy to become more mainstream. Manufacturers are aware of these key challenges; however, even where solutions exist, it's difficult to compete with all aspects of dairy products in a plant-based milk or yogurt and offer the same food experience.

Indeed, versatility of sources, inherent plant characteristics and off-notes, as well as nutritional propositions, are multiple elements to consider when it comes to selecting the right sources and ingredients to develop winning consumer products.

But how can this market evolve toward 2030? Givaudan's research with the foresight agency, Synthesis, has deep dived into future scenarios for the alternative dairy market. Consumer habits, technological advancements, the political and regulatory context, and environmental factors will play a key role in facilitating greater market adoption and ensuring the alternative dairy movement continues to evolve toward 2030.

Let's work together to prepare for the future, create alternative dairy experiences that meet consumer needs, and drive the transition to more mindful diets.

#149: Unexpected events in food production are the new normal? Results of an industry survey for highlighting factors, which influence resilience in food production and food value chains

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Due to the multiple events that have taken place in the last couple of years, the food industry has been faced with the challenge of sustaining its production. Resilience is defined as the ability of food production entities or food value chains to respond to, survive and learn from disturbances and crises. The focus of this survey was to gain insight into the current challenges and influences on the resilience of food supply systems. The survey was submitted to stakeholders of different food supply chains.

The survey included questions on the business field of the companies, estimation of the influence of various causes of disturbances and measures to increase resilience. Respondents could select from the following categories for the causes of disruption: i) technical factors, ii) organizational factors, iii) human factors, iv) turbulences v) economic factors and vi) environmental factors.

The results show that most companies estimate that they are not well prepared for disruptive events and with great need for action to improve resilience. 84 companies mainly from primary food production and food processing/packaging participated in the survey. Among others, organizational factors, such as the company's production capacity or the availability of raw materials were named as particularly influential by almost all. More than 60% of the producers and more than 80% of the processors affirmed that they wanted to make investments to improve resilience. Which topics are particularly in focus will be presented.

In summary, the survey reveals factors that have an influence on the resilience of primary food production and food processing/packaging and what needs arise from it. To address the demands in a targeted manner, a concept for assessing resilience will be presented. It supports the identification of vulnerabilities and the comparison of different system configurations in the areas of i) resilience management, ii) financial management, iii) production and machinery, iv) building and facility management, v) Human resources and training and vi) procurement, storage, packaging, and transport.

Keywords
resilience survey, raising resilience, food production, food safety, security and resilience

#162: The use of blockchain systems to ensure sustainable global food safety and security: A review

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As the world population increases, the demand for food continuously increases. Good production and manufacturing practices and proper storage conditions help minimize food spoilage and waste. Drought, limited agricultural lands, climate change, *etc.* are the major threats for food supply. Agricultural applications and food industry use high amount of water and energy resources. Different problems are encountered in the supply chain, like the inability to provide appropriate storage conditions or shipment disruptions as we have just experienced in COVID-19 pandemic. In addition, food products that are stored in unfavorable conditions can pose a health risk. Contaminations of food with microorganisms and/or their toxins can cause foodborne diseases. Due to eating contaminated food, approximately one in ten people worldwide fall ill with symptoms ranging from diarrhea to cancer. Foodborne diseases also cause economic losses due to the treatment costs and destruction of the market.

Digital and smart technologies seem promising for combating these problems. These technologies can enable efficient use of the resources, thus reduce waste and carbon footprint. Information technologies make agricultural practices and food production processes more traceable and controllable. The digital mechanisms used in these technological systems can identify potential risks and make preventive recommendations.

There is a need to develop effective food production and monitoring systems in order to identify foodborne contamination, improve food safety systems, and provide supply-demand balance. Recently, various digital technologies have been tested in agri-food applications in order to ensure the sustainability and safety of food. Among them, blockchain is one of the technologies that can be used in the establishment of monitoring systems. When the blockchain is integrated with the supply chain, critical information such as the best/use before date of the product and the present storage conditions can be monitored remotely, and this traceability contributes to the improvement of food safety. In this study, the current applications of blockchain technology in the agriculture and food industry are evaluated and the potential advantages and challenges are discussed.

Keywords
food safety, food security, blockchain

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#122: Transition of food systems, a diversity of expectations

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Agricultural activities and food systems (FS) impacts require urgent and significant reduction of their negative externalities (IPCC, 2019, Cartron et al., 2020). This urgency is reinforced by the fact that the current functioning of FS contributes to reducing our future capacity to feed humanity healthily (Tilman and Clark, 2015). In order to frame the actions to be taken in this direction, it seems important that the different stakeholders of these FS agree on the transition objectives to be pursued. The definitions of sustainable FS proposed by institutional actors (e.g. the FAO or Ademe in France) share a holistic dimension that is not very operational. Researchers approach the transition objectives of FS from often different and potentially contradictory angles (Béné et al., 2019). How do citizens' expectations fit into these frameworks? It is to a better understanding of this subject that this work intends to contribute.

The study is part of the French Projet Alimentaire Territorial (PAT) of the Plaine aux Plateaux (supported by the association Terre & Cité). The PAT brings together 77 municipalities in the agglomeration communities of Paris-Saclay, Versailles Grand Parc, Saint-Quentin-en-Yvelines and the Plaine de Versailles. We wanted to highlight the expectations of the inhabitants of this territory by distributing a questionnaire in six parts: 1. Choice of supply practices and consumption habits 2. Characteristics of sustainable food 3. Evolution of food practices 4. Availability of sustainable food 5. Perceptions and involvement of respondents in their territory. The testimonies of 789 inhabitants and users of the territory were collected. This study was carried out during the year 2022.

The results show that consumers associate sustainable food mainly with local food and organic farming. We will present will allow us to compare the expectations of these users with the normative definitions proposed by institutions and researchers and to ask the questions that these differences raise for the transformation of our food systems.

Keywords
sustainable food, citizen expectation, short food system

Acknowledgements
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Session 3: Poster presentations

#26: Dietary exposure of Koreans to fumonisins: Comparison by age in the Korean total diet study

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Mycotoxins are natural toxins defined as secondary metabolites produced by fungi species which can cause severe adverse health effects in humans and animals. Fumonisins are one of the mycotoxins produced by Fusarium species. In protecting the population from the health risk of mycotoxins, dietary exposure assessment of mycotoxins is an important component.

Hence, we attempted to estimate the exposure to fumonisin B1 (FMB1) and fumonisin B2 (FMB2) as a part of the Korean Total Diet Study (KTDS) in 2022. A total of 1,446 samples (241 'food x cooking method' pairs) were analyzed using the isotope-labelled internal standards and LC-MS/MS. Exposure to fumonisins was estimated based on the fumonisins content in samples and corresponding food intake data and bodyweight of individuals from the Korea National Health & Nutrition Examination Survey (2016-2020).

Mean exposure of the Korean population to FMB1 and FMB2 varied from 0.1243 to 1.0243 ng/kg bw/day and from 0.0015 to 0.0401 ng/kg bw/day in different age groups, respectively. Also, the mean exposure of the Korean population to total FMs was 0.3315 ng/kg bw/day, which corresponds to 0.02 % of the tolerable daily intake of total FMs (1.65 μg/kg bw/day).

This study revealed that the Koreans' dietary exposure to fumonisins is unlikely to be of health concern.

Keywords
TDS, fumonisins, dietary exposure, LC-MS/MS

Acknowledgements
This research was supported by a grant from the Ministry of Food and Drug Safety of the Republic of Korea in 2022.

#27: Dietary exposure of Koreans to fumonisins: Comparison between two approaches of 'Non-Detect' handling in the Korean total diet study

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Estimation of the dietary exposure to mycotoxins is important for the food safety control. In traditional exposure assessment, low bound (LB, 0), middle bound (MB, 1/2 LOD), and upper bound (UB, LOD) has been used to handle the 'non-detect' (ND) data. However, this tends to result in the unrealistic over-estimation of exposure when LOD is high and/or many samples have ND values. Since we found many ND samples for fumonisins in the Korean Total Diet Study (KTDS), we adopted a 'hybrid approach' (HA), suggested by US EPA, and compared the results with that of traditional approach (TA). In HA, among the samples with ND, only those with the known history of detection in recent years are handled in the same way with TA. In this study, 'known history' was determined based on 1 or more detection in 30 samples analyzed during last 5 years (2018 through 2022) in KTDS for each 'food x cooking method' pair. A total of 241 'food x cooking method' pairs (1,446 analysis samples) were analyzed using the two isotope-labelled internal standards and LC-MS/MS. Exposure to fumonisins was estimated based on the fumonisins content in 2022 KTDS samples and corresponding food intake data & bodyweight of individuals from the Korea National Health & Nutrition Examination Survey (2016-2020). Mean exposure of Koreans to fumonisin B1 and B2 using MB for ND were 8.5078 and 11.6867 ng/kg bw/day by TA and 1.5608 and 0.1799 ng/kg bw/day by HA, respectively. The hybrid approach resulted in much lower and realistic exposure values compared with TA.

Keywords

dietary exposure, fumonisins, hybrid approach, total diet study

Acknowledgements

This research was supported by a grant (Korean Total Diet Study) from the Ministry of Food and Drug Safety in 2022.

#96: Impact of environments on *Staphylococcus aureus*: insights into adaptation, virulence, and antibiotic resistance

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Staphylococcus aureus is a major opportunistic pathogen and is the first cause of food poisoning worldwide. It can be found in many environments like human, animal hosts, hospitals, food, or water. Methicillin-resistant S. aureus (MRSA) is the major cause of nosocomial severe infections. This study aimed to evaluate the impact of adult bovine serum and row cow milk host environments, on S. aureus USA300 (MRSA strain) and its mutant ΔfabD. ΔfabD mutant cannot synthesize fatty acids but can survive in lipid-rich environments by utilizing external fatty. We show that the membrane fluidity, envelope thickness, permeability, fatty acid composition and pigmentation of S. aureus differ depending on the environment. We also observed that the environments modified S. aureus resistance to oxidative stress and the bactericidal action of antibiotics. Moreover, we found a strong correlation between pigmentation and strain virulence. Together, our data pointed out that a given environment induces adaptation of S. aureus, which must be considered to develop efficient diagnostics and treatments and improve food safety.

Keywords
microbiology, food security, *Staphylococcus aureus*, detection

#106: A sustainable innovation framework to rebalance agri-food value chains

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Until recently approaches to the agri-food system focused on narrow segments of the overall value chain. Ploutos takes a systems-based approach looking at the overall impact of changes at any point in the value change, thereby enabling a more comprehensive and in depth understanding. The main objective of Ploutos project is to help re-balance the agri-food value chain and enhance its sustainability (economic, environmental and social). This is achieved by creating a Sustainable Innovation Framework, powered by an innovative combination of behaviour change, collaborative business model innovation and data driven technological services. A total of eleven (11) Sustainable Innovation Pilots (SIPs) were launched, engaging more than twenty six (26) agri-food value chains across thirteen (13) different countries.

During the implementation of the project, several significant achievements have been made. A representative example comes from SIP1, which takes place in Greece and focuses on "Supporting a frozen fruit value chain composed of small farmers". The engaged value chain actors managed to reduce up to 70% irrigation water consumption and up to 39% production costs through the use of smart farming solutions. Another exemplary SIP with significant results is SIP9, which is located in Serbia and North Macedonia and focuses on the management, redistribution and rescue of surplus food. More than 50 donations were made so far and a total of 78960 kg of food was redistributed to food donation recipients. In addition, SIP3's social contribution related to empowering consumers through crowdsourcing to take back control of their food and create healthy, sustainable and fair products, managed to support more than 500 farmers' families living in rural areas, who will take over in the production of these products.

Keywords
behavioral innovation, sustainability oriented innovation, agri-food value chain, data-driven innovation

#123: School canteens as a transformation lever for more sustainable food systems?

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French public policies consider school catering as a lever for agricultural and food transitions because of its purchasing power. Some of the objectives of the French EGalim law are to contribute to this goal.

In particular, this law supports the development of more sustainable food for school canteens, with at least 20% of the products purchased having to be organic. However, the impact of these organic products on the organization of these canteens is still poorly known.

The study presented was conducted between March and August 2022 in three French territorial areas. Two of them were highly urbanized areas, the third being a more agricultural area. Some of the canteens studied were self-managed, while others were contracted to catering companies.

The approach was qualitative and based on interviews with canteen managers, cooks and local elected officials. The choice of actors interviewed was based on the distribution of responsibilities retained by each canteen. In addition to these actors, interviews were conducted with food suppliers. The study covered 10 canteens, 18 interviews with canteen stakeholders and three interviews with suppliers.

The analysis of the results obtained shows contrasting situations. The extent of the introduction of organic products, the place occupied by local procurement and the structure of the canteen supply chains lead to a diversity of intensity of organizational changes.

In some cases, major changes affect the operation of the canteens, particularly because of a challenge to the conventions for defining product quality. The acceptance of products that would be refused on traditional channels leads to the redesign of certain organizational modes. In other cases, our results seem to show that the impact of the organizational transformation is relatively weak and that the changes introduced into the organization of the canteen seem to be associated mainly with the additional costs that these supplies generate. These contrasting situations raise questions about the extent and depth of the ecological transitions implemented.

Keywords
canteen, sustainable food, short food system, organic food

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#183: WASTELESS-Waste quantification solutions to limit environmental stress

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European Union generates around 88 million tons of food waste every year, at an estimated cost of €143 billion (FAO, 2011, 2019) with huge negative impacts on society, environment, and economy. The Commission is committed to halving per capita food waste at retail and consumer levels by 2030 (SDG Target 12.3). The approach is the Farm2Fork strategy, at the hearth of the European Green Deal priorities.

WASTELESS project rises at the HORIZON-CL6-2022-FARM2FORK-01 call - fair, healthy and environmentally friendly food systems from primary production to consumption. Its main objectives are: (1) to develop and test a mix of innovative tools and methodologies for Food Loss and Waste (FLW) measurement and monitoring, (2) to recommend a harmonised methodological Framework for FLW quantification, and (3) to develop a decision support systemic Toolbox targeting all food value chain stakeholders. Additionally, WASTELESS will carry on research activities concerning innovative processes and streams to valorise unavoidable FLW.

WASTELESS multidisciplinary consortium is led by UTAD (Vila Real, Portugal) and counts with 17 partners from 14 countries: Austria, Belgium, Czech Republic, Denmark, Estonia, France, Greece, Hungary, Italy, Portugal, Slovenia, Spain, Switzerland, and Turkey. WASTELESS will run for 36 months and is divided in 9 work packages distributed according to the project methodology by dimension (harmonised framework, integration, tools and methodologies) and project step (evaluation of current limitations, development, testing, final development and replicability across EU FSC).

WASTELESS is expected to contribute, by the end of the project, to the Food 2030 priorities on: climate and environment, by providing digital tools for better measurement of FLW and establishing better prevention policy actions and business strategies,; circularity and resource efficiency, by bringing added value for higher circularity of food systems (development of novel food and feed products and the enrichment of the FoodEXplorer platform) on local levels, exploited on larger regional and EU scale; innovation and empowerment of communities, by providing open access to all research outputs and by establishing multi-actor collaboration outside of the partner's consortium.

Keywords
farm2fork, food loss and waste, measurement, monitoring, circularity

Acknowledgements
WASTELESS has received funding from HORIZON-RIA under Grant Agreement No. 101084222.

#215: Cyanotoxin removal from water using different types of adsorbent materials.

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There are many contaminants in water that can damage the health of people and animals, such as naturally occurring cyanotoxins, which have increased their presence in recent years due to climate change and eutrophication. Although water must be directed to a treatment station before consumption, there is still no method that can eliminate 100% of the cyanotoxins present in the water. Therefore, cyanotoxins are a threat to public health, since they can produce hepatotoxicity or neurotoxicity in people. To mitigate this problem, a complementary method for toxin removal is investigated which consists of using nanostructured beads with a magnetic core coated by an adsorption material. Different adsorption materials have been evaluated: activated carbon, mesoporous carbon, graphene and chitosan.

The experiments have been carried out by keeping each type of particle in contact for 120 minutes with a known concentration of each of the toxins evaluated. The adsorption effectiveness of microcystin-LR, cylindrospermopsin and anatoxin-A, several of the most abundant toxins in Europe, were studied. Subsequently, the influence of water pH in adsorption of each toxin was evaluated as well. The amount of toxin was quantified using ultra-high-performance liquid chromatography coupled to tandem mass spectrometry (UHPLC-MS/MS).
The results show that activated carbon and mesoporous carbon are the most effective materials to capture cyanotoxins from water. This effectiveness could be owed to the pore size of the adsorbent material, since mesoporous carbon is more effective in removing higher molecular weight molecules and activated carbon with smaller ones. In addition, adsorption effectiveness is influenced by water pH, which is probably due to electrical charges.

In conclusion, the use of magnetic beads coated by activated carbon or mesoporous carbon can be an effective method of removing cyanotoxins from water and improving drinking water safety, although more studies are needed to evaluate this effectiveness in other cyanotoxins.

Keywords
cyanotoxin removal, magnetic beads, drinking water safety

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#217: Mesoporous carbon, microcystin adsorbent characterization and *in vitro* toxicity

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Microcystins are toxins which belong to the group of cyanotoxins. They are drinking water contaminants, which have increased their concentration and frequency of appearance in recent years, due to climate change and eutrophication. They can entail serious danger to people and animals' health, as they are hepatotoxic substances. Although water Is routinely treated before consumption, current water treatment methods can not completely eliminate cyanotoxins present in water. In this study removal of several microcystins through adsorption to mesoporous carbon-magnetic nanostructured material was evaluated. Regeneration of the material with solvents for further use was also tested, as well as potential *in vitro* toxicity in cell cultures.

On the one hand, adsorption experiments were performed by keeping in contact mesoporous carbon magnetic beads with 7 different microcystins for 120 minutes. Toxins were quantified using ultra-high-performance liquid chromatography coupled to tandem mass spectrometry (UHPLC-MS/MS).

Mesoporous carbon magnetic beads have acceptable effectiveness eliminating microcystins from water, maybe due to their large pore size, which permits adsorption of toxins with a high molecular weight. Desorption studies with acetonitrile and methanol were made as well.

On the other hand, *in vitro* toxicity was evaluated with two cell lines, CAKI-1 cells (human renal proximal tubule cells) and SH-SY5Y cells (human neuroblastoma cells). Milli-Q water kept in contact with mesoporous carbon beads for extended periods of time was added to cultures of both cell lines. No *in vitro* toxicity was observed in the cell lines evaluated.

In conclusion, mesoporous carbon is a good material to adsorb microcystins of water and improve public health, since it allows to remove several analogues of the microcystin class from contaminated water and it is not toxic in the cell lines studied. However, more *in vitro*, *in vivo* and adsorption studies are needed to further characterize and use this water treatment method.

Keywords
microcystin removal, mesoporous carbon, magnetic beads, drinking water safety

Acknowledgements
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#260: Wise Frami Food - Digitalization of Frami Food Lab at Seinäjoki University of Applied Sciences Finland

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Wise Frami Food is an ERDF funded project focusing on digitalizing Frami Food Lab, the teaching environment / Living Lab located at Seinäjoki University of Applied Sciences in Seinäjoki, Finland.

Wise Frami Food projects stems from a need to make the regional agrifood sector more resilient after corona and to enhance the capabilities of regional companies to rise to the challenges presented by Food 4.0. Digitalisation of Frami Food Lab and open data streams from different analysis equipment will help agrifood sector competitiveness.

Wise Frami Food project has five work packages. First, the project consists of making a zone of trust between various stakeholders. Based on feedback from stakeholders and research made the project will identify proper technologies and acquire them as needed and integrate them to Frami Food Lab. In the last phase the ready made demonstration and pilot environment will be put into practice to benefit the digital transformation of regional business. Wise Frami Food will make a permanent digital demonstration environment and data warehouse based on open source technologies and principles.

Companies and business can use Wise Frami Food as an example and starting point when developing systems for their own needs and for networking purposes to other stakeholders and officials. Because Wise Frami Food will be open, it will be possible to base development on the findings of the project. Measurement and analysis data can be accessed and used as a base for research and development purposes. The accessibility of various digital systems will be significantly better for SMEs.

The presentation will highlight the project activity in digitalizing an existing two phase lab homogenizer with a IoT development board which logs the pressure measurement data and stores it in an Influx database. Data can be viewed from a Grafana dashboard and exported as needed for further analysis.

Keywords
IOT, ERDF, digitalization, grafana, living lab

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Sustainable aquaponics farming system for local food production

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Aquaponics combines aquaculture (fish farming) and hydroponics (soilless plant cultivation) in a closed-loop system using locally sourced materials and solar energy. This sustainable food production system has the potential to minimize the environmental impact of food production while providing fresh, locally grown produce. By recirculating nutrient-rich water from fish farming to nourish the vegetables, aquaponics reduces reliance on synthetic fertilizers while promoting sustainable agriculture.

The initiative aims to establish a solar-powered aquaponics system using local materials, fostering sustainable fish farming and diverse vegetable production. By addressing poverty and hunger through employment opportunities and affordable goods, we aim to enhance community well-being. The expected outcomes include a resilient aquaponics farming system that ensures a consistent supply of high-quality vegetables and strengthens short food supply chains. Through socioeconomic analysis such as the input-output model, we will assess scalability, socio-economic impact, and promote gender equality in aquaponics farming. This endeavor aims to cultivate sustainable communities and empower their growth.

The fish that will be grown are *Chanos chanos, Oreochromis niloticus, Clarias* spp. and other endemic freshwater fish in Cebu, Philippines, while the vegetables include pechay, okra, kamote tops, beans, onions, squash, and other vegetables that are part of the Philippine diet.

The initiative contributes to the next generation of food research, education, and industry by showcasing innovative aquaponics. It establishes a local food production system, supporting community resilience and self-sufficiency. Integration of renewable energy aligns with sustainable advancements in the food industry. Community involvement, education, awareness, and collaborations ensure inclusivity, knowledge exchange, and collective impact.

In conclusion, this initiative advances food system innovation, sustainability, and social empowerment. It promotes local ownership, environmental stewardship, and access to fresh, locally grown produce. By addressing future food system challenges, it contributes to a more sustainable and resilient local food system in Cebu, Philippines.

Keywords

aquaponics, aquaculture, hydroponics, short food supply chain (SFSC), local food systems

INVITED SPEAKERS

CATHERINE BAYARD

Givaudan Naturals, France

STELLA CHILD

Good Food Institute Europe, Belgium

HUGO DE VRIES

INRAE, France

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GILLES TRYSTRAM

AgroParisTech, France

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7th International ISEKI-Food Conference

The general aim of the ISEKI-Food conference series is to contribute to the creation of an "open" international forum for researchers, education scientists, technologists and industry representatives, as well as food consumers, to promote constructive dialogue and collaboration on topics relevant to Food Science and Technology, Industry and Education and to present and disseminate the results of the activities developed by the ISEKI-Food network projects.

The topic of the 7th ISEKI-Food Conference was "Next-Generation of Food Research, Education and Industry". The conference focused on future challenges in **education** on food science and technology, in **research** activities related to production, processing, quality and safety, packaging of foods and in **societal engagements** in the field.

www.iseki-food2023.isekiconferences.com

ISEKI Conferences

1st ISEKI-Food Conference, 10 - 12 September, 2008, Porto, Portugal
2nd ISEKI-Food Conference, 31 August - 2 September, 2011, Milan, Italy
3rd ISEKI-Food Conference, 21 - 23 May, 2014, Athens, Greece
4th ISEKI-Food Conference, 6 - 8 July, 2016, Vienna, Austria
5th ISEKI-Food Conference, 3 - 5 July, 2018, Stuttgart, Germany
6th ISEKI-Food Conference, 23 - 25 June, 2021, Online
7th ISEKI-Food Conference, 5 - 7 July, 2023, Paris, France

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