Bridging Training and Research
for Industry and the Wider Community

6th International ISEKI-Food Conference

"Sustainable Development Goals in Food Systems:
Challenges and Opportunities for the Future"

BOOK OF ABSTRACTS

23 – 25 June, 2021
ONLINE

6th International ISEKI-Food Conference

Sustainable Development Goals in Food Systems: Challenges and Opportunities for the Future

BOOK OF ABSTRACTS

Editors

Margarida Vieira, Paola Pittia, Cristina L.M. Silva,

Florence Dubois-Brissonnet, Rui Costa

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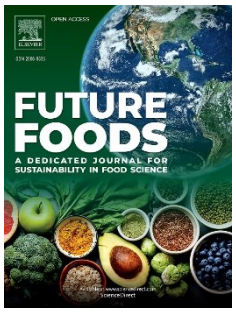

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PREFACE

The general aims of the ISEKI-Food conference series are to contribute to the creation of an "open" international forum for researchers, education scientists, technologists and industry representatives as well as the wider society, to promote a constructive dialogue and collaboration on topics relevant to research, industry and education in the agri-food sector for the benefit of our society.

The 6th ISEKI-Food Conference, planned in July 2020 in Cyprus, due to COVID-19 pandemic has been postponed to 2021 and held as an online event**.** The title of this 6th conference edition is "***Sustainable Development Goals in Food Systems: challenges and opportunities for the future***".

The 2030 Agenda for Sustainable Development issued by the United Nations and its 17 Sustainable Development Goals (SDGs) call all actors of our society to commit, at all levels, to identify, develop and apply appropriate actions to contribute to the main societal and environmental issues. Development and innovation strategies are required to sustainably increase agricultural and food production, improve global supply chains, decrease food losses and waste, diminish environmental impact, save energy and ensure nutritious and safe food for all worldwide. The food system represents a key strategic approach in achieving the SDGs thanks to its intrinsic inter-disciplinarity and involvement of social, political, cultural, technological, economic and natural environments. Sustainable food systems, including production and consumption, must be pursued from a holistic and integrated perspective. Thus, there is a main need to promote a wide and constructive discussion on the current status and achievements of the SDGs among all the stakeholders of the food system.

The 6th International ISEKI-Food Conference consists of three main sessions dedicated to Education, Research and the Wider Community hosting oral and poster presentations on innovative practices, researches, methodologies, projects, programmes and other initiatives aimed at implementing the 2030 Agenda for SDGs.

196 abstracts, submitted from all over the world, were reviewed by members of the Scientific Committee. 59 oral (10 invited) and 123 poster presentations were selected and assigned to the following Sessions:

- **Education** – *Facing challenges in education for a globalised and sustainable world.*
- **Research** – *Sustainable Systems for High Quality, safe and healthy foods*, including parallel sessions on: New technologies, Minimising losses in food production, Valorisation of postharvest losses and food wastes, Food Risk assessment and Food safety, New products for a sustainable diet.
- **Societal Engagement** – *Sustainable development goals: good practices and the way forward.*

In this book, the abstracts of the presentations delivered at the **4th International PhD Workshop** are also included.

The 6th International ISEKI-Food Conference Scientific and Organizing Committees thank all conference attendees for their participation and their active contribution.

Greatly appreciated is also the help and valuable contribution of all members of the Organizing Committee, the Scientific Committee and the Industry Advisory Committee.

On behalf of the Organizing and Scientific Committee

Paola Pittia, Cristina L. Silva, Florence Dubois-Brissonnet

Margarida Vieira, Rui Costa

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SESSION 1: EDUCATION – FACING CHALLENGES IN EDUCATION FOR A GLOBALISED AND SUSTAINABLE WORLD

Session 1: Oral presentations

Teaching the SDGs in Higher Education: The example of Production and Consumption

Aravella ZACHARIOU

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The current presentation focuses on the role that education encompasses, and more particularly, to the importance of Higher Education in achieving the Sustainable Development Goals (SDGs), with emphasis on SDG 12 "Sustainable Consumption and Production" (SCP). The aim of the presentation is to address the complexity and connectivity of SCP with the other SDGs, while seeking to discuss and examine more critically, the factors that can contribute to its effective integration in Higher Education Institutions' (HEIs) structures and programs.

Issues, regarding the contents and the learning outcomes of SCP in HEIs courses, as well as the competences and the pedagogy for SCP are analyzed. The aim is to suggest specific proposals in HEIs for SCP, acknowledging that HEIs are organizations that promote learning, research and innovations and they have a significant impact on the way in which future generations are dealing with social challenges.

Particular attention is given a) to change on the dominant culture of the HEIs, in relation with the SCP, on the basis of Whole Institution Approach, b) to the need for re-orienting the courses from discipline-based courses to interdisciplinary, "open" and flexible programs for the SCP, c) to the importance for reformulating the teaching for SCP from knowledge- based to competence- based approaches and d) to the necessity for creating transformative learning environments and pedagogies that empower learners to make environmentally and ethically sound decisions and to take informed and responsible decisions and actions on SCP.

Keywords
Sustainable Development Goals, Education for Sustainable Development, Sustainable Consumption and Production, Higher Education

#265: Using Learning Analytics to Enhance Course Design in undergraduate food science and technology

Vusi MSHAYISA

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No one could have anticipated the urgent need we faced to transition to remote teaching and learning due to the COVID-19 pandemic. This major disruption forced many institutions in South Africa and globally to make a massive paradigm shift to their approach to teaching and learning (T&L) with most courses embracing online spaces. Course analytics reports derived in Blackboard (MyClassroom) provide vital information for reflection on the effectiveness of course design. This presentation will highlight a case study on how the reports, namely, Overall Summary of User Activity, Course at-a-Glance, Activity and Grade Scatter Plot and Activity Matrix reports were used to evaluate the relationship between assessment activities, student online behaviour and the students' learning performance in an undergraduate Food Science and Technology. The use of course analytics provides lecturers with a means to meaningfully evaluate their pedagogical practices or newly implemented teaching practices, in a context where it is becoming increasingly difficult to monitor student progress through personal contact. This approach supported processes to monitor and assist at-risk students towards learning improvement and may provide other universities with a path toward an information systems curriculum that is more in tune with the emerging big data world.

Keywords
Learning analytics, Learning management system, Course at-a-Glance, Food Science and Technology, COVID-19 pandemic

#226: Integrating open-access interactive digital resources to support face-to-face sessions and improve students engagement and learning

Valérie CAMEL[1], Marie-Noëlle MAILLARD[2], Mathieu CLADIERE[1], Gérôme FITOUSSI[1], Isabelle BILLAULT[3], Cécile DUMAS[4], Cécile SICARD-ROSELLI[3], Emilie BRUN[3], Jonathan PIARD[4]

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Digital media offer attractive features to complement traditional instruction method as well as lab work sessions. They also give an opportunity to engage students in learning and to complement their training. With this in mind, about ten professors team has developed an interactive website thanks to a funding of the Paris-Saclay University in order to providing attractive pedagogical digital resources in support of face-to-face sessions, especially wet lab practical sessions. The website opened in 2016, with an extended version available since 2019 both in English and French. It is unique, featuring an attractive design and gathering interactive digital educational resources related to chemical analysis, with a great diversity of media (scientific content, short videos, interactive schemes, pictures, games, quiz and exercises).

The CHIMACTIV website (*chimactiv.agroparistech.fr*) covers a broad range of techniques and applications, with 30 autonomous sheets classified in five topics: safety in a chemistry lab, basics of lab experiments, drug analysis, food analysis and experimental methodologies. It offers many interesting features for both teachers and students, especially for those concerned with food science and analysis. It is also of great interest for lifelong training, such as chemists who want to recall some theoretical notions combined with good laboratory practice.

All resources are in open-access with responsive character allowing their consultation on any digital support (including smartphone), thereby offering a broad diversity of teaching and learning usages. According to our user experience, different teaching-learning scenarios may be created and proposed in line with the pedagogical intention of the teachers. Several examples are presented and discussed, along with data relative to students' engagement and teachers' satisfaction.

Keywords
digital tool, blended learning, computer supported learning, lab work, engagement

Acknowledgements
The authors acknowledge the Université Paris-Saclay for its funding.

#248: Facilitator Reflection on online Action-learning

Line LINDNER, Christoph KNÖBL, Katherine FLYNN

ISEKI-Food Association, Vienna, Austria

Reflection workshops are an integral part of action-learning because they bring valuable insights on the educational activity and feed into the improvement of learning methodology; learning sources and tools; assessment methods and the role of the facilitator(s). Two reflection workshops following the action-learning FoodFactory-4-Us international online student competitions in 2019 and 2020 brought together 2 and 5 facilitators, respectively, for half day online reflection workshops addressing quantitative and qualitative aspects of the 4.5 month online competition course. A third workshop in March 2021 will have 3 facilitators follow the same methodology. The facilitators assessed the transition to action-learning based on facilitator activities: the shift from teaching to learning and from knowledge to competence. They used a Likert scale of 1 to 10 to individually rank the shifts from (1) lecture hall to a diversity of learning arenas; (2) lecturing to peer learning; (3) syllabus to supporting literature/a variety of learning sources; (4) written exam to a variety of assessment methods; and (5) lecturer to learning facilitator. Average rankings indicated that (4) shift to a variety of assessment methods and (5) role of the facilitator were the highest rated, 8.6 and 7.4, respectively. Facilitators also wrote responses to reflective questions on what could further push the shift to action learning and specifically how this could be accomplished. A discourse analysis was carried out through inductive coding of these qualitative data using NVIVO 12 software to produce a word cloud indicating the most commonly used phrases. Interaction among teams, and learning methods fostering interaction and collaboration across teams were the improvement factors most frequently stated. Most commonly stated methods were to actively facilitate questions during online trainings and to move further away from typical webinar formats where linear learning prevailed. Reflection workshops have become an integral part of FoodFactory-4-Us online competition cycles providing valuable insights into the planning of these ongoing competitions.

Keywords
action-learning, reflection, facilitators, action-research

Acknowledgements
This work was funded by the NextFood project (Horizon2020 European Union, Grant Agreement No 771738).

#353: The ASKFOOD Permanent Observatory on education and skills: a new tool to promote innovation in education and training in the agro-food sector and to boost innovation and competitiveness of the food system

Paola PITTIA[1], **Gerhard SCHLEINING**[2], Germana DI FALCO[3], Line LINDNER[2], Foteini CHRYSANTHOPOULOU[2]

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Future global scenarios to 2050 highlight the increased complexity of the food system along with the stakeholders and policy makers that need to be involved to allow a systemic development of a sustainable and modern knowledge-based society. A better interplay and cooperation among the food and food-related sectors is thus necessary both to tackle the emerging challenges, and to catch common opportunities in the job market and thus to lead to further development and innovation in the food sector.

Thus, Higher Education (HE), a pillar with research and industry of the innovation model, needs to promote a paradigm shift and a new educational eco-system has to be implemented by networking the main stakeholders of the food and food-related sectors in a life-long learning perspective. A multidimensional approach has to be applied to boost innovation by implementing modern educational methodologies, setting new approaches of permanent and synergistic interplay with the job-market, as well as forecasting future changes in skills and competences demand.

The Erasmus+ ASKFOOD (2018-2021,www.askfood.eu) project is setting a Permanent Observatory as an open Community of Practice (CoP) aimed (i) to connect experts and representatives from different stakeholders of the food sector to boost innovative HE and training and to upskill the workforce in a lifelong learning perspective, (ii) to monitor knowledge, skills and competences needs of the future food professionals based on trends and scenarios; (iii) to collect innovations in education and training and boost their implementation; and (iv) to stimulate the development of projects on education and training.

The ASKFOOD Permanent Observatory, that will start its activities by June 2021 in collaboration with the ISEKI-Food Association, one of the funding members, will be supported by a web platform (www.askfood-observatory.net) that will contain information about innovations in training and education, events and links to relevant other sources of interest for the community.

Keywords

Permanent Observatory, Community of Practice, innovation in training and Higher education, skills and competences

Acknowledgements

ERASMUS+ KA project ASKFOOD, Project N 588375-EPP-1-2017-1-IT-EPPKA2-KA

#328: Bringing innovation in sustainable product design in the digital era

Maria KATSOULI, Maria TSEVDOU, Georgios DIMOPOULOS, Eleni GOGOU, Ioanna SEMENOGLOU, Athanasios LIMNAIOS, Alexandros KATSIMICHAS, Virginia GIANNOU, Efimia DERMESONLOUOGLOU, Dimitrios TSIMOGIANNIS, **Petros TAOUKIS**

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The current pandemic brought unexpected changes to teaching practices and raised challenges as the Higher Education Institutions (HEIs) were forced to change their pedagogical practices. The improvement of digital teaching skills and the promotion of a better framework for the guidance of students were essential in order to give them the opportunity to continue their education in the digital era.

Based on the Ecotrophelia competition, an e-lab course for the design of eco-innovative food products was developed and introduced to the teaching curriculum of the integrated master Food Engineering program. This course project effectually fits to the concept of the Erasmus+ project "Digital transformation of project-based learning guidance in agri-food Higher Education Institutions" and is planned to be included in the white book to be developed by this project.

The students are divided into groups and motivated to develop their eco-innovative food products. Each group is assigned to a trainer who remotely guides and supports them. At the end, the students present their eco-innovative food product and submit their final technical file in which the product's profile is presented accompanied with the product innovative characteristics, a general description of the proposal, necessary technological studies (e.g. formulation process, manufacturing diagram, ...), market analysis and product environmental impact and all sustainable development aspects. This e-lab course project is innovative and paves the way to the modernization of pedagogical practices, building a solid foundation for high-quality digital education. Training sessions are performed between the trainers and the students that resort to project-based learning approaches. Questionnaires are created and used to collect the feedbacks of the project participants. The obtained results will assess the benefits they brought to the teachers, pedagogical staff, students and even organizations and the agri-food sector.

As part of the Erasmus+ project "DigiFoodEdu" is expected that this kind of e-learning approaches will give the opportunity to create a white book with new pedagogical practices that may be adopted when distance learning is obligatory, including either situations like a pandemic or complementary to regular or e-learning programs of HEIs.

Keywords

digital, e-learning, HEIs, pedagogical practices

Acknowledgements

Co-funded by Erasmus+ Project "Digital transformation of project-based learning guidance in agri-food HEIs".

Session 1: Poster presentations

#192: Toward to a New Curriculum for Food Engineering at Unicamp (Brazil)

Priscilla EFRAIM, Ana Silvia PRATA, Rosiane CUNHA, Guilherme MAXIMO, Flavia NETTO, Juliano BICAS, Celso LOPES

University of Campinas, Campinas, Brazil

The School of Food Engineering (FEA – UNICAMP), founded in 1967, pioneered the creation of the Food Engineering Program in Latin America. In 2014, the faculty members started a process of curricular reformulation motivated by the change in the profile of professionals, the drop in demand in recent years and the increase in the evasion rate. The process aimed at reducing workload, especially in the classroom to allow creative time for students; courses were revisited by encouraging the application of student-centered methodologies; an effort was made to promote the integration of content by stimulating interdisciplinarity, learning disruption and extra-curricular activities to make the student's formative trajectory more flexible. The process was carried out in 5 stages, starting with a reverse methodology and moving towards the creation of integrated courses, involving the whole community to collectively build the new curriculum. The reformulation led to a 20% reduction in the number of hours in the classroom and a 15% reduction in the number of courses. The new curriculum brings the possibility of horizontal and vertical integration between courses. The process, although extensive, allowed for the effective participation of faculty members. In a collaborative act, the implementation of the curriculum has the technical support from the Active Teaching and Learning group at the University (named ea2), who is accompanying the entire process by offering training courses, funding for the application of new teaching methodologies and daily consultations. About 70% of the faculty members have already been trained and a repository of digital tools applied specifically to our reality has been created, supporting projects and assessments in the courses. The Structuring Teaching Nucleus (NDE), a select group of professors from FEA-UNICAMP, monitors the new Courses, and every semester, in the Pedagogical Planning meetings, present proposals for the Faculty, to align with the pedagogical objectives of the Pedagogic Plan of the Course. The reformulation process was extremely important not only to generate discussion among faculty and students, but to increase contact and information exchange between the faculty staff.

Keywords
curricular reformulation, integration, interdisciplinarity

#193: Innovation in education and the dairy industry. Training Needs Analysis (InnoDairyEdu Project, Erasmus +, 2018-2021)

P PAPADEMAS[1], Teresa LOPEZ-DIAS[2], J.M RODRÍGUEZ-CALLEJA[2], J.A. SANTOS[2], M. LOPEZ[2], A. ÁLVAREZ-ORDÓÑEZ[2], B BOTTARI[4], A LOBACZ[5], J. ZULEWSKA[5], S ZARKANELAS[6], A CHATZI[6], M ALEXANDRAKI[7], A KARAGEORGOS[7], G KARAGOUNI[7], I PAPADOPOULOS[7], A MANOURAS[7], E MALISSIOVA[7]

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InnoDairyEdu is an Erasmus + project that aims at providing innovative, digital training material for students and professionals of the dairy sector. University of Thessaly (GR) is coordinating the project, with the partners: Uni of Leon (SP), Uni of Parma (IT), Unι of Warmia-Mazuri (PO), Cyprus University of Technology (CY) and 4obs Consulting (GR). In addition, several associated partner are actively involved (http://innodairyedu.eu/). The material is freely accessible in the format of Massive Open Online Courses-MOOC through an interactive e-platform that has been developed under the scope of the project. InnoDairyEdu aims in connecting academia with dairy industry, initially through the associated partners (29) and through the interactive platform that will act as a dissemination tool of the training material to interested parties.

Before the training material production was carried out, a training needs analysis on Dairy Science (DS) in Food Science/Technology (FS/T) Study Programs in the participating Univ was performed. This first stage consisted on an evidence-based evaluation of the state of the art of the study programs in relation to Dairy Science (curriculum assessment), followed by the design and dissemination of questionnaires in 5 languages (EN, SP, IT, PO and GR) addressed to students/graduates, teaching staff and food industries. The aim of the questionnaires was to analyze the needs on DS related topics for the FS/T studies/professional activities. In relation to the curriculum assessment, there were some differences noted among the universities in the depth of knowledge, credits and competences dedicated to DS. Among those offering a FS/T degree at bachelor level (3-4 years), without a DS specialization, 7.1% of the total ECTS (average) were focused on DS. In relation to the disseminated questionnaires, a total of 650 questionnaires were collected (66% from students/graduates, 22.3% from academic staff and 11.6% from food business operators). The priority DS topics of interest for the target groups were identified. The results of both curricula assessment and questionnaire analysis, lead to valuable data that allowed the partnership to develop a curriculum training guide that included specific contents of the training material to be designed and produced in the second stage of the project.

Keywords
MOOC, Innovative, Dairy Science and Technology, Education material, training need analysis
Acknowledgements
Innovative Dairy Science Education material development, 3018-1-EL01-KA203-047844".

#214: InnoDairyEdu- An example of innovation and sustainability in Dairy Science Education

P PAPADEMAS[1], B BOTTARI[2], J ŻULEWSKA [3], A LOBACZ[3], T LÓPEZ-DÍAZ[4], J M RODRÍGUEZ-CALLEJA[4], J A SANTOS[4], M LÓPEZ[4], A ÁLVAREZ-ORDÓÑEZ[4], A CHATZI[6], S ZARKANELAS[6], A MANOURAS[7], I PAPADOPOULOS[7], M ALEXANDRAKI[7], G KARAGOUNI[7], A KARAGEORGOS[7], L MALISSIOVA[7]

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The worldwide rapid changes demand major educational reforms in order for student and the industry needs to be taken under consideration, the natural resources of the educational environment to be respected, and the young generation to be adequately prepared to meet the demands of the real world. In this sense, actions with regard to curriculum design, teaching methodology, teacher training, and equity-enhancing programmes are in demand, in order to create an educational domain that produces sustainable outputs.

An example of an innovative and sustainable tool for Dairy Science Education is the Erasmus+ project InnoDairyEdu (www.innodairyedu.eu). It aims to use the potential of Europe's human and social capital, originating from higher education's institutes and the dairy industry, in order to exchange and transfer knowledge and know-how in dairy science education, by developing a network that will provide opportunities for cooperation among stakeholders, in order to foster employability, socio-educational and personal development. The main objective of InnoDairyEdu is to offer to Food Science and Technology students and/or professionals an innovative, holistic and sustainable training on Dairy Science.

InnoDairyEdu develops education material, focused on Products, Processes, Quality, Safety and Entrepreneurship in the Dairy Sector. This new curriculum design approach and other good practices will be shared through a collaborative platform, using Information and Communication Technologies and Open Educational Resources. The project used as a starting point the assessment of the current situation in relation to the Dairy Science education by students, academics and industry. Based on this, the partnership produced a freely-available, tailor-made Dairy Science module. The project aims at enhancing digital integration in learning, teaching and training by developing scientific, pedagogical and informative materials in Dairy science, that assist the principles for sustainable education.

Keywords
innovation, sustainability, Education, Dairy Science and Technology, Module development

#222: Hybrid-Innovative-Learning-Lab (HILL), a project to develop a novel model of LMS tailoring the training to each learner in the field of sustainable food design

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HILL (Hybrid-Innovative-Learning-Lab) is a nationwide French project that involves 25 partners (including 16 academic institutions, professional institutes, trade associations) to collaboratively develop an innovative offer of initial education (from bachelor's to master's degrees) and lifelong learnings in the field of sustainable food design. The project has been funded by the French National Research Agency (ANR) since 2018 and will run for 10 years (https://hill.ecotrophelia.org/). It aims to build and improve the modularity of training paths by better aligning the individual objectives of each learner, the formative resources (existing and developed) and the assessment of scientific, technical and soft skills. To reach it, three different laboratories have been designed by the HILL consortium to form the Hybrid-Lab: i) a Learning-Lab to build individualized, versatile and adapted pedagogical innovations, ii) a Virtual-Lab to develop digital tools for face-to-face and distance learnings, and iii) a Fab-Lab to pool the experimental tools and equipment of the HILL network (experimental kitchens, pilot plants, analysis laboratories, etc.). These three Labs share the objective of developing a Learning Management System (LMS) that will offer an original learning model supported by trainers, adapted to learners and their diversity, and widely available. This LMS is currently under construction and will allow users to have access to i) tools to define the learner's objectives according to her/his professional target as well as the training path adapted to these objectives (job orientation, learner's diagnosis before and during training, etc.), ii) a set of innovative formative resources in food eco-innovation, iii) a tool to coach groups of learners, project-based approaches being key in the HILL pedagogy, and iv) indicators to monitor the learner's progress at different levels of the training and make the right adjustments (remedy a difficulty, identify additional training, etc.). This communication aims to present both the global pedagogical approach of HILL to face challenges in education for a globalized and sustainable world, and the future LMS, currently in its UX-design phase to develop a simulator integrating all the needs and objectives of HILL.

Keywords

Hybrid-Lab, Learning Management System, Initial education, Lifelong training, Individualization

Acknowledgements

HILL project is funded under a French investment program (https://anr.fr/en/investments-for-the-future).

#239: Virtual dynamic learning methodologies in times of covid of the thermal calculation of concentric tube heat exchangers using online web tools

Edgar MAYTA, **José Manuel PRIETO**, Joel Jerson COAQUIRA , César Augusto CONDORI

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The presence of covid 19 in 2020 has generated a series of problems in the training of engineers in food industries in most of the world's universities, especially in Peru. The objective of this research work is to be able to size a concentric tube heat exchanger with a capacity of 500 liters per hour for a regeneration stage of a milk pasteurizer, simulating the most optimal design conditions that can be used in the construction of the exchange and its subsequent evaluation and validation, for this, free online digital platforms of 3 international universities have been used, Polytechnic University of Valencia Spain https:// labmatlab.upv.es/eslabon/Perfil/, California Davis University, http://rpaulsingh.com/ learning/virtual/experiments/heatexchanger/index.html and from Massachusetts Amherst, https://demonstrations.wolfram.com/ParallelAndCounterflowHeatExchangers. Additionally, an Excel spreadsheet has been developed with functions that allow the analysis of the thermal load of the heat exchangers through the logarithmic mean temperature with calculations of individual convective coefficients. The calculations that have best represented the required design are those of the Excel spreadsheet where it has been found that for the required design capacity a pipe length of 12 linear meters is required with an inner tube diameter of 10.52 mm schedule 10 and external diameter of 15.8 mm schedule 40, the amount of heat exchanged is 17295 watts, the global heat transfer coefficient calculated is 930 watts / m2, with these data the tubular concentric exchanger has been built in AISI 304 stainless steel material of 1.5 meters of section, with the exchanger the validation thermal calculations have been carried out, with the mean logarithmic temperature of 33 degrees Celsius and the calculated one of 34 degrees Celsius, with an error variation of 3%. This virtual learning methodology coupled with the construction and validation of the results has allowed the eighth semester students of the Peruvian University Union of Peru to learn the concepts of heat transfer.

Keywords
Heat exchangers, Online tools, Virtual learning

#247: A blended learning approach for food chemical safety education

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Food safety is a major issue in the 21st century, since access to safe and nutritious food is crucial to sustaining life, promoting good health and economic growth. Diet is recognized as a major contributor to several chemical hazards exposure, with possible long-term deleterious effects on the human populations. Several chronic diseases are suspected to be related to chemical contaminants present in the food chain, such as obesity possibly related to endocrine disruptors. The graduate program considered here is the second year of a Toxicology and Environmental Health master degree, delivering 60 European Credits (EC). Chemical food safety is part of the Food Toxicology one-week course (30h, 3EC) placed at the end of the first semester and proposed as an option to students. Students are traditionally educated to chemical food safety through a 6h lesson delivered in class. A blended learning approach was tested with a new 7h session format. It combines distance self-learning using open-access interactive digital resources organized in several successive modules available on the LMS platform, and in-class group activity based on a Thiagi frame game to favour cooperation with production of graphical representations. Testing this blended learning approach with one cohort of students showed benefits since they were more engaged and encouraged to collaborate, learning from their peers through production of graphical representations in class. Also, success rates in the final exam increased. Since open-access resources have been used for designing this innovative teaching format, they could be used by colleagues interested with food chemical safety. Alternatively, the innovative format tested could be transposed to other teaching issues.

Keywords
cooperative learning, graphical representations, ICT enhanced teaching and learning, open-access resources, food safety

#261: An innovative way to introduce precision farming practices to young farmers through gamification – The Farming Simulator case

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Application of precision farming (PF) might offer many advantages to a farmer, e.g. economic benefits, yield increase, support in the decision-making process, as well as to the environment, such as contribution to soil health, biodiversity, reduction of chemicals, etc. Despite the rapid development of precision farming techniques, their spread among farmers depends on several factors and remains low for some technologies.

Several methods are practiced by scientists, governments, and NGOs to popularize knowledge about the benefits of PF among different groups of stakeholders. One of the ways to facilitate the adoption of PF technologies is to educate and train younger generations. Recently, the intensification of the adoption process is actively supported by the introduction of serious games. Thus, gamification is a popular method that is being increasingly used in agriculture. This approach formed a basis of a study that has been done in the scope of the EIT Food funded project “Integrating Precision Farming in Computer Game”.

This work aimed at developing a Precision Farming mode (downloadable content) and implementing it as a part of the GIANTS Farming Simulator game. This is a famous video game that is being played by millions of users around the world. Such popularity offers a great advantage to attract young students, farmers, and other stakeholders and increase their interest in PF.

The development of the mode was based on the interactive approach with students and partners who were involved in the study. Several workshops lead to the finalization of the specifications to be integrated into the Farming Simulator mode. The following features were implemented: automatic steering, soil heterogeneity, soil sampling, and soil properties, site-specific variable-rate lime spreading, site-specific variable-rate N fertiliser spreading, yield maps, and economic analysis.

Keywords
gamification, serious games, site-specific, soil sampling, variable rate

#264: An exploration of student online behaviour and performance in flipped food technology laboratory classes

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The ability of students to adequately be prepared both conceptually and procedurally is of critical importance for any long term benefit to be obtained from practical laboratory sessions. Laboratory work is an integral part of food science and technology instruction. It provides students with opportunities to interact with varying phenomena, which engages and improves their understanding of food ingredient functionality, unit operations, food nutrition and packaging. This study investigates the effect of habituation (student experience in using e-learning automatically) on student performance in an undergraduate food science and technology module. In 2018 and 2019, blended learning components were added to food technology 1. Short pre-lab videos gave students a conceptual background and an overview of each week's lab. Students engaged with the material in online pre-lab quizzes conducted experiments and completed practical reports. The instructor used pre-lab quiz responses to gauge students' conceptual understanding, leading to more time for lab skills development in the lab. Data were analysed descriptively and statistically for significance (t-test) effect size (Cohen's d and Hedges g). There was a significant difference ($p < 0.05$) in both online pre-practical tests and practical reports between the two cohorts, indicating an improvement in the 2019 cohort. This study shows that flipped laboratory classes result in improved academic performance.

Keywords

Flipped laboratory classes, blended learning, habituation, academic achievement., food science and technology

#285: FOSTER-xR: An Erasmus+ educational strategic partnership for the introduction of xR to the FoOd induStry of the digiTal ERa

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The food and drink industry is a major contributor to Europe's economy. In 2018, it had a turnover of 1,109 billion, making it the largest EU manufacturing sector and the leading employer (4.57 million people). This amounts to 294,000 companies and 110 billion exports -17.9% of the EU global exports. Given this size, it is important that such organisations are supported in creating competitive, technologically efficient supply chains through innovation, necessitating novel educational strategies. Considering that Europe's food and drink industry committed to increase value added by 2.5-3.5% per year to 2025, such innovative strategies need to be firmly on track. The food industry is also growing into a data-driven community, responding to the growing demand from the modern consumer for fully nutritious, sustainable and safe foods.

This paper describes the development and implementation of an Erasmus+ Strategic partnership which focuses on introducing new practices in training and skills development though Extended Reality (xR). The aim of the project is to integrate all the elements required for a sustainable food chain, including the application of disruptive technologies in the food production, the knowledge transfer and the entrepreneurship. This strategic partnership introduces, teaches and trains early stage researchers in the area of digital technologies through a multilateral trans-European cooperation, which fosters both institutional collaboration and innovative problem based learning initiatives.

New educational practices and knowledge transfer strategies based on extended Reality (xR) will be developed. The concept of xR (extended reality) is that it includes Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR). The project will ensure that participants will be supported in developing autonomous initiatives in digital technologies as well as innovative and open pedagogies in education and training. The most recent activity, organised in April 2021, included an intensive one-week training of PhD and MSc students at University of Macedonia via a virtual platform.

Keywords
vitual reality, extended reality, virtual reality, food industry, digitalisation

Acknowledgements
FOSTER-xR is co-funded by the Erasmus+ programme of the European Union.

#290: Sector Skills Alliance EQVEGAN - European Qualifications and Competences for the Vegan Food Industry

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Consumer trends towards more sustainable and healthy diets are boosting the development of new process and technologies applied to plant-based raw materials. As a consequence, food industry is expanding in plant-based products, including those that did not exist before (e.g. cereal or nut drinks, vegan dairy and meat new alternatives, etc.). Additionally, the increased sustainability requirements, and digitalization and automatization trends, are quickly changing the working environment and place a stress on the developing of new up-to-date skills of workers.

The aim of the EQVEGAN project is to support the fast-changing sub-sector of the food industry, the processing of plant-based products (vegetables, fruits, cereals and nuts), by responding to the urgent needs of training staff to support this change, by upscaling staff competences and facilitating the conversion of staff into this sector through the correction of skills gaps.

This work describes how EQVEGAN will achieve this aim by implementing the following activities: i) supply innovative and scientifically updated training; ii) assess trainings with quality assurance imbedded principles, iii) create a European certification scheme for trainings and job profiles; iv) establish a Sector Skills Alliance on training for the vegan food industry. The main outcomes of the project (stakeholders' database, updated job profiles, trainings, certification and apprenticeship schemes) will be available in a skills web portal. This platform will be open to students, educators, food industry professionals, food companies and any other interested in the project activities, findings and results.

Overall, the expected project impact is in having better prepared professionals in the vegan food industries, either at the subject specific level (vegetables, fruit, nut and cereal processing), but also in updated skills in automation, green skills and soft skills, to more quickly support the growth and appearance of new companies, providing a fast adaption to the new market demands, thus also correcting skills gaps.

Keywords

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

Acknowledgements

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#323: Extraction of fulvic acid using different solvents

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Humic acid (HA), fulvic acid (FA), and humin are the main fractions of the soil. Fulvic acid, which is 25-75% of the organic materials in soil, is a water-soluble fraction at all pH values. The colour of FA is ranged from yellow to black.

FA includes minerals, amino acids, sugars, peptides, nucleic acids, phytochemical compounds, and vitamins. In addition, it has several known properties including heavy metal chelation, antioxidant, anti-inflammatory, and antimicrobial properties as well as positive health effects for humans such as to transport some nutrients, mainly minerals, to cells and remove deeply embedded toxins from the body. Thus, FA became a new, valuable, and natural alternative material as a food additive.

Mainly two methods which are NAGOYA and IHSS were reported in order to extract FA from different sources such as leonardite, coal, lignite. In this study, the IHSS method was used with different solvents to extract FA from leonardite using to obtain different extracts of FA. High-performance liquid chromatography (HPLC), Fourier transform infrared spectroscopy (FTIR), spectrophotometric method were applied to characterize these extracts.

Keywords

fulvic acid, extraction, IHSS

Acknowledgements

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#333: Changed learner experiences after action learning

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Student participation in, and evaluation of, learning activities are both effective measures for faculty improvement of future course content. Between 2017-2021, a series of 7 international online competitions for Master students in the food sector were held. Participation in each 4-month competition was voluntary, and required students to attend several online trainings, including a final virtual conference where they presented their proposal of a solution to a food-related challenge. In 2019, the format of the competition changed when a participatory action learning approach was implemented. In the 4 competitions before action learning implementation (ALI), 52 teams (192 students) registered and 48% completed the competition. In the 3 competitions after ALI, completion percentage almost doubled: 30 teams (107 students) registered and 90% completed the competition. Students were asked to rate the competition online trainings using a Likert scale of 1-5. The average for each student was calculated and the average of averages before/after ALI was the basis for analysis. The average online training rating before ALI was 4.1+/-1.0 with 38% of the 90 students that finished the competition voluntarily returning their evaluations. After the ALI, returning the evaluation became mandatory; the average rating decreased to 3.9+/-0.9, but 80% of the 93 students who completed the competition returned their evaluations. A student t-test showed no significant difference, p=0.162, indicating that the students after ALI found the online trainings just as useful as students before ALI. Considering that the number and intensity of online trainings increased after ALI, it is interesting that students rated the trainings equally. Additionally, since pre-ALI, evaluations were returned only by a small self-motivated group, the 4.1 rating may not be representative of the overall student view. Action learning is an innovative approach to participatory learning and continued collection of student participation and evaluation data will contribute to further improvements in this online competition.

Keywords
action research, action learning, self assessment, student assessment

Acknowledgements
This work was funded by the NextFOOD project (Horizon2020 EU), Grant agreement: No. 771738.

#337: Comparison of face-to-face versus online delivery systems and individual versus group work on the learning outcome about the influence of food choice determinants on the achievement of the sustainable food consumption goals

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Incorporating the sustainable food consumption perspective in food degrees' curricula may be crucial to ensure sustainable consumption patterns. Each student is a potential food consumer who has experienced food consumption decisions and an ambassador to promote the goals. The purpose of this paper is to compare face-to-face versus online students' preferred learning modality: working individually or collaboratively. Students of both MSc's, attending Food Choice Criteria (online) or Introduction to Consumer Sciences (face-to-face), were invited to analyse the different attributes modelling organic food choice and presented with the same support materials. Students distribution followed a random assignment for each course, with half working collaboratively and the rest working individually on an assignment. Students had an open website questionnaire at the end of the module, answering collectively or individually, according to the specific way of studying assigned. The dimensions considered were as follows: general expectations, learning organisation and interactions. Twenty-three students answered the questionnaire: 10 answered individually (five at each course) and 13 collectively (six online, seven face-to-face). Despite the awareness of collaborative learning advantages, students that worked individually at the online course preferred maintaining this learning modality. Some e-learning collaborating students complained about the learning process' negative aspects because it requires more time and is more stressful to accomplish the task. For the face-to-face MSc course, both students referred to as advantages of extra collaboration learning because they discussed different views that they would not have noticed otherwise. Another advantage was that this modality increased work productivity due to tasks allocation among members of the group. As for disadvantages of collaboration, those who worked collectively mentioned face-to-face time management problems to discuss and accomplish the task. These findings are particularly relevant, as cooperative interaction, communication skills, and team-based problem-solving skills are necessary to achieve the sustainable food consumption goal regarding the food system's complexity.

Keywords
collaborative learning, higher education, face-to-face learning, virtual learning environment

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#341: A roadmap for sustainability agrifood and forestry education

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Inflexible educational and research institutions locked into outdated traditions and practices will not be equipped to address the complex sustainability challenges our societies are facing. Nextfood was initiated in 2018 as a collaborative project bringing together 19 partners in an international network with the aim of designing a shared inventory of skills needed for future professionals and a research-based learning strategy to enhance stakeholders' understanding of complex situations in the transition towards more sustainable agri-food and forestry systems (www.Nextfood-project.eu). The overall aim of NEXTFOOD is to generate an innovative European science and education road map for sustainable agriculture, food and forestry along the value chain from research via fabrication into application. The roadmap will foster quality education, ensuring that students are taught by qualified faculty, develop the skills crucial for sustainable food and forest production, with the resources needed to support the curriculum. In this paper we present the first outlines for such a roadmap based on experiences and research outputs from the NextFood project. It comprises a set of standards for new and existing programmes, both academic and professional programmes, on high school, vocational and university level. Standards will encompass several domains, such as course content and structure, curricular needs, faculty and student support etc.

Keywords
Education, Training, Lifelong learning, Sustainability

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#352: The ASKFOOD Reversed Incubator: an innovative training approach for entrepreneurial skills development and innovation in food-related sectors

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The food and drink industry is one of the biggest manufacturing sector in the EU and worldwide. Despite its high competitiveness, it has reached a maturity level and several factors are hindering innovation. Advancements in science and technology along with new interfaces with food-related sectors need to be taken into account to promote both sustainability and innovation. A systemic approach involving all stakeholders and an academia-industry joint collaboration is required to tackle emerging challenges, to catch common opportunities in the job market, and to boost innovation in the food sector. Thus, food professionals require new skills and entrepreneurial competences to meet the requirements of the current and future job market, in a continuously changing working and societal environment.

The Erasmus+ ASKFOOD (2018-2021,www.askfood.eu) project, has developed and piloted a new "Open innovation" training methodological approach to promote entrepreneurial skills, the "ASKFOOD Reversed Incubator" (ASKFOOD-RI, www.askfood.eu/reversed-incubator-0). It aims at inverting the logic with which we transform ideas into new businesses and combines training with entrepreneurial opportunities to generate innovation in food-related sectors. Students and young talents organized in teams develop ideas based on real needs/opportunities of innovation expressed by companies, under the supervision of mentors within a co-creation project in a development framework and supported by a business-oriented training.

The first pilot test, carried out in 2019 in Italy, involved 9 companies of different manufacturing sectors and 11 talent teams; in 2020 and 2021 three editions of the ASKFOOD-RI have been implemented in The Netherlands, Croatia, and in Italy.

The results highlight the positive impact of the methodological approach both in developing entrepreneurial skills of students and, by the close collaboration between academia and industry, in boosting innovation seeds in the food sector.

Keywords

reversed incubator, entrepreneurial skills, innovation, collaborative academia-industry training

Acknowledgements

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PHD SESSION: INNOVATION FOR SUSTAINABLE FOOD SYSTEMS

PhD Session: Oral presentations

Opportunities and challenges in exploiting microbiomes in the food system

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The food system is facing a number of challenges, which should be properly addressed by using the most appropriate strategies, based on strong scientific evidences. Increase of the world population, malnutrition and non-communicable diseases in under-developed and industrialized countries, respectively, climate change, water scarcity and land desertification are just some of the main challenges that human beings have to address in the near future. Sustainability has become a must, and modern food production systems have to be designed in order to take this into consideration.

In 2015, the World Health Organization identified 17 sustainable development goals (SDGs) to be addressed and reached by 2030 (https://www.un.org/sustainabledevelopment/) and food production can be identified as one of the main drivers to reach the objectives identified by several of them. The SDGs strategy has been also embraced by the EU Commission, which in 2015 initiated Food2030, a research and innovation policy to transform food systems and ensure everyone has enough affordable, nutritious food to lead a healthy life (https://ec.europa.eu/info/research-and-innovation/research-area/food-systems/food-2030_en). Food systems are also an integral part of the European Green Deal, which aims at transforming the 27-country bloc from a high- to a low-carbon economy, without reducing prosperity and while improving people's quality of life, through cleaner air and water, better health and a thriving natural world (https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en).

With this scenario, there is urgency in contributing to the advancement of the scientific knowledge in the context of the food system. More specifically, there is a strong evidence that current food production systems are not sustainable. Food production is the largest cause of global environmental change. Agriculture occupies about 40% of global land, and food production is responsible of up to 30% of global greenhouse-gas emissions and 70% of freshwater use (Willet et al. 2019).

Microbiomes are defined as the microbial populations present in a specific ecosystem in a certain moment in time and their spectrum of activity. This definition underlines how microbiomes have a primary role in shaping the behavior of an environment and impact its characteristics.

The microbiome concept fits very well in the context of the food systems, as a matter of fact they can contribute (both in a positive but also in negative way) in the production and processing of foods, as well as have an important role in influencing human health. The application of microbiomes is new in the food chain and offers possibilities that are in line with the request of the consumers of foods that are more "natural" (low use of chemicals in both production and processing), sustainable and healthy.

In this talk the application of microbiomes in different segments of the food system will be examined as well as challenge-based educational activities, focusing on microbiomes, will be described.

Encapsulation of bioactives by high throughput electrospraying assisted by pressurized gas

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One of the most promising approaches to preserve bioactive compounds is their encapsulation within protective matrices. Recent developments in engineering and industrial investment have allowed our research group to develop an innovative encapsulation technique based on the combination of electrohydrodynamic technology and pneumatic atomization process. This novel high-throughput technology, termed as electrospraying assisted by pressurized gas (EAPG) is based on the atomization of the polymer solution by a pneumatic injector using compressed air that nebulizes within a high electric field. During this process, the solvent is evaporated at room temperature in an evaporating chamber and the encapsulated material is collected as a free-flowing powder. This technology is a versatile technique that presents multiple advantages compared to conventional encapsulation techniques. For instance, it is carried out a room temperature, which reduces the denaturation of bioactive compounds, produces particles with high encapsulation efficiency, results in a reduced particle size with narrow size distribution, does not require a subsequent step to separate the particles from the medium, and it is highly versatile in terms of the encapsulating materials and bioactive compounds that can be processed. In addition, by means of this technology it is possible to achieve the production volumes required by commodity food applications.

The current presentation will introduce the technology and highlight some use cases for the stabilization, shelf-life extension and controlled release of different bioactive compounds.

Keywords
EAPG encapsulation, omega-3, probiotics, polyphenols, functional foods, nutraceuticals

Acknowledgements
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#216: Functionalities and characteristics of novel fermented milk drinks based on donkey milk and commercial probiotic bacteria

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In recent years, donkey milk is considered as one of the best milk alternatives due to its unique composition. It is included in the category of "functional foods" as a result of its positive effect on human health. In addition, probiotics could enhance donkey's milk functionality by adding extra health benefits. In this study, a starter culture (Streptococcus thermophilus) and five commercial probiotic strains (Bifidobacterium animalis subsp. lactis BB-12, Lactobacillus acidophilus LA-5, Lactobacillus rhamnosus LGG, Lactobacillus paracasei subsp. paracasei L. CASEI 431 and Lactobacillus helveticus R0052) were used to ferment donkey, enhance the milk's nutritional value and prolong its shelf life. Probiotics were used in pure cultures and in co-cultures with and without prebiotic (inulin) addition. Fermentation temperature was 37oC. The process was subsequently stopped by cooling milk at 4oC; i.e. when milk had reached pH <5. Acidification and viable cell population were followed during fermentation. Additionally, antimicrobial activity, ACE-inhibitory activity and organic acid production of produced milk drinks were also examined. All probiotic strains were grown in sufficient populations (i.e. >6 log cfu/ml) for a period of 24-30 hrs. Generally, the fermentation time was reduced when the probiotic strains were co-grown with Streptococcus thermophilus and the addition of inulin. Lactic acid was the most abundant organic acid produced. The milk drink produced by Lactobacillus helveticus R0052 showed a significant antimicrobial effect against Listeria monocytogenes, Staphylococcus aureus and Bacillus cereus. Future research will examine a variety of other bioactivities i.e. α-Glucosidase activity, immunomodulation as expressed by the stimulation of specific cytokines in PBMC cell lines after in-vitro digestion and sensory characterization. The best combination would be utilized for the development of a novel fermented, probiotic milk drink based on donkey milk.

Keywords
Donkey milk, Probiotics, Functional foods

#162: Microbial Interactions in Kombucha: Impacts on the Beverage's Chemical Composition

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Kombucha is a traditional low-alcoholic beverage made from sugared tea and transformed by a microbial consortium including yeasts and acetic acid bacteria (AAB). This soft drink is now highlighted for its potential health benefits. Compounds with antioxidant and hepatoprotective activities have namely been isolated. Moreover, kombucha brewing is a sustainable process using natural ingredients without another additive. Kombucha can be sold not filtered and/or not pasteurized as a raw product with high nutritional values, but this exposes the products to stability issues. Other difficulties are faced regarding reproducibility, control on elaboration and quality of the product that are mainly attributed to the complexity induced by a multi-species consortium expression. The study of microbial interaction occurring in kombucha consortia is therefore crucial to have a better understanding of the parameters to control the process of elaboration.

To study these interactions and their impact on the chemical composition of the beverage, three yeast strains belonging to the genera Brettanomyces, Hanseniaspora, and Saccharomyces and three strains of Acetobacter and Komagataeibacter species were chosen. Monocultures in sugared tea were analysed to determine their individual microbial behaviours. Then, cultivation of the original kombucha consortium and cocultures were compared to determine the interactive microbial effects during successive phases of production: open and closed incubation conditions. Results highlight the main impact of yeasts metabolism on the product's chemical composition and the secondary impact of bacterial species on the composition in organic acids. The microbial interactions can be explained by different strategies for the utilization of sucrose. Brettanomyces and Saccharomyces yeasts possessed efficient invertase activity, whereas this activity was low for the Hanseniaspora yeast. AAB were unable to perform efficient sucrose hydrolysis and relied on yeasts with high invertase activity to access released monosaccharides. Moreover, the presence of AAB rerouted the metabolism of Saccharomyces yeast towards higher invertase and fermentative activities.

Those results open perspectives for optimization of kombucha elaboration and more sustainable production processes.

Keywords

Kombucha, Interaction, Yeast, Acetic Acid Bacteria, Beverage

#279: In search of honeybee indigenous probiotics

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Honeybees, like all social insects, exhibit cooperative hive behaviour expressing a colony-level phenotype, such as feeding processes and immune response pathways. Social immunity is of paramount importance and is an efficient method of controlling a disease and its spread within colonies. However, the accurate way of how some pathogens influence the honeybee well-being is largely unclear or even debatable. The honeybee microbiome is recently on top of research interest and the core microbiota has already been described, as it has roughly constant structure. According to many studies, honeybees' diet supplemented with probiotics may enhance their sensitivity into pathogens and enemies, as it leads to balanced gut microbiota, boosting their social immunity. This study aims in the isolation and identification of microbes from honeybees' guts and stomachs. The main goal is to evaluate their beneficial characteristics and potential probiotic properties in Cyprus. Specific biochemical tests, namely gram-staining, catalase test, tolerance to acidic conditions, bile salt (0.3%), hydrophobicity, auto-aggregation tests, and antimicrobial susceptibility testing are targeted in order to select a small number of beneficial bacteria with the best probiotic properties. Primarily, these microbes will be tested as supplements in sugar syrup in feeding honeybees for 30 days (Apis mellifera cypria) into small cages. We will focus on determining the effect of these probiotics on honeybees' longevity, productivity, food ingestion, disease susceptibility (nosemosis and American foulbrood) or even, possible mortality. So far, numerous beneficial bacteria have already been isolated from the midgut and hindgut of worker bees, including Lactobacillus spp., Fructobacillus spp., Acinetobacter spp. and Enterococcus spp. All the tested probiotics will be compared with isolated control cages, where the honeybees will be fed only with sugar syrup without any supplement. In addition, commercial probiotics will be assessed for their beneficial properties into honeybees' well-being. The ultimatum of this doctoral research is to generate an indigenous, environmentally adapted, probiotic candidate or a mixture of probiotic isolates from the honeybees' gut that boost their health.

Keywords
honeybees, gut, probiotics, well-being, health

#208: Chestnut purée: a possible growth media for probiotic microorganisms – Preliminary results

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Portugal and Spain are important chestnut producers. It is crucial to valorise this nut by using small-size and broken fruits that are usually discarded or used to produce animal feed. In this way, the production of chestnut purée seems to be an excellent alternative to valorise these fruits. Considering that chestnut does not contains lactose and is gluten-free, the present work aimed to use chestnut purée as a growth medium for probiotic microorganisms to obtain a probiotic product that lactose-intolerants and celiac people could consume.

In the present study, chestnut purées were produced and inoculated with Lactobacillus casei subsp. casei CECT 4043, Lactococcus lactis subsp. lactis CECT 539 and kefir grains. The following parameters were determined: Colony forming units per millilitre (CFU/mL), pH, total sugars, protein, total phosphorous and total nitrogen. Previously, a rheologic study was also performed to understand the flow behaviour of the chestnut purée when subjected to different temperatures (15, 25, 50 and 75 °C).

The chestnut purée showed a pseudoplastic behaviour, as the viscosity decreased with the shear rate. Nevertheless, at the lowest temperatures, some time-dependency was observed. A hysteresis was detected between the loading and unloading curves, suggesting the existence of thixotropy. However, this behaviour was not so evident at 50 or 75 °C. Furthermore, the viscosities of chestnut purées decreased with temperature due to starch gelatinization.

Regarding the bacterial growth, Lb. casei and L. lactis reached approximately 109 and 108 UFC/mL of chestnut purée, respectively, after 26 h fermentation. Concerning the fermentation with kefir, bacteria and yeasts were detected, being the first in higher number than the second at the end of fermentation. At this time, bacterial counts higher than 107 UFC/mL of chestnut purée were achieved.

In all fermentations a reduction in pH was observed. The initial pH of the chestnut purée was around 6.4, decreasing to 4.7 for Lb. casei and L. lactis, or 3.7 for the kefir grains, at the end of the fermentation.

In conclusion, the chestnut purée seems to be a good growth media for probiotic microorganisms.

Keywords

Chestnut purée, Lactobacillus casei, Lactococcus lactis, Kefir, Rheology

Acknowledgements

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#254: Apple pomace – a potential substrate in sourdough fermentation

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Food waste and by-products are a severe global problem, especially in many developed countries. One of the most concerning industries is apple juice of which production generates a massive volume of waste, considering the annual processed tonnage of up to 12 million tons (Mt). By contrast, the low cost and high abundance of this waste, highlights the economical perspectives of its potentially valuable components.

Apple (Malus sp.) is among the most popular fruits in the world. Global production has over 87 Mt in 2019 compared to 1990, where just over 47 Mt were produced. In addition, global production is expected to undergo a constant increase in the next years. In case apple production and consumption will exhibit the same trend and constant growth, it will increase by 16%, more precisely over 14.17 Mt until 2030. Additionally, 18% of global production is processed, which generates a significant volume of by-products.

The circular economy pushes the boundaries of environmental sustainability by emphasizing the idea of transforming products so that there are viable relationships between ecological systems and economic growth. It is thus concerned with reducing the use of the environment and creating self-sustaining production systems in which materials are used repeatedly. Therefore, the present article aims to capitalize on food by-products, apple pomace (AP), and integration into a continuous flow of food biotechnological processes. This paper integrates the performance of traditional sourdough enriched with AP and fermented by lactic acid bacteria and yeast (mono- and co-cultures). The use of agro-industrial by-products could ensure an additional source of income and, at the same time, contribute to reducing the problem of by-product disposal and increase the nutritional profile of fermented food products. However, there is limited information on the potential for using this specific by-product in various fermentation processes. Nonetheless, due to the results reported in this study, it is expected that the food processing industries will better manage their by-product and waste, thus avoiding an environmental problem that is continuously growing.

Keywords

Apple pomace, Sourdough fermentation, Sustainable food, Wheat flour

Acknowledgements

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#185: Spatial organization of food pathogens Listeria monocytogenes and Escherichia coli O157:H7 in jellified media

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Predictive models based on planktonic growth are found to be biased when applied to the behaviour of bacteria in food matrix because those are semi-solid or solid media (Pipe et Grimson, 2008). Contrary to liquid media, those matrices have a structural heterogeneity with multiple micro-gradients of physico-chemicals parameters such as: pH, temperature oxygen and nutrients repartition, and they evolve over time. In those conditions, bacteria are confronted to multiple micro-environments which lead to a phenotypic heterogeneity as adaptative response kick in with diverse mechanisms: e.g. genetic expression, genetic variations, and stochastic expression (P. S. Stewart et al, 2018). This phenotypic heterogenetic may results in multiple responses to each stress encountered in food matrix which heighten chances of survival or, possibly, alter the virulence levels of pathogenic bacteria (Nielsen et al, 2013). As the physiology of bacterial cells in food matrix is poorly understood, we aim to study the behaviour of pathogens L. monocytogenes and E. coli in jellified media.

In situ confocal laser scanning microscopy is used to study bacteria in which we inserted a gene bearing a fluorescent protein. This allows us to observe the dynamics of spatial repartition and growth of the pathogens in the jellified media. The computer analysis of said microscopic images yielded quantitative parameters such as the speed at which cells swim (when motile cells exists) or the final volume of micro-colonies in the gel. Our study shows the significative roles that the concentrations of gelling agent, lactic acid and NaCL play on those process. As such, the results obtained here lead us to the conclusion that there is an interest in investigating the spatial expression, at the single cells level, of genes linked with the observed heterogeneity.

Keywords
Food matrix, Spatial organization, Bacterial mobility, Listeria monocytogenes, Escherichia coli

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#221: Exploring the potentiality of hyperbaric storage to steer hygienic and techno-functional properties of egg white

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Hyperbaric storage (HS) has been proposed as a more sustainable alternative to refrigerated storage of fresh food. It consists in storing foods under moderate hydrostatic pressure (P < 250 MPa) in water-tight steel vessels. When the storage temperature is not controlled (i.e. room temperature), this technology has a quasi-zero energetic cost, which is needed just for pressurization. HS has been reported to maintain the hygienic quality in fresh meat, fish and fruit juices, due to bacterial inactivation under pressure. This goal is claimed to be reached with minor changes in chemical, physical and sensory properties of the food matrix. However, the effect of HS has never been studied in protein-rich ingredients, which could easily undergo changes in techno-functional properties upon pressurization.

The aim of this study was thus to investigate the effects of hyperbaric storage on egg white, taken as an example of a highly perishable food ingredient, prone to both microbial spoilage and depletion of techno-functional properties. To this aim, egg white was packed in plastic pouches and stored at 200 MPa at 20 °C or under refrigeration (0.1 MPa; 4 °C). During storage for up to 28 days, samples were analysed for counts of inoculated S. aureus and S. enterica, protein physical and structural properties (colour, absorbance at 280, 380 and 680 nm, particle size, Z-potential, free sulfhydryl groups, FTIR spectroscopy, DSC) and techno-functionality (apparent viscosity, gelling capacity, foaming capacity and stability).

After 1 day under HS, S. aureus and S. enterica inoculated in egg white were irreversibly inactivated, indicating the remarkable capacity of the technology in guaranteeing food hygienic properties. Prolonged hyperbaric storage only promoted minor changes in protein size, secondary and tertiary structure, and electrical stability. These changes were associated to an increase in egg white viscosity, which was not due to a higher networking ability of proteins but to their better solvation. As a result, hyperbaric stored egg white presented slightly lower gelling properties but significantly higher foaming capacity. Based on these results, hyperbaric storage might represent an interesting sustainable technology to guarantee safety, extend shelf life and even improve techno-functionality of fresh foods.

Keywords

Hyperbaric Storage, Egg White, Hygienic Properties, Protein Structure, Techno-functional Properties Improvement

#343: Insight into the environmental impact of the food basket of an island: case study of Aruba. Challenges and solutions in moving from an exploratory analysis towards a more detailed analysis

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This research focuses on calculating the environmental impact, such as carbon footprint, of the food basket of an island, by using life cycle analysis. The scientific field of assessing the environmental impact of food systems and of food consumption is growing rapidly. Assessments often occur at a global, continental, national or occasionally provincial level, but with fewer studies at an island level. The functional unit of this study is: Food basket of Aruba in 2019, at the end of the professional part (retail / restaurant) of the food chain. The food basket of Aruba consists of approximately 99% imports, and very limited local food production and local fish catches, and a limited amount of export. Drinking water and impact from food losses and waste will also be taken into account.

In preparation of the detailed assessment of the environmental impact we have performed an exploratory analysis which shows the environmental hotspots of food groups within Aruba's food basket. These hotspots indicate where extra attention might be necessary in the more detailed analysis. This more detailed analysis will then give insight into the contribution of different life cycle phases (e.g. agriculture, air transport, waste management etc.), as well as the contribution of different food groups to the total environmental impact of Aruba's food basket. These results can form the basis for strategic decisions towards more sustainable and more circular food chains, food choices, and food systems.

This oral presentation will show the results of the exploratory analysis. Then we will focus on challenges and solutions in calculating the environmental impact of a food basket, with special attention to island-related features. Challenges at different stages of the research process will be outlined: challenges in carrying out the first analysis, challenges in moving forward to a more detailed analysis, and (expected) challenges in carrying out the more detailed analysis. Challenges include data availability of the complete chain leading to products in Aruba's food basket, and data availability, quality, comparability, and transparency related with environmental impact models.

Keywords

Environmental impact, Carbon footprint, Islands, Challenges, Food basket

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PhD Session: Poster presentations

#190: Upcycled food research for small food businesses: a solution towards SDG 12.3

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Small grocery stores and restaurants generate food by-products and surplus food during the production and preparation process. A survey of food waste conducted in 2019 for Tokyo's commercial areas showed that there were 13 types of by-products and surplus food types in food waste, including vegetables, okara, and other ingredients for upcycled food. These were found in small quantities but can be sold as upcycled foods. Additionally, it is possible to use these foods in combination to produce and sell a wide variety of products.

Upcycled food contributes positively to the environment and generates profits for the entire community; it will likely have a positive impact on the operation of small food businesses.

A study on the commercialization of food by-products and surplus food was conducted in the study area in 2018, using sold doughnuts made from deep-fried manjuu (steamed bun) scraps.

The result was a positive economic impact in addition to reducing food waste and carbon emissions. Forthcoming research projects will collaborate with local food stores and restaurants to produce and sell upcycled food products and to start demonstration experiments in July 2021.

Keywords

Upcycled food, SDGs12.3, Small food business, Local community

#195: A green strategy to isolate bioactive extracts from saffron floral by-products

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Saffron and its floral by-products are suitable and affordable raw materials for the production of sustainable and highly bioactive healthy food ingredients. Considering that only stigmas are used for saffron spice, the current production system is generating several hundreds of tons of tepal wastes, representing an enormous lack of profitability and sustainability. Consequently, the valorisation of saffron floral by-products by developing stable functional ingredients leads to the environmental impact minimization. The main objective of this research was to optimize microwave assisted extraction (MAE), an efficient technique to obtain high added value antioxidant compounds from saffron flowers with low energy footprint, at laboratory scale. Response surface methodology was used to optimize process parameters. Several MAE variables were studied (radiation time (0.5−5 min), temperature (25−100 °C) and water:ethanol solvent ratio [v:v (100:0, 50:50 or 0:100)]) to determine the optimal extraction parameters for maximizing responses such as: mass yield, concentration of bioactives (Total Phenol Content (TPC), Total Flavonoid Content (TFC)), and antioxidant capacity by Oxygen Radical Absorbance Capacity (ORAC) assay and Hydroxyl Radical Scavenging Capacity (HOSC) assay. The mass:solvent ratio (1:10 w/v) was fixed. The results indicated that depending on the time, temperature or solvent ratio used, the responses were different. The optimal extraction conditions were the combinations of higher temperature (100 °C) – lower time (3.25 min) using ethanol 50% or lower temperature (25 or 62.5 °C) – higher time (5 min) with ethanol solvent 50 or 100 %. Besides, saffron flowers extracts showed high levels of antioxidant compounds and high antioxidant capacity being the maximum values obtained: 126.20 ± 2.99 mg GAE/g dw (TPC); 8.05 ± 0.11 mg CE/g dw (TFC); 6219 ± 246 µmol TEAC/g dw (ORAC) and 3131 ± 205 µmol TEAC/g dw (HOSC). These results provide new information about the functional compounds present in saffron floral by-products extracts representing an important source of natural antioxidant compounds which could be considered as promising bioactive ingredients for the development of functional foods.

Keywords
saffron flower, phenolic content, flavonoids, antioxidant activity, added value ingredients

#197: Investigating instrumental and sensorial changes in a vegan tomato soup during accelerated storage

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A new vegan tomato soup was developed in this study. This soup was subjected to two different heat treatments T1 (=95 °C, 18 min) and T2 (=120 °C, 14 min). The two products thus obtained were stored under two accelerated conditions A1 (=37 °C) and A2 (=42 °C) for 140 days. Instrumental measurements (Colour, rheology, infrared spectroscopy, fluorescence and pH) and sensory profiling of these products were performed for different time points. The CIEL*a*b* values a* and ΔE* were significantly (p=0.05) higher for A2 than A1 in both treatments. Rheology analysis revealed shear thinning behaviour (n = 0.32±0.001 < 1). Stress-strain relationships showed a higher viscosity of A2 than A1 for both treatments. Comparisons of infrared spectral data indicated formation of aldehydes and unsaturated esters in samples stored for more than 100 days due to oxidation. Fluorescence spectroscopy revealed the formation of advanced Maillard reaction compounds in the stored samples. pH change was non-significant. Generic sensory descriptive analysis was performed on 18 (including two control) samples by a trained panel of 10 assessors (9 female:1 male; mean age 32±11 years). Altogether 19 sensory attributes related to appearance, aroma, taste, texture and aftertastes were identified. Samples were served in triplicates in a completely randomised block design. An Analysis of Variance (ANOVA) model was used to find out significant attributes in the samples. Results from ANOVA showed that 7 attributes were significantly different in T1 and 14 attributes were significantly different in T2. Principal component analysis performed on these attributes showed that samples at 30-day storage were closest to the control and exhibited green, vegetable, tomato and fresh attributes. Attributes such as off-flavour, bitter, burnt and thick were increasingly prominent in the samples as storage time increases in both treatments. Partial least square regression was employed to find a correlation between the sensory attributes and instrumentally measured values. A practical implication of this study is to illustrate the applicability of instrumental measurements to predict sensory properties to aid in new product development. A broad objective of this study is to provide a holistic approach in food science and towards a more sustainable production.

Keywords
Vegan tomato soup, Instrumental measurements, Sensory descriptive analysis, Accelerated storage

#202: Determination of mineral content in lulo (Solanum quitoense L.) fruit parts

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Lulo o naranjilla (Solanum Quitoense L.) is a tropical fruit highly wasted, having attractive sensory characteristics and nutritional potential. With the purpose of encouraging the use of lulo to reduce losses and expand markets, the present study aims to determinate the percentage of different parts of lulo and their major (K, Mg and Ca) and minor (Na, Fe, Zn, Mn and Cu) minerals content. Lulo fruits were separated into exocarp, mesocarp, juice, placenta and seeds. The components were dried at 105 ºC and calcinated at 550 ºC. Subsequently, the ashes were dissolved in HCl, diluted with deionized water and filtered in order to measure the mineral content by Atomic Absorption Spectrometry. Juice accounted for near 50% of the total mass of lulo, mesocarp for around 33%, and placenta, exocarp and seeds together add up to near 20%. Potassium was the major mineral on the different parts of lulo, with a concentration higher than 0.3% (FW) in exocarp, mesocarp, juice and placenta, and around 0.2% in seeds. This K content in lulo was larger than in pineapple and blueberries, similar to banana, and smaller to durian. The content of the other minerals decreased as follows: Mg > Ca > Na > Fe > Zn > Mn > Cu. Concentration of these minerals was larger in seeds and exocarp than in mesocarp, placenta and juice. Given the large content of potassium in the edible part of lulo, it would be recommended to improve the processing techniques to take advantage of the nutritional and commercial potential of this tropical fruit.

Keywords
Tropical fruit, lulo, minerals, potassium

#205: Valorisation of tomato industrial by-products in Campania for sustainable recovery of components and energy

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The Campania Region, due to its long-standing experience, is the main tomato processing pool in Europe; companies operating in this region process almost half of the Italian tomatoes for industry, namely 2.2 Mtons/y of fresh fruits.

The processing of tomato leads to a huge amount tomato pomace as residue. These residues can represent even the 10% in weight of the processed tomato, with a high moisture content in the range 69-90 % by weight. It is estimated that 64 ktons of tomato by-products are produced every year in Campania. Unfortunately, these residues are disposed of without any income for the processing companies, that is as animal feed or in the worst case sent to landfill, thus wasting high-value compounds and contributing to earth pollution.

Given the above, tomato processing by-products could be exploited through conventional biomass conversion (i.e., the biotechnological and the thermochemical route) to obtain biogenic fuels, and then electricity and heat. Anyway, it is undoubtedly convenient to extract and recover, before conversion, the high-value compounds present in the pomace. An extensive literature study revealed three main components of interest: i. lycopene, which is the most abundant carotenoid in peels and is well known to be the most powerful antioxidant; ii. cutin, which is the main building block of the fruit cuticles and it can be used as starting material for biopolymers; iii. pectin, which is another building block of the cuticle and can be used in food processing.

Considering this background, this PhD work is focusing the recovery of both added-value compounds and energy from tomato by-products of Campania industries by making recourse to the “biorefinery cascade approach”, namely a series of unit operations that, extracting the most valuable components from biomass first, leads to sustainable co-production of energy and high-value chemical compounds, with minimal generation of waste. Therefore, processes for the extraction, separation and exploitation of the building blocks of the residues will be analyzed, compared and selected in terms of tecno-economic feasibility by the means of modelling and simulation, and in terms of environmental sustainability by the means of Life Cycle Assessment (LCA), in a green chemistry and circular economy perspective.

Keywords

Tomato by-products, Biorefinery, Lycopene, Biodiesel, Energy recovery

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Regione Campania (DGR No. 156 21/03/2017 - POR Campania FSE 2014/2020 - obiettivo specifico 14 - azione 10.4.5)

#245: Preventing potato supply chain losses by use of FT-NIR spectroscopy

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For fruit and vegetables, ripening at harvest time is the main factor that determines product quality and shelf life. In fact, an incorrect estimation of the harvesting time and an improper application of the harvesting practices may cause harvest and post-harvest losses. Their reduction is pursued by the 3rd target of the 12th Sustainable Development Goal (United Nations), as evidenced by the following quote: "by 2030, halving per capita global food waste at retail and consumer levels and reducing food losses along the production and supply chains, including post-harvest losses".

Potato (Solanum tuberosum L.) is the fifth most cultivated crops in the world being considered as a staple food in many developing countries. The dry matter content (DM) is an important quality parameter for potatoes, and it is commonly used as a maturity index. The DM analysis is generally carried out gravimetrically or by oven drying. These methods are accurate, repeatable, and simple, but time consuming: they require a laboratory, 48-72 h of measurement and, most importantly, cannot be performed in situ. Thus, developing novel methods to enable operators to carry out fast and reliable on-site measurements may be important for choosing the optimal harvesting time for potatoes and for continuously monitoring the DM during storage, determining the destination of use and the price of the product as well as circumventing food losses by reducing possible storability issues.

The aim of this work was to develop a FT-NIR based method for DM analysis in potato tubers. Scans were carried out in the spectral range of 10000-4000 cm-1 (4 cm-1 resolution). Each scan area was cored (8-mm diameter, 5-mm depth) for DM determination by reference method (105°C for 72 h). Data obtained were used to characterize 12 varieties in terms of DM and for the development of DM predictive models for each potato tissues: (1) periderm, (2) cortex, (3) peripheral parenchyma and (4) central parenchyma. Model development was computed using the Partial Least Squares (PLS) algorithm. Features' selection was also performed and tested by using the interval PLS (iPLS) algorithm.

The best results were obtained through features selection. Specifically, the most performing iPLS model was obtained using spectra scanned on the central parenchyma: i.e., $0.78 < RMSE < 0.99$; $0.89 < R2 < 0.93$.

Keywords

Food losses, Solanum tuberosum L., Dry matter predictive models, Near-infrared spectroscopy, Chemometrics

#262: Effect of acid whey components on lactose crystallization properties

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Acid whey (AW) is the major by-product of Greek strained yoghurt industry. It contains lactose (3.8 % w/v), proteins (0.3 % w/v) and lactic acid (LA, 0.8 % w/v). AW has significantly high Biological Oxygen Demand (BOD, 30,000-35,000 ppm) and low pH value (4.5), making its biological treatment in regular sewage systems problematic. Thus, innovative methods of AW utilization for the production of high added value components like galactooligosaccharides (GOS) are currently investigated. In this direction, lactose crystallization occurring at high lactose concentrations, may interfere with AW valorisation processes optimization.

In the present study, the effect of major AW components (LA, proteins) and GOS on water sorption of lactose model systems was investigated. Water sorption on lactose systems, containing LA (0-20 % w/w), whey proteins (0-20 % w/w), and GOS (various lactose : GOS ratios) was monitored for 360 h in environments with water activity (aw) values of 0.11-0.97, at 20-50 °C. Glass transition temperature (Tg), crystallization temperature (Tcr) and latent heat of crystallization (ΔHcr) of lactose in selected model systems were also studied, via Differential Scanning Calorimetry.

The addition of LA affected water sorption isotherms of lactose model systems and the degree of lactose crystallization. Higher LA content resulted in more hygroscopic lactose systems and higher lactose crystallization degree. Addition of 10 % w/w LA in lactose led to reduction of Tg of pure lactose (60.8 °C) by 34, 39, and 44 °C after incubation at 30 °C and aw = 0.23 for 24, 48, and 72 h, respectively. On the contrary, the presence of whey proteins and GOS in lactose model systems showed an inhibitive effect on lactose crystallization.

In conclusion, the results of this study indicated that LA enhances lactose crystallization, which affects negatively AW lactose valorisation for enzymatic GOS production. On the other hand, the presence of GOS were found to hinder lactose crystallization, as did whey proteins. This indicates that during the enzymatic reaction, the produced GOS could hamper crystallization of AW lactose. Consequently, further research is required in order to clarify the ramifications of lactose crystallization affected by AW components, towards the optimization of enzymatic conversion of AW lactose into GOS.

Keywords

lactose, crystallization, acid whey, lactic acid, galactooligosaccharides

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SESSION 2: RESEARCH – SUSTAINABLE SYSTEMS FOR HIGH QUALITY, SAFE AND HEALTHY FOODS

Session 2: Oral presentations

Protein aggregation for food formulations: using electric fields to modulate protein functionality

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Proteins and protein-based ingredients are in the spotlight of scientific and technological research in the food area, mostly due to the most recent consumer trends, leading to a justified growing attention from both academy and industry. The ways of such research are very diverse, covering both new functional ingredients and new processes envisaging novel food and protein-based structures towards health and well-being. They often include the combination of emerging processing technologies with newly discovered functionalities of food components/ingredients and with out-of-the-box approaches (e.g., using nanotechnology to improve bioavailability of said food components/ingredients), targeting improvements of food functionality or food structure.

This lecture will address the use of proteins for the production of nanotechnology-based structures, using electric fields to tailor proteins' functionality, together with an approach to evaluate their behaviour during digestion using an *in vitro* gastro-intestinal system.

Keywords

Changes in protein functionality, electric fields processing, food properties

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Outcomes of the fecal excretion of SARS-CoV-2

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Despite COVID-19 is a respiratory disease, large amounts of genomes of its etiological agent, the SARS coronavirus-2 (SARS-CoV-2) are shed in the faeces that ultimately reach wastewaters. However, there is no epidemiological evidence of a potential faecal-oral transmission, though contaminated food products, food packages, surfaces or water, since very few infectious particles are actually shed in stool.

Water-based epidemiology (WBE) is a valuable early warning tool for tracking the circulation of the virus among the population, including not only symptomatic patients, but also asymptomatic, presymptomatic and misdiagnosed carriers, which altogether represent a high proportion of the infected population. In addition, SARS-CoV-2 occurrence in wastewater ascertains the efficacy of adopted lockdown measures on the circulation of the virus. Sentinel surveillance of specific sewers may also help to locate COVID-19 hot spots and to conduct massive RT-PCR tests among the population.

With the appearance of several SARS-CoV-2 variants of concern, early detection of these variants in wastewater samples is imperative for the adoption of rapid and adequate measures to mitigate the effects of their transmission. Our laboratory is presently involved in surveillance networks comprising around sixty wastewater treatment plants in Catalonia, and thirty in the rest of Spain.

Keywords

SARS-CoV-2, COVID-19, epidemiology, surveillance, early warning, sewage

2.1. Minimising losses in food production

The ins and outs of Life Cycle Assessment for agri-food chains

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Our modern agri-food chains are inherently very entangled and complex chains. Currently, most of them are optimized for efficiency and profit from an economical point of view. When it comes to the environmental impact of our foods, we have to bring Life Cycle Assessment (LCA) into the picture. LCA is essential to decipher the best way to go, the option to choose. In this invited lecture an overview of LCA and its application in the agri-food chain will be presented.

The aim of the first part is to go into the broad LCA steps but also into rather technical details, all of this with the goal to inform food engineers and food scientists without a background in LCA about its strengths and limitations.

In a second part, we will illustrate how LCA helps to get answers to existing questions on food and food chains, like whether to prefer local or imported food or choosing a suitable packaging solution. We will show how, even with all of its imperfections, it is better to take the chain perspective, inherent to LCA, then to overly focus on visible environmental impacts or *green* reputations.

Finally, we will illustrate what it means when one compares several schnitzels (meat, vegetarian, vegan) regarding their environmental impact when we look at several so-called LCA *functional units* such as weight after processing or nutritional value.

Altogether, this lecture will show how the chain perspective of LCA allows to make scientifically founded choices towards a more sustainable food production and consumption.

#170: Quick and non-invasive assessment of fish freshness with a tiny gas sensor based on a single SnO2 nanowire

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A solid state gas sensor consisting in one single tin oxide nanowire is used to assess the freshness status of mackerel fish (Scomber scombrus) in a quick and non invasive way. The response of the tiny chemiresistive sensor is first tested with different concentrations of pure ammonia, and then used to measure the total volatile basic nitrogen (TVBN, mainly composed of ammonia, trimethylamine and dimethylamine) from different samples of fish, at different degrees of freshness. The sensor has proved capable of determining the freshness of a sample in few seconds, compared to traditional methods such as microbial count and chromatography which take hours. The sensor response is well correlated with the total viable count, proving that the gas sensing of TVBN is a good way to quickly test the bacterial population in the sample. After calibrating the sensor (following the degradation of the fish during almost two days), it has been tested with random double blind samples, proving that it can well discriminate the degree of freshness of the fish preserved at different temperatures.

Considering the rapid deterioration of fresh food and the modern and long and complex supply chains, we believe that such a small device (less than a square millimetre, can also be integrated into a mobile phone) can help assess the freshness of fish in a non-invasive way throughout the entire journey from producer to consumer. This would reduce food waste and food poisoning.

Keywords
fish freshness, total volatile basic nitrogen, gas sensor, single nanowire, chemiresistor

#235: Effect of different packaging materials on the shelf-life of chestnut (Castanea sativa Miller) during short-time storage

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Chestnuts are a perishable product that loses weight and spoils quickly. Therefore, it is essential to find methods to reduce economic losses. This study aimed to evaluate the effect of four different packaging materials - polyethene packaging" POLY", polyethene packaging with holes "PH", Modified Atmosphere Packaging "MAP", Vacuum bags "VAC-bags" and unpackaged chestnuts "control" - on the shelf-life of chestnuts stored at room temperature during 0, 2, 4 and 6 weeks. Several parameters such as colour, texture, moisture content, water activity, titratable acidity, total soluble solids, starch, amylose, aerobic mesophiles, and moulds and yeasts were determined.

The results showed that the colour, texture, moisture content, water activity, titratable acidity and total soluble solids were little affected by the type of bags used. The starch ranged from 35.2 to 50.4% dry matter (d.m.) without a specific trend, and amylose expressed on the starch basis (25.7 to 45.0%) suggested no remarkable starch functionality changes.

On the contrary, significant differences were observed between bags in weight loss, reducing sugars and microbial counts. The VAC-, MAP-, and POLY-bags showed percentages of weight loss lower than 2%, while the control and PH-bags had values equal to 13.2 and 9.2%, respectively. The highest values of reducing sugars were observed in POLY- and PH-bags, followed by the control, suggesting partial hydrolysis of the starch. Furthermore, VAC- and MAP-bags' application caused a considerable decrease in aerobic mesophiles, moulds and yeasts growth compared to the control during two and four weeks of storage.

Keywords

Chestnuts, Vaccum bags, Polyethene bags, Modified Atmosphere Packaging, Storage

Acknowledgements

FCT (Portugal) [CIMO: UID/AGR/00690/2019] and PDR2020 [ValorCast Project - PDR2020-101-032034

#282: Agro-industrial side streams recovery to the nanocellulose production by different methods

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Salicornia ramosissima is a halophyte plant commonly found in salt marshes and coastal areas worldwide. In Portugal, there are some ventures of industrial production of Salicornia for human consumption using different cultivation methods including hydroponics. After harvesting, the lower part of its stem, and the roots are discarded as there is no commercial value to it. This study was developed to find solutions for the valorization and application of these waste streams, by extracting and isolating its nanocellulose and investigating its potential for the development of biopolymer composites. To obtain the cellulose nanofibers (CNFs), Salicornia waste samples were first subjected to alkaline treatment to eliminate non-cellulosic components. Then, bleach (H2O2) broke down the phenolic compounds which were next easily removed, whitening the pulp. Finally, for the separation of cellulose fibrils from the cell wall and obtaining CNFs, the insoluble residue was hydrolyzed by either the acid treatment (AT) or the enzyme treatment (ET). The analysis of FTIR spectra revealed that both AT and ET effectively removed the amorphous components from the bran structure and allowed the isolation of CNFs. From the analysis of XRD patterns, it was possible to observe the elimination of partial hemicellulose and lignin, resulting in an increased crystallinity degree of CNFs. The CNFs from AT (CNFsAT) presented a lower mechanic resistance due to their smaller particle size compared to CNFs from ET (CNFsET). The zeta potential values for CNFsAT and CNFsET were respectively, -29.9 and -52.2 mV. The higher potential for CNFsET suggests more electrically stable nanofibers. SEM micrographs indicated fiber exposure caused by both the AT and ET, in addition to the irregular bran structure. TEM images confirmed the presence of nanofibers in both CNFs-ET and CNFsET samples. ET successfully isolated cellulose nanofibers from the by-products of Salicornia, encouraging the use of this agro-industrial residue as a renewable source of nanofibers as in contrast to the AT, it does not generate toxic residues, presented mild thermal conditions, and produces nanocellulose fibrils with high-value applications.

Keywords

Food waste recovery, Salicornia ramosissima, Cellulose nanofibers, Acid hydrolysis, Enzymatic hydrolysis

Acknowledgements

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#310: Possibilities for sustainable reduction of apple losses at packaging level

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The environmental impact linked to food loss and waste can be significant, due to the unnecessary use of all production inputs (energy, water, …) used throughout the agri-food chain up to the moment of loss. Thus, striving for a sustainable food chain, minimizing food losses and waste by dedicated intervention steps has become an important topic for all actors, including food engineers and food technologist.

Agri-food chains, which intend to bring for example high quality, safe food products to the consumers, are inherently very complex and optimized from an economical point of view. This complexity implies it is not straightforward to know which type of intervention is – at the end of the day - the most rewarding, the most contributing to an environmental impact reduction, while still being able to deliver the same high quality, safe food products to the consumers.

When it comes to the apple food chain, more specifically the post-harvest chain, there are opportunities at the packaging level to avoid losses by reducing the package size, seeing as for pre-packed apples, the entire package is thrown away when one apple is spoiled, and by changing the food grade packaging materials. In this research, we started from our previously conducted life cycle assessment where we covered the entire apple chain from orchard to consumer, with a functional unit of one kg of apples available for sale in the supermarket (Goossens et al., 2019). Specifically, we compared the environmental impact which would be obtained when employing five different packaging configurations involving combinations of cardboard, EPS, HDPE and/or PVC plastic foils for 4 or 6 apples. In our adjusted life cycle assessments, we also considered the implications of such changes on other stages – e.g., the change in transport by using different materials – only modeling the change in the specific package would not be scientifically correct nor reflecting reality. The results showed a beneficial effect linked to the use of plastic instead of cardboard, and reduction of the number of apples from 6 to 4 showed promising results.

The prevention of food losses at retail level and the valorization of food waste at household level contribute to achieving Sustainable Development Goal 12.3, while at the same time allows the supply chain to take action against climate change (SDG 13).

Keywords
apple, packaging, life cycle assessment, package size, package material

#317: Supercritical carbon dioxide extraction of flavour compounds and bitter acids from hops: process optimization and product characterization

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For centuries hops are used as bittering, flavouring and stability agents in brewing industry. In addition, various secondary hop metabolites (aroma compounds, bitter acids, prenylflavonoids) exert a broad spectrum of beneficial pharmacological effects (antioxidant, immunomodulatory, anticancerogenic, antimicrobial, antifungal, anti-inflammatory, etc.), indicating its potential as an effective herbal remedy. Due to the poor shelf life of hop inflorescences and unstable nature of bioactive constituents, hops are typically processed into various products (powders, pellets, extracts, isomerised extracts, hop oil, etc.). This study demonstrates the valorisation of dual-purpose Ella variety hops (T90 pellets) into functional aroma and bitter acid fractions by supercritical carbon dioxide extraction (SFE-CO2) under different experimental conditions. The obtained results indicate that after 300 min of SFE-CO2 at low pressure (10-15 MPa), 9.3-22.1g/100 g of pale to dark yellow fraction of varying volatile compound composition was recovered. At higher pressure (25-45 MPa), SFE-CO2 was optimized by response surface methodology (RSM) and central composite design (CCD) for the effective α- and β-acid isolation. Under different experimental conditions (25-45 MPa, 40-60°C, 30-90 min), SFE-CO2 yielded 13.9-27.6 g of non-polar extract from 100 g of hop pellets, containing 143-238 mg/g of bitter acids and exerting strong oxygen radical scavenging capacity in vitro (252 to 375 mg TE/g hops). The major constituents were α-acids, amounting 37-138 mg/g hops (64% of humulone and adhumulone, 32% of cohumulone), while the content of β-acids was up to 2-fold lower. The dominant volatile compounds identified were the sesquiterpenoids β-humulene, α-humulene and α-selinene, the monoterpenoids β-pinene and β-myrcene, the ester methyl-4-decanoate, contributing to the fruity, herbal, spicy and woody odour notes to the extracts. In conclusion, the results of this work may be considered as another case study demonstrating the application of SFE-CO2 to concentrate target functional hop phytochemicals and to produce lipophilic extracts with broad commercial applications.

Keywords

Hops, Supercritical CO2 extraction, α- and β-acids, Flavour compounds, Antioxidant capacity

Acknowledgements

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#338: Mathematical modelling of avocado (Persea americana) fruits quality changes along with storage and distribution

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Avocado, a fruit that originated from southcentral Mexico, is nowadays distributed all over the world due to its health-promoting properties. The long-distance transportation and storage conditions can significantly affect the fruits quality and shelf life. The mathematical modelling of avocado quality parameters at different storage temperatures can be a tool to manage the distribution chain and minimize quality losses.

In this study, "Hass" avocados were stored at three different temperatures of 5, 20 and 30ºC, and physical and physiological changes were evaluated over time. A set of 30 avocados were used to follow mass loss, size and colour. By using computer vision system analysis, co-occurrence matrices were generated and standard features calculated. Other 200 avocados were used to evaluate the firmness and chlorophylls degradation.

The avocados shelf life was 55, 20 and 10 days, respectively, at 5, 20 and 30˚C. Kinetics of quality parameters change were well described by first-order reaction models at the three storage temperatures, except chlorophylls content with no significant changes. The temperature effect was well described by the Arrhenius equation. Using a one-step nonlinear regression, it was possible to obtain the reaction rates at a reference temperature of 20ºC and corresponding activation energies. Moreover, it was possible to correlate image features, such as correlation and energy, with mass losses and firmness.

This work will contribute to better management of avocado fruits distribution under dynamic conditions, by using a non-destructive computer vision system method.

Keywords

"Hass" Avocado, Shelf life prediction, Quality, Computer Vision System, Predictive model

Acknowledgements

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2.2. New technologies for healthy food and sustainable food production

Sustainable nonthermal food processing: innovative solutions

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Nonthermal processing technologies have been researched for their possible improvement of food preservation technologies. There are mechanical based, pressure-based technologies, electro-technologies, and non-electro-technologies. High pressure processing (HPP) and pulsed electric fields (PEF) have reached technology readiness level (TRL) to be successfully implemented in food industry processing plants. Majority of other nonthermal technologies are in TRL 3-4 level. Another great driver to focus on, is the need to obtain efficient, low energy, low temperature processing by achieving food safety and food quality. There is need to develop (improve) nonthermal processing to achieve higher TRL and to show advantages of these technologies. For some of them, *i.e.,* high power ultrasound processing, there is a need to combine mild heating with acoustic processing to achieve food safety. There is need to develop research and development strategy, in line with Agenda 2030. and sustainable development goals (and indicators) to monitor, measure (by life cycle assessment approach) and to validate nonthermal processing. When discussing about sustainability, one needs to know that sustainability is showing the impact to environment, economy, and society.

Focus on application of nonthermal technologies in processing, is to obtain "cleaner technologies" and efficiency through the life cycle of a product or system. Innovations in the processing line of implementing nonthermal processing, are through interdisciplinary, interprofessional cooperation. There is need to focus on applying elements of Industry 4.0 in complete product development and digitalize elements of nonthermal processing. By digitalization, it will be easier to monitor and to optimize processing, achieving lower carbon, water, waste footprint, and monitor processing in closed circle (circular economy). There in need to go "green" and digital, to improve existing processing line, and to innovate processing chain. The process is sustainable, in terms of having waste management and zero waste processing. By using nonthermal technologies, one can tackle, food preservation, by-products extraction (bioactive compounds, fibres, pigments), wastewater processing, waste management, pre-treatments, in-packaging treatments etc.

Keywords
Sustainability, nonthermal processing, innovation, digitalization, Industry 4.0.

#209: Green approach to the extraction of functional phytocompounds from olive pomace: focus on drying methods and supercritical fluid extraction

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The management of wastes and by-products of large-scale agricultural processes represents a key factor in reducing production costs, providing economic and environmental advantages related to their reuse. Moreover, huge amounts of residues resulting from food industries (i.e., olive oil, wine, and dairy product chains), in some cases, induce issues of pollution related to their phytotoxicity and high costs for their disposal. Olive pomace represents a semisolid by-product of olive oil production which is considered a promising source of interesting functional compounds, such as polyphenols, tocopherols, β-sitosterol, squalene, chlorophylls, and carotenoids. In this framework, our research was aimed at upcycling olive pomace by supercritical carbon dioxide (SC-CO2) extraction of functional phytocompounds, further evaluating two different drying methods, based on freeze and hot air-drying. Moreover, olive pomace obtained by the two most common olive oil industrial extraction processes with two (2P) and three-phases (3P) decanters were considered. Our results showed that freeze-drying preserved better the functional molecules (especially α-tocopherol, carotenoids, chlorophylls, and polyphenols), whereas for squalene no differences between freeze and hot-air drying were detected. Hot-air drying did not compromise the content of β-sitosterol. Higher amounts of α-tocopherol and polyphenols were extracted from 2P olive pomace, while β-sitosterol, chlorophylls, and carotenoids were more concentrated in 3P olive pomace. Finally, tocopherols and pigments/polyphenols fraction exerted antioxidant activity as in vitro as in accelerated oxidative conditions. Overall, our results highlight the potential of the olive pomace to be upcycled by extracting from it, with green methods, functional phytocompounds for reuse in food and pharmaceutical fields, thus also contributing to the sustainability of the olive oil system.

Keywords

olive pomace, upcycling, olive oil system sustainability, supercritical fluid extraction

Acknowledgements

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#320: High-pressure extraction of antioxidant-rich fractions from shrubby cinquefoil (Dasiphora fruticosa L. Rydb.) leaves

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Dasiphora fruticosa (basionym *Potentilla fruticosa*) is a shrub, known in traditional medicine for centuries. Due to the wide range of pharmacological effects, interest and applications of *D. fruticosa* extracts are continually increasing; however, reports on optimization of extraction conditions are scarce. Herein, a multi-step high-pressure extraction process with increasing polarity solvents was developed to isolate valuable fractions from *D. fruticosa* leaves.

Supercritical CO_2 extraction recovered 2.46 g/100 g of lipophilic fraction, rich in polyunsaturated fatty acids. Further, pressurized liquid extractions (PLE) with acetone, ethanol, and water were applied to obtain antioxidant-rich higher polarity extracts. PLE extraction conditions were optimized employing central composite design and response surface methodology. Under optimized PLE conditions, the cumulative polar fraction yield was 29.98 g/100 g. Ethanol fraction showed the highest yield (15.3 g/100 g), TPC values (148.4 mg GAE/g), ABTS•+, and DPPH• scavenging capacity (161.1 and 151.8 mg TE/g, respectively). PLE was more efficient than conventional solid–liquid extraction in terms of extraction time, extract yields, and in vitro antioxidant capacity. Phytochemical characterization of PLE extracts by UPLC-Q-TOF-MS revealed the presence of hyperoside, ellagic acid, among other health-beneficial phenolic substances.

Overall, this study highlights the potential of sequential high-pressure extraction as a simple and efficient alternative for the recovery of natural antioxidants from *D. fruticosa* leaves, a promising source of bioactive compounds for food nutraceutical and pharmaceutical applications.

Keywords

Dasiphora fruticosa, phenolic compounds, response surface methodology, high-pressure extraction

#311: Engineering aspects of moderate electric field (MEF) processing of food emulsions

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The Moderate Electric Field (MEF) processing of foods consists in the application of an electric potential gradient ranging from 1 to 1000 V/cm on a food system placed between two electrodes, its main effect being the food heating due to the dissipation of the electric energy into heat within the food item. MEF heating is considered as a high efficiency process and its application in food processing can contribute to enhance food processing sustainability. The heating performances of such a system (and its efficiency too) depend on several parameters, including the applied potential gradient, the food electrical conductivity, and its thermo-physical properties. MEF heating has been successfully proposed for homogeneous food systems, while its application in heterogeneous food systems is still under investigation. This work presents the engineering aspects of MEF processing of food emulsions (constituted by "pesto", a basil-based sauce, thus vegetable fibers dispersed in a slightly salted water-oil emulsion) treated in a custom MEF system on the food heating rate are investigated. The samples were prepared at different salinities and water/oil ratio.

The MEF system used was mainly composed by: a variable transformer (VAM20F-1N, Input, 230V AC, 50/60Hz, K-FACTOR Castellarano, Italy); a MEF cell made of glass (internal dimensions of L=10 cm H=6 cm W=5.1 cm) and two stainless steel electrodes (thickness 0.19 cm).

Results showed that an optimal composition exhists to enhance the process efficiency: while in homogeneous food systems, the salt content is the main responsible for heating rate and process efficiency (the higher the salt content the shorter the processing time and the higher the process efficiency), in emulsions both the salt content and the ratio between oil and water in the sample formulation play a crucial role in determining the thermo-electrical behavior of the food systems. In a range of salinity of 0-3.25% w.w. and of water/oil ratio 0-4, the samples with an intermediate salinity (1.63%) and intermediate water/oil ratio (2.07), exhibited a higher electrical conductivity, being due to a minor concentration of the non-conductive phase (namely the oil phase as well as the dispersed vegetable fibers into the solution) that exerts a major degree of electrical insulation.

Keywords

MEF heating, sustainable food processing, food emulsion

Acknowledgements

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#217: Pulsed electric field (PEF) treatment of house crickets: effect on drying and protein extraction

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The growing interest on the utilization of insects in the food and feed sector is due to their high nutritional profile and specifically high protein content. Low consumer acceptance of insects in the western countries creates the need for utilizing them as a food ingredient or isolating their valuable compounds. The application of pulsed electric fields (PEF) has been shown to be a promising pretreatment to assist the drying process and the extraction of valuable compounds. Therefore, this study focused on the enhancement of drying and protein extraction due to a PEF-pretreatment of house crickets. Fresh crickets were pretreated with PEF at several levels of energy input (4.9-49.10 kJ/kg), using a batch chamber. The insects were dried with a drying oven operating at 70 oC, until they reached constant weight. The moisture ratio was expressed mathematically as a function of drying time, using several mathematical models that were evaluated based on their regression on the experimental data. Protein extraction was performed from the crickets, directly after the PEF pretreatment, after oven drying and freeze drying, with a 0.5M NaOH solution at room temperature for 1 h. The functional properties, such as oil-binding capacity (OBC), water-binding capacity (WBC) and emulsifying capacity (EC) of the isolated proteins were evaluated. PEF-pretreatment reduced significantly the drying time of the crickets, while all the models showed a high goodness of fit ($R2 > 0.9$). Furthermore, PEF-pretreatment led to an increase of the protein yield (18.62% increase after 60 min), with no significant differences between the yield obtained by treatments at different energy input.

Keywords
crickets, pulsed electric field treatment, drying, protein extraction, functional properties

#278: Exopolysaccharide production in doughs fermented with black chickpea yeast

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Black chickpea is a regionally known colored chickpea variety with high fiber and antioxidant content. Chickpea yeast is a traditional yeast type that gives bread its distinctive aroma and obtained by fermentation of a mixture of crushed chickpeas and water. In recent years, the increasing demand for natural polymers for various industrial applications has led to a growing interest in microorganisms' exopolysaccharide production. Exopolysaccharides produced by lactic acid bacteria are the most natural alternatives to hydrocolloids commercially used in bread production. In this study, exopolysaccharide production in doughs prepared using black chickpea yeast and black chickpea flour was investigated. Firstly, the preparation of black chickpea yeast was optimized by fermenting black chickpeas at different fermentation times and temperatures by monitoring the odor formation, foam formation and pH change. Afterwards, process variables of fermentation temperature (25-35 °C), sugar amount (5-15%) and dough yield (200-300) were selected as factors in experimental design because of their critical roles in exopolysaccharides production. The fermentation time was kept constant. The doughs were prepared according to the experimental design using prepared black chickpea yeast and black chickpea flour. The pH, acidity and the amount of exopolysaccharide produced during fermentation were measured at the end of fermentation period. The effects of the selected process variables on the exopolysaccharide production were determined. The titratable acidity of dough was in the range of 1.47 to 3.1%, while the pH values varied between 4.32 and 5.06. The fermentation temperature and dough yield had a significant effect on exopolysaccharide production, but the amount of added sugar did not affect on exopolysaccharide production. Black chickpea flour fermented with black chickpea yeast can be used directly in gluten free formulations due to its natural exopolysaccaride content.

Keywords
Black chickpea, chickpea yeast, fermentation, dough, exopolysaccharide

Acknowledgements
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#164: Priming and Elicitation under LED lighting to Enrich Cruciferous Red-Coloured Sprouts in Glucosinolates

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Cruciferous foods (Brassicaceae) are rich in glucosinolates/isothiocyanates (GLS/ITC), characteristics for the organoleptic quality of these vegetables and their claimed bioactivity against cancer, respiratory problems, chronic inflammation, as well as cardiovascular and neurological disorders.

Very recently, the use of LED lights for the production of foods is becoming popular for indoor production systems, as well as the replacement of other methods of artificial lighting to reduce costs and energy consumption, increasing the value of fresh foods. The use of LED lights for the production of cruciferous sprouts, needs optimization. Seeds of Red radish (Raphanus sativus var. sativus L. cv. Sango) and Red cabbage (Brassica oleracea var. capitata f. rubra) were first primmed with food grade H2O2 vs. household bleach, followed-up with aeration until 24 h of imbibed seeds that were sown and let grown on inert substrate in a growth chamber using SysLED BioLED LED lights in a controlled environmental conditions chamber. After 3 days of dark growing germination period, the 2 varieties were sprayed daily either with Methyl-Jasmonate (250 µM) or salicylic acid (100µM), until harvest day (8-day old sprouts). The study of the performance (biomass) of the sprouts and the GLS profiles analysed by HPLC-DAD under this novel production system were carried out in order to find differences between the priming and elicitation treatments on the quality and GSL composition of the edible sprouts. The preliminary evaluation of data leaded to differences in terms of germination rates (H2O2 versus bleach) as well as in the fresh biomass at harvest depending on the variety. The identification of glucosinolates in these sprouts revealed qualitative differences according to variety and suggested the possibility of using specific GLSs as markers for the variety: glucoraphenin (GRE) and Dehydro-Erucin (DH-ERN) in red radish; glucoerucin (GER) and Neoglucobrassicin (NGB). The effects of the elicitor applications (MeJA and SA versus untreated control) using LED lights for obtaining the red-coloured cruciferous sprouts enriched in glucosinolates (GSL) is under evaluation.

Keywords
Brassica, Healthy Foods, Bioactive Compounds, Sustainable Food Production, Indoor Farming

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#152: Multiplex lateral flow immunoassay for the determination of meat products adulteration

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Consumers are nowadays concerned by food authenticity and adulteration. A problem of contamination of meat products with undeclared kinds of meat necessitates the need for rapid tests to detect meat adulterants. The traditional analytical methods (HPLC, PCR, etc.) have to be accomplished by rapid and cost-effective tests to carry out mass monitoring of food products. Immunoanalytical techniques which are characterized by high sensitivity and specificity are considered to be an effective tool to solve this task.

This study presents the development of immunoanalytical test systems for the detection of meat types in raw and processed food products. It is based on immunochromatographic analysis of immunoglobulins as a biomarker for species identification. The proposed analysis can be applied both for rapid authentication of several species in meat products and for quantitative estimation of their ratio in raw materials.

During the assay, immunoglobulins that are contained in muscle tissue and can be easily extracted from meat are detected. A sandwich format of lateral flow assays (LFIAs) based on gold nanoparticles as a label and colorimetric detection (both visual and instrumental) is used to determine immunoglobulins and, consequently, a source of meat.

It was found that the developed LFIAs allows distinguishing mammalian (beef, pork, and lamb) and poultry (chicken, turkey) meat sources within 20 min. To achieve the highest analytical parameters, the LFIAs were optimized by varying combination of immune reactants, test strip composition, and the assay conditions. Different methods for sample preparation of meat products were tested and compared. The developed LFIAs were applied to analyse meat foodstuffs and allowed revealing an adulteration with up to 0.06% (w/w) sensitivity thus demonstrating high productivity and accuracy of the results. The proposed test systems can be recommended for rapid on-site screening control of the composition and quality of meat products.

Keywords

Lateral flow immunoassay, immunoglobulins, meat products, adulteration, food safety

Acknowledgements

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#183: NIR spectroscopy as a sustainable technology for the food system

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The stakeholders of modern food production chain, aware of their pivotal role in facing Sustainable Development Goals, are envisioning the reorganization of their systems to reach optimized sustainable productions, guaranteeing safe and good products while minimizing food wastage. Therefore, the scientific community must look for innovative approaches, answering the industrial needs in a holistic vision.

The work aims at presenting few key applications of near infrared spectroscopy (NIRS), combined with chemometrics, to monitor and optimize production processes and food quality, thus answering to loss reduction and sustainable production challenges.

Dairy sector - A NIRS Process Analytical Technology solution for the monitoring of rennet-coagulation during cheesemaking is presented. The chemometric model allowed the identification of profiles describing the three main coagulation phases. The obtained control charts provide the dairy sector with reliable solutions to detect possible coagulation failures from the very beginning, thus improving product quality and production yields.

Extra Virgin Olive Oil sector – The use of NIRS and image analysis was evaluated for the assessment of the ripening stage of intact olives. The classification models were constructed on data collected from 13 olive cultivars at different maturation stages along three harvesting years. The promising results pave the way for the development of dedicated devices to be used directly in the field.

Milling sector –An integrated solution for process monitoring and control based on the real-time data collection by MicroNIR sensors, installed directly on-line, is described. The obtained results demonstrate the possibility of predicting relevant common wheat grain and flour characteristics (such as chemical composition, and Farinograph®, Alveograph® and Extensograph® indexes) at industrial level, thus guaranteeing the desired quality while minimizing losses.

The presented approaches provide the food sector with fast, green, and non-destructive methods in line with the Industry 4.0 vision.

Keywords

near infrared spectroscopy, sustainable production, dairy, extra virgin olive oil, milling industry

Acknowledgements

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#312: Mathematical modelling for design and optimization for novel – innovative (and sustainable) food processing

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Knowledge of mathematical modelling provides significant information for further design and optimization of food processing operations. Advantages of modelling can be summarized as providing quick predicting the results of what-if scenarios and insights into complex processes. Mathematical modelling in food processing is an interdisciplinary approach involving transport phenomena driving the process, and it must be combined with chemistry, reaction kinetics and predictive microbiology for further optimization purposes. Essential aspects of a mathematical model are to define physical, chemical or biological changes, develop the mathematical basis with appropriate assumptions, solve the problem with the required mathematical background and validate for various conditions. Optimization approaches, based on an experimentally validated mathematical model, are then used for further design of the process.

Based on this brief background, this review covered mathematical approaches (numerical solutions: finite difference and finite element-finite volume methods and computational fluid dynamic-CFD applications) for modelling of simultaneous transport phenomena, emerging approaches for model validation, optimization strategies (for process efficiency and food product quality) and modelling and optimization examples for novel emerging processing technologies of microwave – radio frequency heating, rotational and shaking retort processes.

Keywords

food processing, mathematical modeling, design and optimization

#159: Textural changes after solute aqueous extraction from beetroot subjected to a pulsed electric field pre-treatment

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PEF (pulsed electric fields) assisted extraction by diffusion is widely studied for different products and shown to be promising for fresh food plants in modern industrial technologies (e.g., sucrose extraction from sugar beetroot, phenolic extraction from grapes) (Vorobiev and Lebovka, 2011). The modern green extraction seeks to avoid the use of dangerous and polluting solvents and encourages the use of eco-friendly solvents like water. For example, the extraction of sugars from sliced beetroot requires prolonged hot water diffusion at 70-75 ºC followed by several steps for juice purification. PEF-assisted "cold" extraction prevents thermal degradation of the cell wall and the extraction of components to the juice it is easily achieved. This study intends to investigate the effect on beetroot slices (5 mm thickness) texture and colour compounds release using PEF assisted pre-treatment (EPULSUS®-LPM1A-10, EnergyPulse Systems, Lda) before aqueous extraction (0,12-1kV/cm), at room temperature. Texture analysis was performed using a texture analyser TA.XT2 plus, Stable Micro Systems equipped with 50 kg load cell performing a uniaxial compression test using a three-point bend rig HDP/3PB probe (Forward Extrusion cell) and maximum force during deformation was determined. Colour was evaluated by spectrophotometry (540 nm). Results shown that the application of PEF to beet slices between 0.1-1 kV/cm, tPEF = 0.04 s, 0.13–10 kJ/kg, before aqueous diffusion at ambient temperature leads to an increase in samples diffusivity of colour components. It was also observed a decrease in hardness (maximum force) as the electric field strength (energy in kV/cm) increases. The use of PEF treatment in beetroot slices shown to be efficient in the extraction of colour compounds accompanied by microstructural changes as the resistance of the samples decreases. These changes in the microstructure may be associated to the transmembrane electro-permeabilization (electroporation) after PEF treatment.

Vorobiev, E., Lebovka, N. I. (2011). Enhancing extraction processes in the food industry series: Contemporary food engineering. In N. Lebovka, E. Vorobiev, & F. Chemat (Eds.), Enhancing extraction processes in the food industry (pp. 25–83). CRC Press, Taylor & Francis LLC.

Keywords

pulsed eletric fields, sliced beetroot, aqueous extraction

#340: Impact of different biodegradable packaging strategies on the sensory profile of cheese: application of check-all-that-apply on a shelf-life study

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The shelf-life extension of dairy products, and specifically cheese, is a subject of great interest, and it has mainly been investigated due to high demand and increase in exports. The shelf-life of a product can be defined as the time the product remains safe, whilst the optimal sensory characteristics are kept. As the consumer is the final judge of the chain, it becomes crucial to evaluate whether the acceptance and perception value of the products remains the same, even if the food safety conditions are guaranteed. The purpose of this study was to evaluate the shelf-life (0, 40 and 80 days) and to evaluate the sensory perception of mixture-milk cheese with three different packages, considering the primary film and the coating used. The packages used were: (i) Biodegradable polylactic acid (PLA) + synthetic coating with natamycin (PLA+SyntNat); (ii) Biodegradable polylactic acid (PLA) + polysaccharide-based coating with natamycin (PLA+EdNat); (iii) Biodegradable PLA with natamycin + polysaccharide-based coating (PLANat+Ed). For each shelf-life time, a panel of 80 consumers evaluated overall liking on a 9-point hedonic scale and assessed the sensory profile using a Check-All-That-Apply (CATA) ballot. This ballot had a total of 27 attributes organised by sensory dimension. The sample PLA+EdNat had a higher overall liking value with significant differences from the remaining. Over time, the sensory profile was similar, revealing a positive correlation with the attributes light colour, creamy and buttery texture, and milk taste. The sample PLA+SyntNat was stable over time either on the liking value either on the sensory profile, where it was associated with low intense odour, thick, hard and mealy texture. Sample with PLANat+Ed was associated with negative attributes as rancid odour and taste, mould and intense taste. It was also denoted some microorganisms on these two samples after 40 days of storing. Results show that consumers' sensory perception of cheese samples should be considered on the definition of shelf-life once the different packaging strategies lead to the perception of different attributes, positive and negatives, with a significant impact on overall liking.

Keywords

Check-All-That-Apply, mixed milk cheese, overall liking, sensory shelf life, sustainable packaging

Acknowledgements

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2.3. Risk assessment and strategies for food safety in a sustainable production

Microbiological food safety: challenges due to emerging risks

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Despite food safety management, about 600 million people fall ill after eating contaminated foods and 420 000 die every year in the world.

Microbial risk assessment allows to quantify the risk of public health effect and to optimize control measures. It consists in hazard identification, hazard characterization (severity, dose-response), exposure assessment and risk characterization. Emerging risks can shake the predictions because one or more factors become unexpected.

We will present an overview of emergence drivers illustrating them by several examples: changes of the pathogen itself (new virulence factors, new genes of resistance, ability to adapt and persist in food-processing environments), changes in microbial environment (climatic changes, modes of primary production, new modes of transformation or preservation, new consumption habits, globalization of commercial trade), and changes in host sensitivity (increasing in sensitive or ageing populations).

In conclusion, we will outline insights of the future challenges to microbial food safety which rely in particular on the development of rapid and quantitative methods as early warning systems, on the improvement in methods for detection and identification of pathogens, and on the development of next generation microbiological risk assessment.

#178: Knowledge and Attitude of Roadside Vendors Towards Food Safety in Thulamela Municipality, South Africa

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The objective of this study was to assess the knowledge and attitude of road vendors of food towards its safety in Thulamela Municipality of South Africa. Exploratory sequential mixed methods research design was adopted. Qualitative data were collected using a semi-structured interview guide administered to 28 respondents. Quantitative data were collected using a questionnaire administered to 136 respondents. Qualitative data were analysed using Atlas.ti version 8.0. Mean of scores and Spearman's rank correlation coefficient were computed using Statistical Package for Social Sciences version 25.0 for analysis of quantitative data. Among the 136 respondents, 90 % were married women aged between 41-60 years. Almost half of them (46 %) had attained primary schooling while 80 % had not received formal training on food safety. Respondents were knowledgeable about personal ($\bar{x}$ = 1.77) and food ($\bar{x}$ = 1.75) hygiene. They rarely considered knowledge of foodborne diseases ($\bar{x}$ = 1.41) and rules and regulations ($\bar{x}$ = 1.29) in defining the quality of food. The highest correlation relations between variables of knowledge of food safety were observed between "Staphylococcus is a term that causes foodborne diseases" and "Hepatitis A virus can cause foodborne disease" ($P < 0.01$). Respondents reflected positive attitudes towards personal ($\bar{x}$ = 3.21), food ($\bar{x}$ = 3.55), hygiene, and utensil management ($\bar{x}$ = 3.43). Although food vendors had considerable knowledge and positive attitudes towards food safety, this was not adequately translated into practice. Thus, the provision of training on basic principles of hygiene practices and safety might help to address the identified challenges. It is recommended to carry in-depth evaluations of roadside vending enterprises and craft suitable regulations that can be used to ensure the safety of roadside vended foods.

Keywords
Food handler, food safety; food supply chain; street-vended food

#238: Design of a low-cost traceability management system for small producers of organic quinoa (Chenopodium quinoa)

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The global pandemic produced by covid 19, has generated the need to know precisely the place of origin of the food we consume, as well as constantly looking for healthier and safer foods, it is in this context that the value chain of organic quinoa in the Puno region of Peru is the largest producer of this Andean grain with 35166 thousand tons exported in 2020, is in the search of technological solutions that allow generating confidence in consumers globally. The objective of this research work has been to generate a low-cost digital traceability system for small producers of organic quinoa, which allows to accurately identify the origin of the product, identify the space or place of production, the storage, processing and marketing conditions. It also seeks to reduce the number of invasive chemical analyzes that guarantee the health and organic quality of quinoa through efficient management of the information on the production system and the identified critical points that are assessed in a quantifiable risk analysis. The database is capable of generating free QR codes to see the validation of the product information throughout the chain. QR codes were obtained with all the necessary information of the product, identifying the producer on the final label of the product, the identification capacity of the traceability system is of the order of 99% of batches of individual producers and 98% of mixtures identified in the same container, that is, the system accurately identifies the origin of organic quinoa, whether in individual batches traced in containers where the QR code is unique, as well as the presence of more than one producer or product in a container considered a mixture where two or two are labeled. more QR codes. The system is also capable of generating a risk matrix based on the information on primary production and collection of organic quinoa, which has made it possible to reduce pesticide analyzes by 80% as a guarantee of organic quality. The development of the system is of great importance and a reference value for future research in complex production chains such as agricultural products.

Keywords

Traceability, organic quinoa, computational algorithms

#339: The quest for listeriosis prophylaxis – the consortium of a novel coagulin-producing probiotic with Nannochloropsis oculata towards a unique plant-based fermented beverage

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The potential of bacteriocins to counteract hypervirulent pathogens has been highlighted, constituting an alternative to antibiotic prophylaxis or treatment concerning listeriosis, where chemotherapy or vaccination could not be a possibility. Herein, we intended to develop a unique functional oat-based fermented beverage comprising a novel bacteriocin-microalgae consortium with *in gut* antilisterial capability, as a feasible preventive approach concerning this potentially fatal infection.

Bacteriocinogenic strain, *Lactobacillus alimentarius* MK426 was isolated and along with the herein generated corresponding isogenic mutant strain, not harboring coagulin plasmid, was employed as a starter culture for oat fermentation, concomitantly with *Nannochloropsis oculata* microalgae. Barley flour, an agricultural by-product, was utilized as the growth medium for lactic acid bacterium.The functional beverage antilisterial potential was evaluated through a simulated gastrointestinal tract (GIT) model and the ability to impair a 7-strain *Listeria monocytogenes* cocktail infection of Caco-2 cells. Fatty acids (FA) profiles of non- and fermented beverages were determined by GC-FID.

A sustainable vegetable-based culture medium, supporting a prominent bacteriocin biosynthesis, was formulated employing industrial wastages in a concept of circular economy.

L. alimentarius MK426 was first described as a coagulin biosynthesizing probiotic. The strain survival and *in situ* coagulin secretion throughout the GIT was notable. The wild-type strain MK426 presented a significantly higher adhesion ability than the commercial probiotics, and in association with the microalgae elicited an impairment of *L. monocytogenes* cocktail invasion of 90%, whilst the isogenic mutant strain demonstrated no impact.

The novel fermented oat milk unraveled to be a prominent source of important FA, namely, palmitoleic, α-linolenic and eicosapentaenoic acids (*ca*. 170, 20 and 98 mg/dose, respectively).

To the best of our knowledge, this is the first study documenting the listericidal potential of a novel coagulin-*N. oculata* consortium which holds a promising approach towards listeriosis prophylaxis. The atherogenic and thrombogenic indexes highlighted the remarkable potential as cardiovascular health promoter.

Keywords

listeriosis prophylaxis, bacteriocin-microalgae consortium, cardiovascular health, industrial wastages, circular economy

#196: Antimicrobial electrospun materials based on polylactic and ferulic acids for active food packaging development

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Ferulic acid (FA) exhibits antioxidant and antimicrobial properties and its incorporation into biodegradable polymeric matrixes such as PLA could result in an active material useful for food packaging applications. Solutions containing PLA (15 g/ 100 g solution) and FA (15 g/ 100 g solid) were electrospun to obtain novel nanostructured materials that can be used as active coatings in food packaging. Successful electrospinning operation conditions were obtained using 4 food contact solvent combinations, using ethyl acetate (EA), DMSO or glacial acetic acid (AA): E1D1 (1:1 EA and DMSO) E6D4 (6:4 EA and DMSO), E1A1 (1:1 EA and AA) and A1 (pure AA).

All solutions exhibited Newtonian rheological behaviour (viscosity: 0.72-1.26 Pa s), the A1 solution being the more viscous. Conductivity was higher in blend solutions of EA and DMSO (3.1-2.6 mS cm-1) than in those containing AA (0.07-0.08 mS cm-1). Likewise, surface tension (25-31 mN m-1) increased with the ratio of DMSO in the solvent blend. Density values (1.021-1.086 g cm-3) were slightly higher in the A1 sample.

FESEM observations of the electrospun materials showed that solutions containing DMSO formed nanofiber mats, whereas those containing AA formed discontinuous layers of beads. Quantification of ferulic acid in the electrospun materials revealed encapsulation efficiencies higher than 80% in all cases. The antimicrobial activity of the materials was tested through in vitro tests against Listeria innocua. Previously inoculated TSA medium in Petri dishes was coated with the materials and incubated for 6 days. E1D1 and E6D4 samples with nanofiber structure showed high growth inhibition (up to 3 logs CFU/ml) compared to the control sample. Nevertheless, no significant growth inhibition was observed for samples E1A1 and A1, with a similar amount of active compound but with a bead nanostructure.

The obtained results revealed that the nanostructure of the electrospun mats plays an important role in the release of the active compound and its antibacterial effectiveness. The presence of DMSO in the solvent promoted the nanofiber formation, with a higher specific surface, which enhanced the contact area with the culture medium, thus facilitating the active release. These materials represent a useful coating to obtain active food packaging for extending the food shelf life.

Keywords

PLA, Ferulic acid, Electrospinning, Active packaging, Biodegradable

#273: Optimization of the application of cold atmospheric plasma activated water as immersion agent for decontamination of foods: case study on fish fillets

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Fish fillets are among the most perishable products. The filleting process operations, including washing, cutting and skinning may lead to fish products of increased microbial load and reduced shelf-life. Cold atmospheric plasma (CAP) activated water (PAW) has been introduced as a bacterial disinfection media in food production, alternative to chlorination or ozonation, while simultaneously maintaining the quality characteristics of foods. Their antimicrobial efficacy is correlated to their reactive oxygen and nitrogen species (RONS) produced during CAP.

The aim of this study was to evaluate the use of PAW as innovative decontamination technique for the microbial disinfection of fish fillets, retaining their quality characteristics. PAW was produced using a CAP jet (flow rate 0.5 L/min, nozzle–water surface distance 4.3 mm). The peak-to-peak voltage was 7.2 kV (100 kHz). The process time was 16 min for 20 ml water samples. RONS were measured as approximately 53 mg/L for H2O2, 0,80 mg/L NO2- and 12 mg/L NO3-, after CAP treatment. Gilthead sea bream (Sparus aurata) fillets were immersed into i) PAW, ii) plain deionized water and iii) artificially produced water with equal concentrations of PAW RONS. For the treatment optimization, various durations (5-15 min) and fish:antimicrobial agent ratios (1:2, 1:4, 1:6) were studied. All fish fillets after the immersion time were immediately characterized in terms of color, texture, microbial load, lipids oxidation and sensory evaluation. The PAW and artificial water RONS were also measured after treatment.

A 10-20% initial load reduction was measured, depending on the treatment conditions. Higher ratios of fish:antimicrobial agent and longer treatment duration resulted in more efficient microorganisms inactivation. Colour of the samples had a minor alteration (more white flesh), mainly for samples of more intense process conditions. All other quality parameters were not significantly affected. In general, the results validate that PAW could act as an effective antimicrobial agent. In addition, artificially produced water of equal PAW RONS concentrations appeared not to be as effective as PAW.

PAW application was proved an effective tool for the initial microbial load reduction of the fish fillets, indicating potential shelf-life extension.

Keywords

cold plasma-activated water, fish fillets, microbial decontamination, quality retention

Acknowledgements

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#293: Adulteration, a food safety and sustainability issue: can deep chemometrics trace fraud in commercial coffee?

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Food systems sustainability is multi-fold with food safety and security as key elements to ensure food availability, reduce losses and price fluctuations. Food safety as stated by United Nations is everyone's business and shared responsibility of producers, processors, consumers and governments to ensure food quality and integrity. Within farm to fork safety, food frauds threaten the socio-economic constructs of global business with serious implications for public health and environment. Adulteration, a food fraud negatively impacts product market with food recalls challenging the system's sustainability. It also undermines consumer confidence in food safety with less understood threats exaggerated by media-based misinformation and misperception.

Coffee market with a global consumption of 7 billion 60 kg bags is predominated by roasted ground (70 %) Arabica, Robusta or blends thereof for 'espresso'. Coffee adulteration is economically motivated causing regulation non-compliance and public health threats with presence of materials like barley, chicory, and cereals. Adulterant detection is carried out by physical, chemical and biological techniques of which near infrared spectroscopy (NIR) has gained attention of coffee industry for its versatility. Recently, complex spectral data analysis is being simplified by machine learning algorithms with the increase in computational power and open community.

This study aims to demonstrate the use and feasibility of deep chemometrics for coffee adulterant quantification in comparison to chemometrics. Commercial roasted, ground Arabica coffee was admixed with barley, chicory and corn at 0 – 25 %, w/w. Fourier transformed-NIR spectral samples were acquired in absorbance (10000-4000 cm-1 range, 4 cm-1 resolution) and used to develop models based on partial least squares (PLS), interval-PLS (iPLS) and convolutional neural network (CNN) algorithms. Resulting performance metrics showed RMSEs and BIASs usually lower in CNN models compared to PLS or iPLS model, with R2 in all cases higher than 0.98.

The study showed that deep chemometrics can be a feasible and practical alternative to quantify coffee adulteration wherein its feature and transfer learning advantages can be exploited for real-time applications in tools targeted to overcome food fraud crisis.

Keywords

Espresso, Deep learning, Chemometrics, admixtures, Economically motivated frauds

2.4. New products for a sustainable diet

#218: Description and characterization of the fluorescence landscape of edible insect powders

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Fluorescence spectroscopy is an analytic technique used in food sector for physicochemical analysis of foods during processing and storage. Characterization of fluorescence landscape and identification of the fluorescence peaks in different matrices is the first step in order to explore its potential for food analysis. In this study, five edible insect species belonging to the Orthoptera order have been analyzed. Optical signature of powders obtained from freeze-dried insects was recorded in front face mode at excitation range 240-600 nm and emission range 260-700 nm. Comparable fluorescence spectra have been observed, highlighting strong similarity among species. PARallel FACtor (PARAFAC) analysis applied on the overall corrected, averaged and normalized Excitation Emission Matrices (EEMs) was validated for five components (Ex/Em: 295/302÷330 = component 1; 285/333 = component 2; 340/392÷420 = component 3; 390/450÷481 = component 4; 390÷465/504÷527 = component 5). Further, each single component was identified and associated with a list of possible chemical molecules. Standard solutions of these chemicals and mixtures of the pure substances were prepared and analyzed. Fluorescence signature of each single molecule has been described and compared with the optical fingerprint recorded from insect powders. New specific PARAFAC models have been built by using the EEMs recorded on insect powders and the EEMs recorded from the single molecules and mixtures, observing an improvement of the initial model when specific mixtures were considered. Based on this improved model, identification of insect powder fluorescence components was performed. Tyrosine and α-tocopherol were associated with component 1, tryptophan and albumin with component 2, collagen and pterins with component 3. No specific identification was possible for component 4 and 5. Results from this study suggest that fluorescence spectroscopy coupled with chemometrics tools may represent a powerful method for investigating the changes occurring during processing and storage of insect derivate foods.

Keywords
novel food, chemometrics, spectroscopy, fluorescence

#301: Use of food grade hops extracts for the development of innovative food additives

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In food productions, the use of plant extracts represents a useful strategy to replace the use of additives with technological functionalities and to satisfy the consumers' demand for innovative, functional, and clean label products. In this frame hop (Humulus Lupulus L.), is an undervalued plant. Hop, in fact, represents a very rich source of secondary metabolites (resins, pigments, polyphenols, essential oils) with antimicrobial, antioxidant, and biological activities, however, besides brewing and herbal applications, its use in food applications is very limited. Thus, the development of hop-based additives could promote and facilitate the use of hop extracts in food formulations and products.

This study is aimed to develop powdered hops extract with functional and technological properties for food applications. To this purpose, freeze-drying was used as both desolvation and encapsulation technology, and the effect of two different carriers, i.e. maltodextrin (MD) and arabic gum (AG), on the functional properties and technological functionality of the resulting powders was tested.

Hop (cv. Herkules) extracts were obtained using preliminarily optimized solvent (50 % v/v ethanol) and process extraction conditions (ultrasounds: 100 Watt, 50 kHz; time 30 min; T: 25 °C). After ethanol removal, hop extracts were suspended in Tween 20 solution (0.02 % w/w) and freeze-dried with the addition (+12 %) of MD, AG, or MD in combination (ratio 1:1) with AG.

Hop powders were evaluated for the moisture content (Mc), water activity (aw), solubility, moisture sorption isotherms (WSI), colour and colouring power, bitter acids and total polyphenol content (TPC), and polyphenol encapsulation efficiency. The stability over time at different temperatures was also tested.

Results showed that the coating materials influenced the Mc, the aw, the colour and the colouring power of the powders while did not affect their solubility. All the powdered extracts showed sigmoidal WSI, however, those containing AG showed higher equilibrium moisture content than that formulated only with MD. The encapsulating agent differently affected the TPC, the polyphenol EE, the content of bitter acids, and the antioxidant properties after freeze-drying as well as the chemical stability of hops powder over storage.

Keywords
hops extracts, food additive, bioactives, antioxidant activity, encapsulation

#334: Enrichment of pasta with seaweed: influence on microstructure and cooking quality

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A new focus on algae as food ingredients has been growing in western diets given consumers' awareness of its dietary benefits, beyond their macronutrient content. Seaweeds are low caloric ingredients, high protein-low fat, a source of hydrocolloids, minerals, vitamins, and bioactive compounds such as antioxidants. Enrichment of staple-derived products with seaweed is a natural strategy to increase their nutritional quality and supply the consumers with essential nutrients and bioactive compounds.

Pasta, in all its varieties, is a very popular food worldwide. The present work aimed to perform the assessment of pasta made with seaweeds flour on its cooking quality and microstructure. Ulva rigida rich in polysaccharides like ulvans Fucus vesiculosus rich in fucoxanthin and phlorotannins, Gracilaria spp rich in iodine and Porphyra spp. were used in this trial. The control pasta was produced with wheat semolina and water, while in the experimental pasta semolina was replaced with seaweed flour at three different concentrations (1%, 5.5%, and 10%). Raw firmness decreased for all seaweed pasta, though cooked firmness and hardness were, in general, only affected with 10% seaweed inclusion. The replacement of wheat semolina with higher seaweed levels increased fibre content, causing a gluten dilution effect and a more discontinuous protein matrix structure, which was observed at the microscopic level. Also, seaweed fibres competed for water and delayed water absorption on the neighboring starch granules, retarding cooking, which is complete when the starch granules absorb enough water to become gelatinized. The longer cooking time resulted in higher solids loss, thus in undesirable higher nutrient loss, but also in a higher weight gain, originated from a positive net balance between water gain and solids loss. Nevertheless, the seaweed enriched pasta presented acceptable solids loss thus being an excellent alternative to convey valuable nutrients and bioactive compounds.

Keywords

pasta, seaweed, cooking quality, microstructure, nutritional enrichment

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#325: Concentration and microencapsulation of phycocyanin extract from Spirulina Platensis

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In recent years, microalgae have become innovative and promising resources to obtain functional ingredients and add nutritional value to foods. Spirulina platensis, also known as spirulina or Arthrospira, is a blue-green filamentous prokaryotic cyanobacterium with a protein content of 55–70%, which includes the entire range of essential amino acids. It also contains vitamins (B1, B2, B12, E, and provitamin A), minerals (Fe, Mg, Ca, P, Cr, Cu, Na, Zn), pigments (phycocyanin, chlorophylls and carotenoids), and essential fatty acids (γ-linolenic acid). On the other hand, microencapsulation technology is an interesting process to increase the stability of bioactive compounds by packing materials in the configuration of micro and nanoparticles, which protects these sensitive compounds from light, moisture, heat or oxidation. This work aimed to concentrate at low-temperature and microencapsulate a phycocyanin extract, and evaluate the stability of the final powder in terms of pigment concentration and water absorption properties. Results showed that phycocyanin is a very stable compound at different process conditions. The yield of phycocyanin recovery was around 95%. The analysis of colour after reconstitution demonstrates that there was no colour changes due to the microencapsulation process. Finally, the hygroscopicity, Tg and water sorption properties were strongly dependent on the wall materials characteristics.

Keywords
Microencapsulation, Pychocianin, Water sorption properties

#308: Use of different carrier materials during spray drying of prickly pear (Opuntia ficus-indica) juice: Effects on powder yield and storage stability

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Prickly pear (Opuntia ficus-indica) juice is a valuable source of betalains, which could be utilized as natural colorants. Spray drying is an economic method that is being widely used for the drying of heat sensitive materials, although the use of carrier materials is often required during the drying of juices, due to the low glass transition temperatures of the sugars they naturally contain. In the present study, prickly pear juice (orange variety) was clarified by sieving and the extract was mixed with maltodextrin and whey protein isolate in two ratios (matlodextrin: whey protein concentrate 100:100 – WPI100 or 199:1 – WPI1), maltodextrin and arabic gum (175:25 - GA) or maltodextrin alone (MD). The solutions were spray dried and the powders were evaluated in terms of yield, betalains yield, color (CIE Lab* system), water activity, moisture, hygroscopicity and bulk density of the final powder. In addition, storage stability was evaluated in various temperatures (4, 40 and 60 oC) and relative humidity conditions (11 – 90%) was performed in order to evaluate the stability of betalains. All encapsulation systems exhibited good retention of colorants (>90%), while MD:WPI100 resulted in the best yield (58.47%). Stability of betaxanthins during storage was very good in low relative humidity conditions (up to 44%), even when exposed to light. In conclusion, prickly pear powder could be utilized as a natural colorant in various food systems bearing low water activity.

Keywords
prickly pear, betalains, spray drying

Acknowledgements
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#324: Exploring the Yacon juice potential in the fortification of whole organic strawberries

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The trends of healthiness and sustainability have triggered consumers into choosing food products as natural as possible such as organic ones, having at the same time enhanced nutritional and functional properties. The fortification of organic fruit products with juices or solutions containing functional ingredients could be achieved by the application of vacuum impregnation (VI). Yacon juice is rich in fructooligosaccharides, in particular inulin, which exerts the prebiotic activity. Moreover, it has a high antioxidant activity due to the presence of polyphenols and vitamin C. The aim of this study was to obtain naturally fortified organic strawberries by their enrichment with Yacon juice. In the present work, whole organic strawberries were impregnated with organic Yacon juice by vacuum impregnation (VI) technique (200 mbar, 24 min). The pasteurized Yacon juice was analyzed for its viscosity, soluble solid content, colour, inulin, vitamin C and total polyphenols contents and antioxidant activity. The impact of Yacon enrichment on quality characteristics of strawberries (colour, texture, weight gain, water content), microbial growth and stability of the antioxidant compounds and antioxidant activity during refrigerated storage at 4°C were assessed. Results showed that a satisfactory impregnation of strawberries (of about 6%) was achieved and resulted in a strong increase of the antioxidant compounds content and activity. Colour of strawberries were influenced by the impregnation with Yacon, turning to the dark red. During storage, impregnated samples showed a good stability of the bioactive compounds analyzed. In addition, the probiotic potential of Yacon juice and control and VI samples were evaluated, showing a positive effect on Lactobacillus and Bifidobacterium strains of gut origin.

Keywords
functional food, vacuum impregnation, fruit enrichment, bioactive compounds

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2.5. Valorisation of postharvest losses and food wastes

#175: Millet cereal grain – a climate smart crop in sub-Saharan Africa and South Asia: volarisation through a science and technology-based approaches

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This paper provides a vision on how to translate scientific insights on the techno-functionality of millet to practical applications and valorisation in staple food products which will help the agri-food systems in sub-Saharan Africa and South Asia. Traditional climate smart crop (CSC) food processing technologies are revisited with new scientific insights to enable manufacture of affordable and nutritious products from millets. Economic and governmental policy factors to support sustained implementation and valorisation. The socioeconomic imperatives for using millet as major ingredients in products in the region. The adverse impacts of limited developments of indigenous CSCs and no value addition in processing. Climate change and the fact that CSCs can be cultivated in harsh agroecologies leading to livelihoods for smallholder farmers in these regions, good nutritional quality and potential health-promoting attributes of millets. Overview on health-concerns (lifestyle diseases), gluten-free, culinary innovation, novel approaches and opportunities for valorisation of millets. Exploitation of unique functionality of millets within traditional processing and dynamics in consumers' uptake.

Keywords
Millets, valorisation, techno-functionality, gluten-free, climate-smart-crop

#204: Novel applications of Quorn fermentation co-product extracts as oil-lowering emulsifiers and partial egg white replacers

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This study assessed the functional profile, composition and potential applications of a naturally foaming co-product (centrate) from the Quorn fermentation process. A high molecular weight (HMW) fraction obtained via ultrafiltration of the centrate displayed good foaming stability, emulsifying properties and rheological properties (viscosity, gelation). Large mycelium aggregates reported in HMW possibly contributed to high viscosity and viscoelasticity and to foam and emulsion stabilisation. In parallel tensiometry measurements showed that interfacially-active molecules present in HMW formed a rigid film at the oil/water interface. A number of functional metabolites and proteins were identified in the centrate and could have also contributed to the properties reported, including a cerato-platanin protein, cell membrane and wall constituents and guanine-based nucleosides and nucleotides. This study then assessed the potential of HMW as egg white replacer and the modulation of its functionality by sonication for fat reduction purpose. Results indicated that HMW could allow for 25% EW replacement as foaming agent and 25% to 50% EW replacement as gelifier. The large mycelium structures characteristic of HMW were reported in EW-HMW mixtures and possibly contributed to their functionality. Sonication of a HMW solution led to the breakdown of these structures into smaller fragments and to smaller emulsion oil droplets. Confocal micrographs suggested the possible contribution of these small fragments to oil droplet stabilisation. 50% oilreduced HMW emulsions were prepared by mixing HMW emulsions with sonicated HMW solutions and displayed even smaller oil droplets. This study highlighted the potential of extracts from the Quorn process as novel sustainable functional ingredients for the food industry with possible applications in egg white and emulsion oil reduction. This work also highlighted the complex and specific nature of the centrate's functionality, with possible contributions from a broad range of components, and the potential to modulate the structure and functionality of HMW by sonication.

Keywords
Quorn, co-product, sonication, oil-lowering, emulsifier

#223: Valorisation of mussel Mytilus galloprovincialis meat waste to produce bioactive extracts by enzymatic hydrolysis

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Mytilus galloprovincialis is a mussel consumed and appreciated in several countries. However, its commercialization is associated with waste generation since they are submitted to a pre-selection before being delivered for sale. This results to the rejection of broken mussels or mussels with size out of the established criteria in the target market. Mussel meat is rich in proteins and has been described as a source of bioactive peptides with interesting properties for food and cosmetic industries. In this work small sized or broken mussels were submitted to enzymatic hydrolysis with a subtilisin protease, testing different conditions to maximize the production of an extract rich in proteins and bioactive peptides.
First, the mussel meat was homogenised in a mincer and then submitted to enzymatic hydrolysis with subtilisin, using different combinations of temperature, enzyme concentration and incubation time.

The different combinations were stablished using a Box-Behnken experimental design, and their efficacy was achieved by analysing the effect of the three factors on protein release, antioxidant and anti-hypertensive properties. The protein content of each extract was determined by Kjeldahl, the antioxidant activity by oxygen-radical absorbance-capacity (ORAC) assay and anti-hypertensive property by the inhibition method of Angiotensin-I converting enzyme (iACE). The experimental design results were evaluated using statgraphic centurion software.

The optimal extraction conditions achieved were the incubation of homogenised mussel meat with 1.5% of enzyme at 52ºC for 3 hours. A scale up extraction was made using the optimized conditions and the resulting extract showed a protein content of 45%, an antioxidant activity of 426 µmol TE/g of extract and the ability inhibiting ACE with an IC50 of 1 mg of protein / mL.

Thus, the use of discarded mussels to produce functional ingredients for food, cosmetic and pharmaceutic industries may contribute to valorise world waste in a circular economy context.

Keywords

Mussel, Antioxidant, Waste valorisation, Anti-hypertensive, Circular economy

Acknowledgements

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#263: Healthy sustainable snacks based on a winery by-product

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The objectives of the current research was to explore the feasibility of Tannat grape skin (TGS) as a food ingredient in two snacks (yogurt and biscuits) and to obtain novel information regarding the effects of the food matrix and the digestion process on the bioaccessibility of TGS bioactive compounds and health promoting properties of the novel foods. The polyphenolic profile of TGS was analyzed by UHPLC-MS/MS. TGS and the foods were in vitro digested by mimicking oral gastrointestinal human conditions. Biscuits and yogurt with the nutritional claims "source of fiber" and "no added sugars" were prepared and their overall consumer acceptance was evaluated. The antioxidant, antidiabetic and anti-inflammatory properties of the undigested and digested samples were in vitro measured using standard protocols and model cell lines.

Flavonoids (quercetin-3-galacturonide, quercetin, quercetin-3β-D-glucoside, myricetin, and isorhamnetin), phenolic acids (gallic and cis-aconitic acids) and anthocyanins [malvidin-3-pyranoside, malvidin-3-O-(6-p-coumaroyl)glucoside, malvidin-3-(6-O-acetylglucoside)] were found in TGS. TGS digestion caused a significant ($p<0.05$) reduction (36%) of its overall antioxidant capacity measured by ABTS and increase of antidiabetic potential of 29%. In line with these results, the overall antioxidant capacity of the biscuits was significantly ($p<0.05$) increased by adding TGS. The digestion processes of the new yogurt significantly ($p<0.05$) increased the bioaccessibility of antioxidants, antidiabetic and anti-inflammatory compounds of the food. Particularly, TGS yogurt digest reduced reactive oxygen species and nitric oxide formation in macrophages under induced conditions. The use of TGS as food ingredient in biscuits and yogurt was supported by the consumer's acceptance with scores 5.1 and 6.3, respectively, scale 1-9.

In conclusion, two healthy snacks based on a sustainable food ingredient (TGS) were obtained with the nutrition claims, "source of fiber" and "with no added sugars", with good overall acceptance and antioxidant potential. Additionally, the TGS yogurt showed antidiabetic and anti-inflammatory potential. TGS seems to be better accepted by the consumers as yogurt ingredient which provides very interesting health promoting properties to the food.

Keywords

Tannat grape skin, functional yogurt, functional biscuit, bioactive properties, sustainable ingredient

Acknowledgements

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#267: Wheat and oat bran: Integrated technology approach for antioxidants delivery

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Annually, in Europe, the cereal processing industry generates more than 6.5 million tons of wheat and oat bran (European Flour Millers, 2020). These brans, although perceived as by-products, are among the cheapest, highly available and natural occurring-phenolic sources, but with reduced bioavailability. The increasing flour production to meet the needs of the growing global population is of major concern, therefore their re-utilization in the food industry is highly desired.

Considering these limitations, the aim targets the release of bound phenolic acids in matrices before consumption, for an increased health effect due to improved bioaccesibility, whereas the integrated technology approach (thermal treatment and bioprocessing) is a promising route.

In the present study, the food processing thermal treatment (TP) (10 min, 80 °C) was applied to investigate the changes in polyphenolic composition, antioxidant, antimutagenic, and antimicrobial activities of commercially wheat bran (WB) and oat bran (OB). The commercially available *Saccharomyces cerevisiae* yeast strain under solid-state fermentation (SSF) conditions was used to improve the extractable phenolic acids composition and antioxidant activity of thermally treated WB and OB. The ultrasound-assisted methanolic extracts of thermally treated brans were analyzed via HPLC, Folin-Ciocalteu, DPPH antioxidant method, and Ames test. The ultrasound-assisted methanolic extracts of bioprocessed brans were compared for their total phenolic content (TPC), phenolics composition, and in vitro antioxidant activity for study the effect of fermentation time.

The results revealed that the thermal process improved the phenolic content and composition, as well the biological activities tested. During the bioprocess, the maximum increase of TPC was registered on day 3 for WB (+112%), and day 4 for OB (+83%) vs. control. Fermented WB and OB displayed enhanced DPPH percentage inhibition on day 3 (51%), and day 4 (64%), respectively, significantly correlated to TPC.

The integrated technology approach can be successfully applied to improve the bio-accessibility of phenolic compounds having the advantage of its feasible implementation within the food industry.

Keywords

thermal processing, phenolic acids, antioxidants, solid-state fermentation

Acknowledgements

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#166: 'Waste 2 taste': Biorefining berry pomace into valuable food-grade ingredients

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According to the FAO, roughly one-third of edible agro-food materials for human nutrition is lost or wasted. Many berry species are known for their excellent flavor and healthy phytochemicals. However, due to a rapid decay after harvesting, the major parts of berry crops are processed into longer shelf-life products such as juice, jams, etc. Pressing juice results in large quantities of by-products, which are rich in valuable phytochemical compounds and other nutrients; however, currently they are used for animal feeding and composting or even discarded as a waste, mainly due to a lack of scientific, technological and economic valorization studies.

This study proposes and integrated biorefining scheme for processing berry pomace into high value ingredients by using supercritical CO2 (SC-CO2), pressurized liquid, ultrasound and enzyme assisted extraction methods. Valuable substances were recovered from berry pomace by the combination of various methods. SC-CO2 recovered lipophilic fractions, which are rich in polyunsaturated fatty acids triacylglycerols, tocopherols, phytosterols and some other compounds: at optimized parameters the yields were from 3% (chokeberry) to 25% in (guelder-rose berry). The residues were further extracted by using subcritical water or its mixtures with ethanol at different parameters. This process, depending on berry type and extraction parameters, produced 20-60% of soluble fractions. Finally, enzyme assisted extraction recovered different amounts of water-soluble substances, including oligosaccharides, bound polyphenolics and others.

The composition of fractions was analysed by chromatography with various spectroscopic detectors, while bioactivities were evaluated by various in vitro chemical and cellular assays. The results have proved the presence of valuable bioactives in pomace fractions, which may be used in functional foods and nutraceuticals. For instance, strong antioxidants recovered from raspberry, chokeberry and cranberry pomace improved oxidative and microbiological stability of meat products. Moreover, it is hypothesized that berry phytochemicals might mitigate adverse effects (carcinogenicity) of processed meat products to human health. Preliminary studies of such effects on cancer cells were performed using in vitro digestion models.

Keywords

berry pomace, biorefining, bioactive compounds, healthy nutrients

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Session 2: Poster presentations

#151: Kinetic release studies of different microstructures prepared by a spray drying and electrospinning method containing vitamin B12

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Vitamin B12 is the most chemically complex and largest of all the vitamins and is involved in cell metabolism, in the normal operation of the brain and nervous system, and in the formation of blood. The vitamin B12 deficiencies have significant adverse consequences on key aspects of body functioning, such as on immune systems, cognition, endurance and work capacity. Vegetarians, pregnant women, seniors and people with food-bound B12 malabsorption are segments of population who may suffer from lack of vitamin B12. So, the intake of supplements of vitamin B12 to prevent and to overcome vitamin B12 deficiencies appears as a solution.

The microencapsulation/immobilization of vitamins is a promising alternative to improve their stability and bioavailability, to protect and to improve these sensitive compounds with a controlled release, enabling their incorporation in active food products, nutraceuticals and even in therapeutic formulations.

In the present work, microstructures (microparticles, nanoparticles, fibres and even films), prepared with two different methods, spray drying and electrospinning, were studied for the incorporation of vitamin B12. For this purpose, zein, a prolamin protein extracted from corn, was the selected microencapsulating material. The microstructures were characterized in terms of morphological properties, namely by scanning electron microscopy. Their release profiles were simulated and evaluated using different kinetic models: Korsmeyer-Peppas, Weibull and Baker–Lonsdale. These models allowed the evaluation of the mass transport mechanisms that were involved in the release, which, in turn, helps to design a system with specific characteristics and to simulate the effect of the design parameters (geometry and composition) on the resulting release kinetics.

Different structures and different release behaviours were obtained depending on the formulation and method (spray drying or electrospinning) used. The major mechanism responsible for controlled release was identified and is a Fickian diffusion (case I transport) and the model that, in general, better fits the experimental results is the Weibull model.

In conclusion, the Vitamin B12 microstructures prepared present promising characteristics for food and nutraceutical applications.

Keywords

Electrospinning, Microstructures, Spray drying, Vitamin B12

Acknowledgements

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#153: Immunochromatographic test systems for detection of microcystin-LR in water and seafood

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Food safety is currently an important issue of public health in all countries. Contamination of food products and raw materials is a serious reason of foodborne illness. Phycotoxins as food toxicants pose serious risks to human health including mutagenic, carcinogenic and teratogenic effects. In this regard, the need for effective control of phycotoxins' residual amounts in water and foodstuffs causes an increasing demand for the development of highly sensitive tests for their detection.

In this study, an immunochromatographic analysis (ICA) for the rapid control of the highly toxic phycotoxin microcystin-LR (MC-LR) in water and seafood was developed. Two types of gold nanoparticles as markers, namely, spherical nanoparticles (AuNPs) and nanoflowers (AuNFs) were compared. Spherical AuNPs were synthesized by the one-step reduction of chloroauric acid with sodium citrate. Synthesis of AuNFs was carried out using a gold seed-mediated growth method. The indirect format of the ICA was implemented. Here, the introduction of the nanolabel into the analytical system was carried out via the conjugation with anti-species antibodies. For the indirect ICA, two zones were formed on the working membrane of the test strip: an analytical and a control zone with the immobilized MC-LR–protein conjugate and anti-species antibodies, respectively.

The developed test systems allowed for the detection of MR-LR within 18 min with instrumental detection limits of 0.2 and 0.1 ng/mL when using AuNPs and AuNFs, respectively. The visual detection limit was 1 ng/mL for both formats. The parameters of nanoparticles, which determined the analytical characteristics of the corresponding test systems were characterized. The ICAs were tested for the detection of MC-LR in real samples. A simple procedure of sample preparation was proposed. It was demonstrated that the developed test systems enabled the reliable control for MC-LR contamination of water, fish and seafood (shrimp, octopus, squid, and mussels).

Therefore, the developed approach was demonstrated to be an effective tool for highly sensitive determination of food contaminants..

Keywords

Phycotoxins, microcystin-LR, immunochromatographic analysis, food safety

Acknowledgements

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#154: Attitudes of Consumers to Seaweed Polyphenols for Health

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Epidemiological evidence suggests a diet rich in polyphenols has beneficial effects on many chronic diseases. Brown seaweed is a rich source of polyphenols The antioxidant activity of seaweed polyphenol extracts has been demonstrated in vitro, and a protective effect against DNA damage observed in vitro and in vivo. There are demands to exploit the properties of seaweed polyphenols in the food supplement market, however, there is little understanding of consumer acceptance towards seaweed polyphenols for health. The objectives of this study was to clarify consumer understanding about seaweeds, polyphenols, anti-inflammatory agents and antioxidants, and identify any barriers that prevent acceptance by consumers of a seaweed polyphenol supplements. A concise quantitative and qualitative questionnaire was designed and piloted. An online survey, using SurveyMonkey, was administered to adults residing in Northern Ireland, between 18 and 65 years of age. IBM SPSS Statistics 24 and Microsoft Excel were used to analyse quantitative results. Nominal data was analysed using the Chi-Square test and ordinal data was using Mann-Whitney U test. Post-Hoc correction was conducted to identify the significance data. Thematic content analysis was used to analyse qualitative results. There were 91 participants. On average 30% participants recognised the plant phenolic compounds and 51% knew some of the natural antioxidants from plants. Lack of knowledge and lack of recommendation were the main barriers to prevent taking seaweed supplements. Male participants were keener than female to take food supplements in the future. In conclusion, participants will accept the seaweed polyphenol supplements with supportive knowledge, safety assurance and with the scientific evidence provided. A recommendation should be provided by health professionals such as physician, pharmacist and/or dietitian.

Keywords
consumer attitudes, seaweed, polyphenols, health, food supplements

#155: Confocal laser scanning microscopy and image analysis technique in elucidating crumb and crust microstructure of bran-enriched fried dough

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A double-staining protocol for image acquisition using confocal microscopy (CLSM) technique coupled with image analysis were employed to elucidate crust and cross-sectional slices of fried dough (magwinya). Penetrated oil by image analysis (POia), porosity and pore features of fried dough was quantified from the cross-section micrographs; while fractal analysis of crust micrographs was utilised to measure surface roughness. Crumb porosity ranged between 54.94 – 81.84% and reduced ($P < 0.05$) with bran addition. Pore sizes were found in the range of 0 – 475 µm with <1 circularity, thus categorising the crumb pores as elliptical shape. POia values were notably higher ($P < 0.05$) than PO by soxhlet extraction (POsox) except for wheat bran (WB) fried dough where the values of POia and POsox were closely ranked. Linear effect of initial moisture content & bran concentration showed significance on image properties; the same applied to the interaction effect of the independent variables. Mean fractal dimension (FD) decreased as initial moisture increased. The addition of WB caused a significant reduction of FD of fried dough while an opposite effect was noted for its oat bran counterpart. Due to non-collinearity of image properties (FD, POia & porosity), data were fitted to cubic polynomial regression with R2 values >0.70 ($P < 0.05$). The double-staining protocol of CLSM and image analysis proved successful in measuring oil absorption and elucidating the crumb properties of magwinya. The protocol used in this study can be applied to other thick deep-fried foods for qualitative observation and quantitative measurements of specific physical or chemical property.

Keywords
Magwinya, Image analysis, Fried dough, Confocal micrograph, Bran

#156: Structural characteristics of alkaline treated fibers from date-pits: Residual and precipitated fibers at different pH

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Four types of fibers (i.e. defatted, F1; residue after alkaline digestion, F2; precipitated fibers at pH 5.5, F3; and pH 1.5, F4) were prepared from date-pits. The date-pits were first defatted and then digested by an alkaline solution. The fibers F2 showed the highest amount of cellulose (i.e. 46.0 g/100 g sample), while fibers F3 and F4 showed the lowest amount of cellulose (i.e. F3, 9.3 g/100 g sample). The visual structures of the fibers were determined by Field Emission Scanning Electron Microscope (FESEM). Fibers F1 (i.e. defatted date-pits) showed that lignin was coated over holocellulose, however alkaline digestion clearly showed lignin-coating was removed and fibers (F2) contained two main types of structural matrix (i.e. micro-size trapezoidal particles were embedded in nano-size fine interconnected fibers). Fibers F3 showed highly porous particles, while F4 showed that spherical particles were imbedded in an interconnected fiber matrix. Infrared Fourier Transform (FTIR) peaks within the wave number 400-4000 cm−1 showed different molecular structures of the fibers. X-ray (XRD) patterns showed different crystallinity of the fibers. The crystallinity of the F2 and F4 were 76.7 and 95.5%, respectively and fibers F3 was mainly amorphous in nature.

Keywords
Date-pits, Cellulose, Fibers, Infrared fourier transform (FTIR), X-ray diffraction

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#158: Stability of Vitamin C in Capsicum using Micro-Region State Diagram based on Water Activity and Glass Transition

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Water activity and glass transition are the two concepts widely used to predict the stability of foods during processing and preservation. Recently, micro-region state diagram based on water activity, glass transition, and phase transitions is proposed to determine the stability of foods. First the micro-region state diagram for capsicum was developed by measuring water sorption isotherm, freezing curve, glass transition, maximal-freeze-concentration condition, and solids-melting. Water sorption isotherm, freezing-curve, glass line and solids melting line were modeled by GAB and BET models, Chen's model based on Clausius-Clapeyron equation, Gordon-Taylor equation, and Flory–Huggins equation, respectively. The maximal-freeze concentration conditions, Tg¢¢¢, Tm¢, and Xs¢ were observed as -37.0oC, -35.2oC, and 0.72 g solids/g sample, respectively. The un-freezable water was determined as 0.28 g water/g sample. The loss of vitamin C in capsicum was modeled by first order reaction kinetics. The rate constants were determined as a function of moisture and storage temperature; and these were located in the micro-region state diagram. It was observed that micro-region state diagram had potential merits to predict the stability of vitamin C as a function of moisture and storage temperature. In the case of other food systems, the proposed micro-region concept could be applied in the prediction of their stability.

Keywords
Food stability, shelf life, state diagram, vitamin, health functionality

#160: Sensory analysis and physical characterization of cured goat cheese produced at a dairy production Prados de Melgaço (Portugal)

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The present work is the result of a master's thesis in food engineering (ESTG-IPVC, Portugal) in a dairy production called Prados de Melgaço, a company that produces milk and goat cheese. The main objective of the presented work was to characterize the different cured goat cheeses produced at the dairy company and analyze their final organoleptic and physicochemical characteristics, taking into account the raw material (milk) properties, production process and the organoleptic characteristics developed during the maturation period of 10 batches of cured cheese (cured, long cured and cheese with alvarinho wine and bell pepper). pH measurements and sensory analysis were carried out in the different cured cheese phases. Sensory attributes evaluated during analysis were the exterior and interior appearance, texture, aroma and flavor, as to determine the final organoleptic packaging parameters of the three ripened cheeses. From the pH results, the final average pH for the cured cheese is approximately 4.73, the long-cured cheese is 4.63 and the cheese with alvarinho wine and bell pepper is 4.56. These variations are due to the different curing time of each cheese. The cured cheese has 7 to 8 days of maturation, the long curing cheese 20 to 30 days and the cheese with alvarinho wine and bell peppers 40 to 50 days, respectively. The final results of the sensory analysis show little variability between batches. The cured cheese has a whitish color crust, a soft and pasty texture and an acidic flavor, the long-cured cheese has a yellowish crust and a hard and brittle texture, and the cheese with alvarinho wine and bell pepper has an orange crust attributed to the bell pepper color and a hard and brittle texture. From the physical-chemical and organoleptic results, it was possible to conclude that, in each reference, the main characteristics are quite homogeneous in the different batches, which allowed the establishment of final organoleptic reference packaging parameters for each cured cheese and complete the technical data sheets of these products with this characteristics.

Keywords
sensory analysis, cured goat cheese, pH

#163: Effect of steeping and sprouting times on amylase activities of Vigna subterranea seeds

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Vigna subterranea [Bambara groundnut, (BGN)] is a hardy, drought-resistant crop, termed a complete food because of its high nutritional value, with an average protein, carbohydrate, and fat contents of 17.5 %, 64 % (dry matter), and 6.5%, respectively. BGN seeds have climate change potentials. There is a prospective for developing value added products through the sprouting of BGN seeds. Researchers have sprouted BGN seeds, but there is little or nothing on the impact of steeping and sprouting times on α- and β-amylase of the sprouted seeds. Sprouting of BGN seeds will invariably help in producing enzyme-active, fully digested BGN malt. This experiment's objective was to evaluate the effect of steeping and sprouting times on the α- and β-amylase activities of the BGN seeds. Distilled water at 25 ± 3oC was used to steep the BGN seeds for 36 and 48 h, then sprouted for 144 h at 30oC and 98% humidity. Samples were drawn every 24 h, dried, and stored for analysis. The α and β-amylase activities of the sprouted samples were determined by the α-Amylase Assay Kit, Ceralpha Method (K-CERA, Megazyme) and β-Amylase Assay Kit, Betamyl-3 (K-BETA3, Megazyme) respectively. Steeping and sprouting time had a significant effect ($p \leq 0.05$) on the α- and β-amylase activities of the BGN seeds. Steeping BGN seeds at 36 and 48 h resulted in mean α-amylase activities of 0.14 and 0.17 Ceralpha Unit/g, respectively. The 36 and 48 h steeped BGN seeds also showed β-amylase activities of 0.21 and 0.22 Betamyl-3 Unit/g, respectively. Steeping at 36 h and sprouting at 96 h gave high β-amylase activity (0.30 Betamyl-3 Unit/g) while steeping at 48 h and sprouting at 96 and 120 h showed high α-amylase activity (0.19 Ceralpha Unit/g). Based on the 36 and 48 h steeping regime amylase activities, it showed that sprouting for more than 96 h will be loss of β-amylase, and sprouting at 72 h will not give optimum α-amylase. Steeping at 36 h and sprouting for 96 h would provide optimum amylase activities without loss of α-amylase when steeped for 48 h or β – amylase when sprouted above 96 h.

Keywords
Bambara groundnut, Steeping, Sprouting, α-amylase, β-amylase, Climate change

#165: Effect of incorporation of defatted hemp seed flour on the quality of rich dough baked Greek product "tsoureki"

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The importance of food consumption in relation to human health has increased consumer attention in foods containing high concentrations of nutraceutical and bioactive components, as well as in vegan based products. Additionally, the recent requirements for sustainable food processing led to the valorisation of food processing side streams. The hemp seed cake remaining after oil cold pressing is a valuable side stream, rich in proteins and bioactive ingredients, which can be used for value-added novel food products. Hemp seed cake can be incorporated in rich dough baked products (RDBP), which include a variety of products consumed around the world. An example is the Greek popular "tsoureki", a rich dough single and/or mixed culture fermented – baked product with an intense and unique taste. In this research, the effect of defatted hemp seed flour incorporation on selected quality characteristics of RDBP- "tsoureki" was studied. The hemp seed cake was milled with a jet-mill using air pressure of 8 bar at a feed rate of 1.25 kg/h. Hemp and wheat flour were mixed at several hemp/wheat ratios (0%, 10%, 30% & 50%). The baking process was carried out at 160°C for 35 min. The baked products were evaluated for physicochemical, structural, textural and sensorial properties, as well as total phenolic content and antioxidant activity. The results indicated that the addition of hemp flour affected significantly the product quality. The hardness of the "tsoureki", as assessed via both instrumental and sensorial methods, increased with the hemp flour addition, while the product was denser. Moreover, the colour of the final products was darker. The hemp flour addition led to a significant increase of the total phenolic content and antioxidant activity of the baked product.

Keywords
baked goods, hemp flour., rich dough., sensory evaluation., texture.

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#167: Valorisation of cherry pomace by using supercritical fluid and pressurized liquid extraction processes

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Pressing of cherries for juice generates large amounts of by-products, called pomace. Currently, sour cherry pomace, which is a rich in health beneficial polyphenols, are used very inefficiently or discarded as a waste. Therefore, there is an urgent need of valorizing sour cherry pomace for the development of high added value food grade ingredients. For this purpose, the application of biorefining concept seems to be a preferable approach for developing effective processes for recovery of various valuable substances from sour cherry pomace, which may serve as functional ingredients increasing the value-added food products. The aim of this work was to develop multi-step biorefining scheme for valorizing cherry pomace as a source of valuable nutrients by using supercritical fluid (SFE) and pressurized liquid (PLE) extraction processes. The objectives were evaluation of chemical composition, antioxidant properties and anthocyanins content in different sour cherry pomace fractions. Extracts from sour cherry pomace were isolated by using traditional (Soxhlet extraction) and modern (SFE with CO2 and PLE) techniques. PLE with the mixture of ethanol with water (70:30) parameters (temperature and time) were optimized by using Central Composite Design and Response Surface Methodology modelling for obtaining the highest product yields and proanthocyanidins content in them. The sour cherry pomace fractions obtained were evaluated by determining important composition characteristics and antioxidant potential. Antioxidant capacity of extracts was measured by ABTS radical cation scavenging, oxygen radical absorbance capacity assays (ORAC) and total phenolic content, which was determined by Folin-Ciocalteu method. Antioxidant capacity of solid substances was evaluated by Quencher method. Fatty acids composition and volatile compounds in lipophilic fractions were analyzed by gas chromatography, triacylglycerols were determined by ultra high performance liquid chromatography (UPLC). Total carotenoids in lipophilic extract and proanthocyanidins in hydrophilic extracts were measured by spectrophotometric methods. Quantitative and qualitative analysis of anthocyanins was performed by UPLC. The results show that sour cherry pomace products may be promising food and nutraceutical ingredients.

Keywords

Cherry pomace, supercritical CO2 extraction, pressurized liquid extraction, phytochemicals, radical scavenging capacity

Acknowledgements

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#169: iFAROS - A multi-source digital farming system for sustainable production in winter wheat

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The demand for agricultural production is rising, due to the 60-70% expected increase in food demand by 2050. The increased production will have to face the challenge of sustainable farm management through an optimized use of the available natural resources with a limited environmental impact. Recent work has shown that fertilizers can be used with much greater efficiency than is currently the case in many of Europe's cropping systems. The iFAROS project, funded by ICT-AGRI, is developing a multi-source digital farming system for site-specific nitrogen application in winter wheat (Triticum aestivum L.), which is the most important crop in Europe and is produced in 56 million hectares.

The technical objectives of the iFAROS project are: (1) To develop a novel cloud-based application, acting as an intelligent middleware with data analytics capabilities, for the collection, storage and integrated processing of the data coming from and related to agricultural production, deriving from data sources such as farm machinery, UAV, Wireless Sensor Networks (WSN), and other sources of open data at farm and at regional level; (2) To realize better decision-support algorithms for farm management and operations. In particular, this will include the creation of application maps for VRA of fertilizers, (ii) yield prediction, and (iii) the reporting for whole farm management productivity costs; and (3) To apply the produced site-specific management fertilizer application map in an automated way by utilizing ISO 11783 (ISOBUS). To achieve this, specific hardware has to be developed.

The results of the first two years highlight the technical characteristics and the information flow of the developed middleware as well as the developed hardware, which enables the automated collection of ISOBUS data. Furthermore, the hardware acts as a gateway between the FMIS and the tractor terminal by downloading the developed site-specific nitrogen application to the Task Controller of ISOBUS.

Keywords
ISOBUS, cloud system, multi-source data, variable rate

#171: Antimicrobial activity of cobalt-citrate against common foodborne pathogens and its potential for incorporation into food packaging material

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Novel antimicrobial compounds can be added to foods directly or incorporated into packaging materials. One potential antimicrobial compound is ammonium cobalt citrate (ACC). Its antimicrobial activity against common food-associated bacteria was investigated in two series of experiments: 1) reduction in growth rate was determined using the Bioscreen C instrument, and 2) the antimicrobial activity of ACC-impregnated poly(lactic acid) (PLA) films was determined on bacterial lawn plates. The effects of elevated NaCl concentration (5% w/v) and the addition of nitrite (150 ppm) on the antimicrobial activity of ACC were determined. The bacteria used were *Listeria monocytogenes*, *Staphylococcus aureus*, *Bacillus cereus*, *Salmonella enterica* serovar Enteritidis, *S. enterica* serovar Typhimurium, *Escherichia coli*, and *Pseudomonas aeruginosa*.

In nutrient broth, without additives, a significant ($P<0.05$) decrease in growth rate was observed, in the presence of 1 mM ACC, for all bacteria except for *S.* Typhimurium. Only in the case of *L. monocytogenes*, *E. coli*, and *Ps. aeruginosa* was the decrease in growth rate greater than 25%. The inhibitory effect of ACC was enhanced (in most cases) when the employed nutrient broth was modified with 5% NaCl or 150 ppm $NaNO_2$, compared to the modified broth without ACC.

In the antimicrobial film experiments, different combinations of ACC concentration (1-40% w/w) and film thickness (20 and 50 μm) were investigated. Best results were obtained with 50 μm films, impregnated with 30% w/w ACC. The largest zones of inhibition were formed with *L. monocytogenes*, followed by *Ps. aeruginosa*. In the remainder of bacteria, zones of inhibition were either very small or absent.

The results show that ACC in solution and impregnated into films has selective antimicrobial activity against foodborne bacteria. Thus it can potentially improve food safety and shelf-life, and, due to its activity against *Ps. aeruginosa*, it may also have clinical applications. The antimicrobial activity was generally enhanced by the presence of other antimicrobial agents, such as elevated salt concentration and nitrite. Ongoing investigations include a) determination of its antimicrobial activity, in the presence of other inhibitory factors, such as organic acids, and b) its experimental application (in films) to real foods.

Keywords
antimicrobial, foodborne pathogens, food packaging, ammonium cobalt citrate

#172: Microbiological safety assessment of cyanobacterial food supplements and food products

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Spirulina is an informal name applied to two commercial cultivated species of cyanobacteria, *Arthrospira platensis* and *A. maxima*. The dried cells are marketed as a dietary supplement as powder or in tablet form and are also added to foods such as cereal bars and spreads. Spirulina is often produced in open pools that are susceptible to microbiological contamination, but no official microbiological standards have been established. In the present study the microbiological profiles of two spirulina supplements (tablets and powder) and three foods containing spirulina (tahini, praline and a cereal bar) were determined. Bacteria were enumerated and isolated using selective and non-selective media and selected isolates were identified by MALDI-TOF MS protein profiling.

The pathogens *Salmonella enterica*, *Vibrio* spp. and *Staphylococcus aureus* were not detected in any of the samples. Low numbers (2.2 log cfu/g) of *Listeria* spp. were found in one of the praline samples. Indicator organisms were also enumerated: presumptive enterococci were isolated from spirulina powder (2.7 log cfu/g), some of which were identified as *Enterococcus faecium*, but coliforms were not detected in any products. Yeasts, moulds and aerobic and anaerobic plate counts did not exceed 3.6 log cfu/g in any products and were generally higher in the spreads than in the cereal bar or dietary supplements. However, some of the isolates from the tahini, praline and the cereal bar were identified as *Bacillus cereus*, a potential pathogen.

Microbiological counts in the products tested were generally low and the products would not allow growth of the bacteria due to the low water activity. However, the presence of *B. cereus* is a cause for concern as it can multiply in the digestive tract and produce toxin. *E. faecium* is also a potential opportunistic pathogen and antibiotic resistant strains are an important cause of nosocomial infections. Nutritional supplements are often taken by people with underlying health issues who may be more susceptible to gastrointestinal infections.

Keywords

food supplements, cyanobacteria, foods containing spirulina, microbiological safety assessment

#176: Olive oil emulsions formed by catastrophic phase inversion

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In the present study, the stability of oil-in-water emulsions prepared by the low – energy emulsification method of catastrophic phase inversion (CPI) was investigated. Emulsions were prepared at pH 3.8 with an olive oil to water ratio of 10:90, in the presence of whey protein isolate (WPI), hydroxypropyl methyl cellulose (HPMC) and Tween 80 at concentrations 5%, 0.1% and 1%, respectively. The stabilizers were added to the emulsions either alone or in combinations. Initially, the surface and interfacial tension of WPI, HPMC, Tween 80 solutions and their mixtures were measured. HPMC exhibited the higher values for both surface and interfacial tension whereas Tween 80 the lower. For emulsion preparation, the aqueous phase was titrated into the oil phase, gradually forming an oil-in-water emulsion. The inversion happened at the 40-50% of the added water phase. Droplet size and stability of the produced emulsions were evaluated. They appeared to be influenced by the used combination of stabilisers, as well as by the phase (oil or aqueous) in which they were dissolved. Droplet size varied from ~11-32 μm. For stability measurements, transmission (TS%) and backscattering (BS%) profiles as a function of time were plotted. The emulsion with all stabilizers in the oil phase showed the higher destabilizing rate. Overall, all studied emulsions showed phase separation and destabilization over time suggesting that the energy offered to the during emulsification was not sufficient.

Keywords
Emulsion, Catastrophic phase inversion, Whey Protein Isolate (WPI), Stability

#177: Optimization of Osmotic Dehydration of white mushrooms by Response Surface Methodology and Desirability Approach for shelf-life extension and quality improvement

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Button mushrooms (Agaricus bisporus) are the most common edible mushroom species, which account for 30% of the global mushroom consumption. Mushrooms are a good source of vitamin B complex, ergo sterols and minerals such as selenium. Additionally, they are containing a wide range of therapeutic compounds such as triterpenoids, glycoproteins, natural antibiotics, enzymes, and enzyme inhibitors that strengthen the human health system. They are low in fat, rich in protein of high biological value andare considered to be cholesterol-free.

Nevertheless, mushrooms are sensitive to corporal and contagious damages because of the absence of a protective skin layer. Therefore shelf-life of button mushrooms is limited, approximately 1–3 days under ambient storage and 5–8 daysat chill conditions. The fast degradation is mainly caused by the high water content, biological procedures, enzyme activity, low pH and microbial spoilage; furthermore, mushroom flesh is influenced by the level of ripeness and any harm to the pile. Mushroom short shelf-life is a disadvantage that limits its economic and commercial value. Osmotic dehydration has been proposed as an efficient way to preserve mushrooms and produce final products of superior quality.

Osmotic dehydration is a mild, non-thermal treatment, mainly used as a pre-processing step of conventional preservation methods (such as drying or freezing), that involves the immersion of a food material in a hypertonic solution (of carbohydrates, salts and other ingredients). In this study, Response Surface Methodology was used to investigate the effect of glycerol concentration (30-50%), temperature (30-50℃), and duration of osmosis (20-180 min), to obtain the optimal osmotic process parameters for mushroom treatment. Experiments were conducted using a Box Behnken Design with three factors at three levels, and the indices measured included mass transfer, physicochemical and selected quality indices. For each response, a second order polynomial model was developed and appropriate statistical analysis showed that all process factors significantly affected water loss, solid gain, aw and color changes. Based on the Desirability approach and particular pre-set criteria, optimum operating conditions were estimated and the corresponding validation experiments were performed.

Keywords

white mushrooms, shelf-life extension, process optimization, Response Surface Methodology, Desirability functions

#179: Is there any significant impact of coloured LED lights on the bioactive compounds of Red radish (R. sativus L. cv. 'Rambo') sprouts?

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Brassica foods including red radish sprouts (R. sativus cv. Rambo) are gaining popularity because of their spicy taste, convenience and their rich phytochemical composition (glucosinolates, hydroxycinnamates and anthocyanins, among others) related to their health-promoting effects on chronic diseases. Very recently, the use of LED lights is growing in relevance for the production of fresh foods such as edible sprouts, because of the potential for indoor farming, sustainability and interesting option for food security under the current global situation of limited resources of water and soil for food production. Having all this in mind, the purpose of this work was to develop red radish sprouts under controlled conditions and LED lights with selective wavelengths (white, red, blue and green light), in order to obtain enriched sprouts in bioactive compounds. Thus, in this research we evaluated the effects of the LED light treatments on performance (biomass production, quality and phenotype) and composition (phytochemicals) of red radish sprouts.

Keywords
Light-Emitting Diodes, Wavelength, Edible sprouts, Cruciferous foods, Bioactive Compounds

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#180: Effect of high voltage electrical discharge treatment and drying technology on properties of cocoa shell

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Cocoa bean shell is a by-product of a chocolate industry that is separated from cocoa beans before or after roasting. It is rich in fibres, proteins, and bioactive components and very interesting material for the enrichment of nutritionally poor food products. Since the shell is very exposed to external factors during the whole processing of the beans, it can be contaminated with different microorganisms, toxins, polycyclic aromatic hydrocarbons, acrylamide, 5-hydroxymethylfurfural, etc. High voltage electrical discharge treatment (HVED) is known to reduce some of those contaminants. HVED is conducted in water by generating electrical discharge (emission of different radicals and UV-light) between two submerged electrodes. After the treatment, drying of the treated material is needed. In this study, we examined the influence of freeze- and oven drying of HVED-treated cocoa shell on water activity, water and oil binding capacity, colour, and total phenolic content. Control samples were prepared by shearing in water and freeze- and oven drying. Results showed that the water activity of control and HVED-treated samples was lower than in untreated cocoa shell. Freeze-drying and HVED had an even greater impact on the reduction of these values. Water and oil binding capacity are important for the potential use of the cocoa shell in food production. These parameters showed that HVED increased water binding and decreased oil binding compared to control samples. In addition, HVED treated samples had a greater total colour change compared to control samples. Oven drying caused a darkening of the samples, while freeze-drying had a brightening effect. Total phenolic content of cocoa shell decreased with all applied treatments, and freeze-drying was less detrimental for the phenolics than oven drying.

Keywords
cocoa shell, high voltage electrical discharge, drying technology, phenols, water activity

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#184: Physicochemical properties of pectin extracted from orange peel waste employing sustainable and green technologies

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Pectin is a natural bioactive hydrocolloid with a complex internal structural organization and growing applications in cosmetics, food industry and medicine mainly as a gelling agent thickener and stabilizer. Commercial pectin is mainly obtained by citrus peel and apple pomace applying heat-assisted acid hydrolysis followed by ethanol precipitation. The implementation of green methods i.e microwave and ultrasound technologies, based on principles of green chemistry, could change the course of the global economic growth towards sustainability providing alternative socio-economic norms and industrial scale transferability. The orange processing industry generates large amounts of side streams in the form of peels, seeds, rag and pulp accounting for approximately 60% of the fruit weight. Orange peel waste constitutes highly promising renewable resources due to their wide availability and propensity to yield value added chemicals and materials.

This study evaluated pectin recovery from orange peel waste using ultrasound and microwave assisted extraction as well as a combination of both methods. Pectin via conventional inorganic or organic acid extraction was also obtained. The corresponding yield varied from 8.46 to 32.6% with the highest yield achieved when using citric acid. The Degree of esterification (DE), intrinsic viscosity ([η]) and molecular weight (Mr) of the extracted pectins were investigated. DE varied from 24-88.6%, [η] from 0.64-2.35 dL/g and Mr from 25-138 kDa. The flow properties of 0.5% solutions of the extracted pectins were measured. All solutions exhibited Newtonian behaviour. Their gelling ability in the presence of either sugar or calcium and their emulsifying properties over storage were also measured. All pectins produced gels and showed an emulsion stability of ~50% at the fifth day of storage.

Keywords

pectin, microwave assisted extraction, ultrasound assisted extraction, physicochemical properties, orange peel waste

Acknowledgments

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#186: Semi-industrial development of novel functional food products containing immobilized probiotic cultures

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For the next seven years the functional food's market is expected to experience an increase driven by consumer concern for healthy diet at a CAGR of 7.5%, reaching $309 billion in 2027. Probiotics is estimated to hold the 25% of this market shared between probiotic supplements and foods. While the pharma industry has focused on the characterization of new probiotic strains and the documentation of new beneficial properties, the efforts of the food industry aim to develop stable formulations to incorporate probiotic strains into food products such as cereal bars, chocolates, juices and yoghurts. Cell viability during production and shelf life of the product remains a real bottleneck for the food industry as more than 107 viable cells/g of product are often necessary in a 100 g product at time of consumption in order to offer a health benefit. To overcome such deficiencies, immobilized cell technology is proposed. The aim of the present study was the semi-industrial production of novel functional food snacks (such as cookies and cereal bars) that will support cell viability of over 7 logcfu/g during the shelf life of the product. Probiotic cells of three commercially available lactobacillus strains were initially immobilized on oats (resulting in cell populations of 8.5 logcfu/g) and subsequently incorporated into the new products. Similar to lab scale, scale up experiments revealed cell populations at levels over 7 logcfu/g in food snacks, when stored at 0-8 ^{o}C for a period of up to 7 months dependent on the exact product. All products retained their sensory characteristics. In contrast, storage at room temperature resulted in a significant decrease of probiotic cell loads in all products during the first 15 days. In conclusion, data supporting the semi-industrial development of novel functional food products containing freeze-dried immobilized probiotic cultures with great market potential are presented.

Keywords

probiotics, Lactobacillus, immobilization, functional foods, snacks

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#187: Influence of ultra-high-pressure homogenization (UHPH) on the oxidative stability of dried emulsions formulated with buttermilk and omega-3 oil

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Buttermilk has a dual functionality based on its emulsifying capacity and bio-functional potential as health-promoting, mainly due to the complex composition in fat globule membrane components. One of the most essential nutrients in dietary patterns are omega-3 fatty acids because their regular intake has potential effects on the health improvement of most of the vital organs of the body. Hence, these two components together has the potential to produce emulsions to be incorporated into food as source of functional components with health benefits. However, it is well known the sensitivity of polyunsaturated fatty acids to oxidation. UHPH, as emerging technology, has the ability of improving the stability of feed emulsions by reducing oil droplet size and creating a protective layer of emulsifying material which could have a positive effect on the oxidative stability of emulsions.

The oxidative stability of dried emulsions was investigated. Feed emulsions were obtained by conventional homogenization (CH) at 30 MPa and by ultra-high pressure homogenization (UHPH) at 100 and 200 MPa. Emulsions formulations consisted in 10 % (w/w) oil mixture (50:50) of chia seed (Salvia hispanica L.) and sunflower (Helianthus annuus L.); 4 to 7% (w/w) commercial buttermilk as emulsifying agent, and 30% (w/w) maltodextrin as wall material of powder emulsions. Spray drying of feed emulsions was performed and their oxidative stability was evaluated during one month storage at 50 °C. Primary oxidation was analyzed by determining the peroxide index and secondary oxidation by malondialdehyde determination using HPLC.

Results showed that in solid emulsions, the storage at 50 ° C for one month and the percentage of buttermilk influenced the oxidation levels. In general, oxidation increased as time increased and decreased as the percentage of buttermilk increased. UHPH technology compared to conventional homogenization had a positive effect, showing better oxidative stability when feed emulsions were obtained by UHPH at 100 MPa.

Keywords
Buttermilk, Omega-3 fatty acids, Spray drying, UHPH, Oxidative stability

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#188: Compositional and functional properties of sweet buttermilk manufactured from sheep or cow milk or sheep cheese whey cream

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Buttermilk is the by-product of butter-making process, which is based on the churning of dairy cream. It exhibits important functional and biological properties and can be utilized in the manufacture of various food categories. An essential stage of the butter-making technology is the fat crystallization that takes place during a low-temperature ripening period of sweet or cultured cream. Opposite to cow counterpart, information and research on the properties and exploitation of sheep buttermilk are very scarce. The present study is a part of a research effort that focuses on the properties of sheep buttermilk as a first step for its exploitation. Its objective was to study the effect of the cream origin - sheep or cow milk or sheep cheese whey– and of the thermal history of cream on the compositional and functional characteristics of the resultant sweet buttermilk. For this purpose, buttermilk was obtained from the churning of non-acidified cream of cow and sheep milk and sheep cheese whey heated at 68oC for 10 or 30 min and ripened at temperature lower than 8oC. Buttermilk was analyzed in respect to gross composition, acidity, antioxidant potential, solubility, viscosity, emulsifying and foaming capacity. Sheep, cow and whey buttermilk exhibited differences mainly in protein and fat contents, acidity, antioxidant properties and functionality. The effects of cream origin and thermal history on the studied properties were assessed by means of statistical analysis.

Keywords
buttermilk, churning conditions, composition, functional properties

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#189: Mathematical Modelling of Ultrasound Pre-treatment in Microwave Dried Strawberry (Fragaria L.) Slices

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In this study, the strawberry (Fragaria L.) fruits, which were pretreated with ultrasound (US), were worked on in the microwave by using 90W power. Then mathematical modelling was applied to dried fruits by using different experimental thin layer models. The sliced fruits were subjected to ultrasound treatment at a frequency of 40 kHz for 10 , 20 and 30 minutes, in an ultrasonic water bath, with a ratio of 1:4 to fruit / water. They are then dried in the microwave (90W). The drying process continued until the product moisture was below 10%. By analyzing the moisture change of the products at a certain time, eight different thin layer drying models, (Newton, Page, Modified Page, Midilli, Henderson and Pabis, Logarithmic, Two-term, Wang and Singh) were tested for verification of experimental data. MATLAB R2015a statistical program was used for the modelling and the best suitable model was determined with R2adj (coefficient of determination of compatibility) and RMSE (Root mean square error) values. According to analysis, the drying model that best describes the drying behavior for both drying conditions was determined as Midilli model by high R2adj and low RMSE values. Control, 10, 20, and 30 min. US for groups R2adj and RMSE values was establishment as respectively; 0,9997- 0,005298; 0,9998- 0,004735; 0,9995- 0,007031; 0,9917-0,02773. In addition, effective diffusion coefficients were calculated for each group and were determined as 3,80x10-8, 3,71 x10-8, 3,26 x10-8 ve 3,5 x10-8 m/s, respectively.

Keywords
mathematical modelling, microwave drying, strawberry, ultrasound

#198: Formation and physicochemical properties of insoluble complexes resulted from high methoxyl pectin – protein interactions

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Protein-polysaccharide interactions and their modulation have been receiving increasing interest from a novel product development perspective as they play a key role in controlling the functional properties of the biopolymers, and hence, the food systems or coating and packaging materials they are incorporated into. Sodium caseinate (NaCas) and whey protein isolate (WPI) are value-added residual products from industrial milk processing and cheese manufacturing, and pea protein isolate (PPI) is the byproduct of the pea starch production line. In this work, mixtures of these proteins and high methoxyl pectin (HMP) were prepared and studied in order to determine the optimum conditions (biopolymer mixing ratio and pH) for the formation of insoluble complexes and the study of their physicochemical properties.

The effect of protein-HMP mixing ratio (1:1-10:1 w/w) and pH (2-7) on complex formation was investigated using turbidimetric analysis, z-potential measurements and phase diagram construction. Maximum optical density and net charge neutrality were achieved at different pH values for the homogenous protein solutions and the protein-HMP mixtures. This is indicative of the significant effect that mixing ratio and pH had on these systems, which was further supported by the constructed phase diagrams.

Based on our findings, the optimum conditions for complex formation were a protein-HMP mixing ratio of 6:1 (w/w) and pH 4 for NaCas and WPI or pH 3 for PPI. The insoluble complexes were converted to powder by oven drying, and the yield was approximately 92%, 51% and 8% for NaCas-HMP, WPI-HMP and PPI-HMP mixtures, respectively. Various physicochemical properties, i.e. bulk density, loose density, moisture, pH, conductivity and solubility of both complex and single biopolymer powders were measured. The complexes showed different values in their physicochemical properties compared to each other and their constituent biopolymers. The findings of this research could provide useful information for future applications with insoluble complexes.

Keywords

Complexes, Pectin, Sodium caseinate, Whey protein isolate, Pea protein isolate

#199: Valorization of Agro-industrial Waste: Useful bioactive Compounds from Dried Apple Pomace for Natural Food Additives

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Waste from industrial use of agricultural products have the potential of being a cheap and reliable source of bioactive compounds for natural food additives. Being a waste product of industrial production of juice, cedar and wine, apple pomace is a good source of pectin, antioxidant and antimicrobial compounds. Before extracting these compounds, proper handling of the pomace is required to inhibit spoilage and microbial growth. Drying to appropriate moisture content and water activity is a key step towards the use of the apple pomace. Drying does not only facilitate proper storage by reducing the size of the storage area and prevent spoilage but also a technical process required for the extraction of useful compounds. Under controlled drying using a conventional oven, apple pomace can be dried by high-temperature short time (HTST) as well as low-temperature long time (LTLT) drying methods. Although both methods can be useful under different circumstances, for optimal results, the choice of the best method can be based on the effect on yield and effectiveness of produced phytochemicals. The proper combination of drying temperature and time helps to mitigate the degradation and quality loss of the interested compounds.

Keywords
Apple pomace, Natural food additives, Extraction, Moisture content, Water activity

Acknowledgements
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#200: Characterization of active films based on Poly (vinyl alcohol) and phenolic acids for food packaging applications

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Active packaging technology is capable of interacting dynamically with the target intrinsic and/or extrinsic factors of the packaged product to preserve food quality and extend its shelf life, enhancing the performance of the package system. Phenolic acids are active agents with remarkable antioxidant and antimicrobial properties. Their incorporation into biodegradable polymer matrices, such as polyvinyl alcohol (PVA), would allow obtaining active materials for food packaging with less environmental impact, which is advisable in midst of the serious pollution problem, even more affected by the increase in the generation of plastic waste caused by the covid-19 pandemic. The aim of this work was to evaluate the effect of the incorporation of phenolic acids into two kinds of PVA (A: Mw 89,000-98,000; 99-99.8% hydrolysed and B: Mw 13,000-23,000; 87-89% hydrolysed) to obtain active films for food packaging application. To this end, cinnamic acid and ferulic acid (at 1 and 2% with respect to the polymer) were incorporated into the film forming dispersions and the films were obtained by casting. The films were characterized as to their crystallinity and microstructure as well as their mechanical, thermal and water vapour and oxygen barrier properties.

The results showed that phenolic acids were more compatible with the B-polymer, as revealed by the more homogeneous film microstructure of B based films. The phenolic acids incorporation changed the properties of the films but did not significantly affect ($p>0.05$) their thermal behaviour. On the other hand, ferulic acid led to greater changes in PVA films than cinnamic acid, promoting the increment of crystallinity, stiffness and barrier capacity to water vapour and oxygen of the films. These effects were attributed to the presence of a phenolic hydroxyl group in ferulic acid, which may promote further inter-chain hydrogen bonds and a cross-linking effect in the polymer matrix. It is remarkable that polymer B exhibited a lower melting temperature and a greater thermostability, which enables it to be processed by melt compounding without thermal degradation. This represents a great advantage for the potential industrial use of this polymer for developing active food packaging materials.

Keywords

Cinnamic acid, Ferulic acid, Food packaging, Food preservation, Shelf life

#201: Antioxidant PLA films containing rice straw extracts for food packaging applications

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Agro-industrial by-products, such as rice straw (RS), are important sources of bioactive compounds with antioxidant potential that can be applied in foods or food packaging materials. A green and efficient aqueous extraction process (sequential combination of ultrasound and reflux heating) was used to obtain bioactive compounds from powdered rice straw. This study analyses the effect of the extract incorporation into poly (lactic acid) (PLA) films and the bioactive release in different food simulants (10% and 50% aqueous ethanol solution). The freeze-dried extract was characterized as to the total phenolic content (TPC) (37.1 mg GAE. g-1 freeze-dried extract) and antioxidant activity (AA) (EC50: 6.3 mg freeze-dried extract. mg-1 DPPH). PLA films, plasticized with PEG1000 (8% wt.), were prepared by melt blending and compression moulding by incorporating different bioactive extract concentrations (0%, 1%, 4%, and 6% wt. with respect to PLA mass). The bioactive extract coloured the films (ΔE*: 18-39) and slightly reduced their internal transmittance or transparency. The incorporation of bioactive extract provoked a reduction of the film resistance to break and stretchability by about 8% and 40%, respectively, while the elastic modulus increased (around 5%) in the films with 6% extract. Thermogravimetric analysis revealed that the incorporation of extracts to PLA films slightly reduced both the temperature of initial degradation and the temperature at maximum degradation rate. The Tg values of the PEG plasticized PLA films were not remarkably affected by the addition of the extract (34-37 ℃). Likewise, the extract incorporation slightly modified the oxygen and water vapour barrier capacity of the films. The highest bioactive release from the films was observed for the less polar simulants (50% ethanol in water), showing a progressive increase in the TPC released and AA throughout 10 days. Therefore, incorporating RS extract in PLA matrix represents a green alternative to obtain bioactive value-added materials for food packaging applications while contributing to revalorising the agro-industrial waste.

Keywords
Agro-indurstrial waste, Phenolic compounds, Release, Active films

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#203: Performance of biopolymers from seaweeds and seagrasses

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BIOCARB-4-FOOD Extraction and characterization of bioactives and carbohydrates from seaweeds and seagrasses for food-related applications

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Carbohydrates are the most important source of food energy. As well, carbohydrates are key ingredients for food formulations, serving as thickeners, stabilizers and gelling agents or providing functional attributes. Seaweeds and seagrasses are a valuable and under-exploited source of carbohydrates, in particular cell wall polysaccharides (phycocolloids), and bioactive compounds such as polyphenols or carotenoids. Current industrial procedures used by European companies for carbohydrate extraction from seaweeds are highly inefficient in terms of processing time, water and energy requirements. Furthermore, the remaining biomass (generally much more than 50% of the initial material) is used as compost or simply disposed as organic waste.

The ERA-NET SusFood2 project BIOCARB-4-FOOD aims, in close collaboration with industry, at novel, environmentally friendly and efficient extraction techniques (ultrasound, microwave, enzymes and their combinations), combined with the exploitation of the remaining biomass, rich in bioactive compounds, to sequentially obtain novel carbohydrate-based extracts and fibers (nanocellulose) from seaweeds and seagrasses. Characterization of structure, technological properties, toxicity and bioactivity of the fractions and a life cycle assessment (LCA) will also be conducted for proving the sustainability of the procedures.

The project is expected to contribute to improved process efficiency, development of ingredients with high added value from already commercialized seaweed species and from under-exploited sources (seagrasses) which can positively impact in the competitiveness of seaweed, food and non-food companies at EU scale by a better valorisation of raw materials.

Keywords

sustainability, algae, seagrasses and seaweeds, bioactives, carbohydrates

#206: An overview on valorisation of tomato by-products in R&D EU-funded projects

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In the last years, European commission has been funding numerous projects regarding the valorisation of food wastes. In particular, tomato by-products received great attention especially in Spain, Italy, Greece and Portugal due to high volumes and high concentration of valuable compounds. Among 32 funded projects about the management of tomato wastes in general, 13 projects are strictly connected to the valorisation and exploitation of the tomato residues/by-products after processing and are of great interest for their scientific, technical and economical outcomes. They received an overall budget of around 37 M€ involving 19 European and 5 non-European countries, with project coordinators located in Germany, Netherlands and Italy in most of the cases. This work aims at gathering all the information about these projects, assessing and reporting about scientific and technical results. Moreover, the interconnection will be highlighted among them by focusing on the contribution that they gave to the European know-how, the management of these by-products and the progress they reached on waste minimization and valorisation. Finally, the industrial and environmental outcomes of these projects will be discussed by highlighting issues and problems that are still to be overcome.

This critical review on the concluded and ongoing projects funded by European commission is a preliminary part of the work program already set for a PhD project entitled 'Valorisation of tomato industrial by-products in Campania for sustainable recovery of components and energy' and funded by the Campania Region (IT). The PhD project is strengthened by the support provided by the University College London (UK) – Dept. of Chemical Engineering and by eLoop, a start-up company founded by young Italian PostDocs and acting as an innovative industrial consultant.

Keywords

Tomato by-products, valorization, European Union, funded projects

Acknowledgements

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#207: Effect of stirring and ultrasound-assisted extraction conditions in flavonoids, tannins, antioxidant and antimicrobial activities of chestnut outer shells (Castanea sativa Miller)

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procedures were used, specifically different solvents (water, ethanol:water (80:20) and acetone:water (80:20)) combined with two extraction methods (stirring and ultrasounds (US)) and times of extraction. Several chemical assays were applied to evaluate the flavonoids, hydrolysable and condensed tannins contents, and the antioxidant activity by total reducing capacity, 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity, and reducing power. Some individual compounds were identified by HPLC-UV detection. Furthermore, the antimicrobial activity of the obtained extracts was screened using different microorganisms, namely Gram-positive bacteria (Staphylococcus aureus, Bacillus subtilis, Bacillus cereus, Enterococcus faecalis) and Gram-negative bacteria (Escherichia coli, Pseudomonas aeruginosa, Enterobacter aerogenes, Proteus mirabilis, Klebsiella pneumoniae), as well as a fungi (Candida albicans).

The mixture acetone:water (80:20) was the best solvent to extract condensed tannins and flavonoids. It was with this mixture that the best total reducing capacity, DPPH radical scavenging activity and reducing power were observed. The highest extraction yield was also obtained with this mixture. Only for the hydrolysable tannins, the most suitable extraction solution was ethanol:water (80:20). The presence of gallic and tannic acids was detected by HPLC-UV.

Concerning the extraction methods, only the extracts obtained by the US exhibited antimicrobial activity. The ethanolic extract showed antimicrobial activity against the Gram-positive bacteria (Staphylococcus aureus, Bacillus subtilis, Bacillus cereus, Enterococcus faecalis) and the extracts obtained with acetone:water (80:20) and water showed antimicrobial activity against Proteus mirabilis.

The results of this study demonstrated that the chestnut outer shell is a promising source of bioactive compounds.

Keywords

Bioactive compounds, Ethanol, Acetone, Water, Chestnut Shell

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#210: Brewing with non-Saccharomyces yeasts

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In the last decades, the rapid growth of craft brewing gave rise to the experimental use of non-Saccharomyces yeasts, which were previously only reported as spoilage microorganisms in brewing. Saccharomyces strains provide better fermentation control and reproducibility. Non-Saccharomyces yeasts generally have slower fermentation rates and lower alcohol resistance. These, however, are not necessarily limiting factors for the small craft brewers who experiment with unfiltered beers and provide to the consumer seasonal specialty products, with novel and more extravagant taste.

In the present study, two different non-Saccharomyces yeasts were studied for their ability to metabolize maltose, as well as the aroma and flavor profile they impart to beer. In particular, the yeast strains that were chosen are two different strains of Torulaspora delbrueckii in both pure and mixed cultures with a S. cerevisiae strain and one strain of Metschnicowia pulcherrima and they were evaluated for a Pale Ale beer production. Pure cultures of S. cerevisiae, T. delbrueckii, and M. pulcherrima and mixed cultures of S. cerevisiae with both strains of T. delbrueckii, at a ratio of 1:10, were used to ferment wort at both temperatures.

This work presents data on fermentation kinetics, chemical and sensory analysis of beers produced with T. delbrueckii and M. pulcherrima yeast strains and how these attributes evolved over time. The examined strains exhibited higher production of some esters, higher alcohols & other volatile compounds, but also, low production of undesirable compounds and greater sensory complexity. In conclusion the results obtained showed that T. delbrueckii either in pure culture or co-inoculated with S. cerevisiae can have a merit that could be exploited in brewing.

Keywords

beer, non-Saccharomyces, Torulaspora delbrueckii, Metschnicowia pulcherrima, volatiles

#211: Antioxidant effect of natural extracts from Satureja thymbra in vegetable oils and oil-in-water emulsions

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Many natural or formulated food products have the structure of oil-in-water (o/w) emulsions, like milk products, salad dressings, mayonnaise, etc. Food products with an emulsion structure are stored at low (e.g. dairy products), or ambient temperature (salad dressing). Knowledge of the stability of added natural phenolic antioxidants and of their protection ability against lipid oxidation, under these storage conditions would be useful for the formulation of relevant products, enriched with natural antioxidants.

Satureja thymbra is a common herb of the Lamiaceae family, wildly grown and also cultivated. In previous works, extracts of the herb proved rich in phenolic compounds and exhibited a potent antioxidant activity.

In the present work, dried leaves of S. Thymbra were subjected to water-steam distillation to recover the essential oil. The solid residue was subjected to sequential Soxhlet extraction with ethyl acetate and ethanol. The obtained extracts were analysed by HPLC-DAD-ESI–MS/MS and the main flavonoids and phenolic acids were identified and quantified. The antioxidant activity of the extracts was tested in bulk palm oil and palm oil-in-water emulsions. Ethyl acetate extract prolonged the induction period and reduced by 42% the rate of peroxide formation in palm oil, while ethanol extract was the most effective in emulsions.

Moreover, the effect of S. thymbra extracts on the oxidative stability of sunflower o/w emulsions stored at 5 °C – 40 °C, as well as the stability of phenolic compounds under these conditions were examined. In parallel, quercetin (Que) and rosmarinic acid (RA) were tested as representative compounds of the flavonoids and phenolic acids present in the extracts.

S. thymbra natural extracts proved effective to enrich vegetable oils and o/w emulsions with polyphenols, mainly RA and flavonoids, and thereby upgrade their nutritional profile. The phenolic content of the emulsion decreases with storage, mainly due to RA decrease. In addition to enrichment with polyphenols, the extracts protect the emulsions against oxidation, offering protection factors close to Que and higher than RA. At 5 °C the extracts reduced the oxidation rate by 75-80%. Higher storage temperatures enhanced oxidation and resulted in lower protection factors and higher loss of the phenolic content.

Keywords

natural antioxidant, emulsion, vegetable oil, satureja thymbra, phenolic compounds

#213: Pulse crops flours and banana peel flour effects on the microstructure and physicochemical characteristics of gluten-free muffins

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Celiac disease is an autoimmune disorder caused by intolerance to gluten, which is found in wheat and similar proteins in barley, rye, kamut, spelt and oats. The only effective treatment is to follow a gluten-free (GF) diet strictly. GF dietary is often characterized by excessive consumption of energy and a reduced intake of fibre, minerals and complex carbohydrates. Nutritionists recommend pulses crops (grain legumes) in the diet as they have many nutritional benefits. The purpose of this study was to produce GF muffins enriched (GFME) with pulse crops, namely lentil, white bean, carob, buckwheat, chickpea and banana peel flour, and to analyse their effect on microstructure and physicochemical properties (protein, total fat, fibre, moisture and ash). Each matrix contained mostly rice flour and 5%(w/w) of a pulse crop. The muffins were baked in an oven (200°C, 18min). Microstructural analysis was performed by Scanning Electron Microscopy (SEM), and the protein, total fat and fibre were determined by Kjeldahl method, acid hydrolysis method and ceramic fibre filter method, respectively. Moisture and ashes were determined by a gravimetric method. An ANOVA with Tukey test was used to investigate significant differences ($p<0,05$) in the analysed parameters. Microstructural analysis showed that GFME were characterized by an heterogeneous structure regardless of the formulation studied. It was concluded that carob GFME showed a more homogeneous morphology with alveoli <1mm. On the contrary GFME with buckwheat and white bean presented larger alveoli (>1mm), with more dispersed sizes. Results showed that the control sample (without pulse flour) presented the highest moisture content and the lowest ash content. GFME with banana peel flour and with chickpea flour scored the highest ash and fibre content. On the contrary, GFME control and with white bean scored the lowest fibre content. There were no significant differences in protein and fat contents of different GFME studied. It was concluded that the use of pulse crops or banana peel flours can be a good alternative to obtain enriched GF products, with a commercial added value and from the point of view of sustainability.

Keywords
gluten-free, pulse crops, banana peel flour, Nutritional analysis, Microstructure

#215: Nutritional quality of a bread with Brewer's spent grain addition and bioaccessibility of its antioxidant compounds

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Brewer´s spent grain (BSG) is the most abundant byproduct generated by the brewing process which has an interesting nutritional value, presenting potential as a sustainable functional ingredient. The aim of this work was the valorization of this food industry waste through the development and study of antioxidants bioaccessibility from a functional bread made with the addition of BSG as a substitute of wheat flour (20 % w/w).

To enhance the release of bioactive compounds from BSG, an enzyme-assisted extraction was carried out using a central composite design with two variables: cellulase and alcalase concentration at two levels (0% and 0.1% w/w in relation to the content of BSG). Total polyphenol content (TPC) determined by Folin-Ciocalteu method, and antioxidant capacity determined by ABTS and ORAC methods were the response variables. The system with 0.1% alcalase addition was selected as the BSG flour (FBSG) to be used in the development of the functional bread (BBSG). Control bread (CB) was formulated without the addition of BSG.

Nutritional characterization of FBSG, BBSG and CB was carried out finding a significant increase ($p<0.05$) in fiber content for BBSG (6.9 %) with respect to CB (2.8 %), achieving the nutritional claim "high fiber content" by MERCOSUR regulation. Color, texture and volume parameters of BBSG and CB were also determined, observing a significant increase ($p<0.05$) of Chroma (parameters L, a, b) for BBSG.

Bioactivity was determined on breads and bioaccessible compounds obtained from an in vitro digestive simulation. BBSG showed increased ($p<0.05$) TPC (0.47 ± 0.06 mg GA/g), as well as antioxidant activity (2.0 ± 0.2 and 0.40 ± 0.04 µmol Trolox/g for ABTS and ORAC, respectively) with respect to CB. After digestive simulation, BBSG showed decreased TPC (0.13 ± 0.01 mg GA/g) and increased antioxidant activity (128 ± 10 and 3.9 ± 0.7 µmol Trolox/g for ABTS and ORAC, respectively). This increase could be due to the release of other compounds (e.g. peptides) with antioxidant activity during digestion.

In conclusion, a sustainable functional bread of "high fibre content" with antioxidant activity was obtained using an industry by-product, contributing to circular economy, healthy nutrition and preventing further environmental issues, in accordance with the sustainable development goals.

Keywords

Brewer´s spent grain, Sustainable functional bread, Antioxidants, Food industry waste valorization, Bioaccessibility

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#219: A sustainable approach for the valorisation of a tomato by-product: green techniques for lycopene extraction

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Nowadays we are facing to a food crisis, as billion tonnes of food are annually lost or wasted worldwide, while people suffer from hunger or are undernourished. The current food situation is worsening by unsustainable behaviours which have also exacerbated environmental issues. These are part of major concerns of the United Nations; in particular several of the seventeen SDGs are related to sustainable food production. Therefore, the valorisation of food by-products, losses and wastes has grown in importance, with improvements in circularity and sustainability, aimed to provide new products rich in high added value compounds, potentially exploitable by the cosmetical, pharmaceutical and food sectors.

In this context, this work aims to valorise the carotenoid content - with a particular attention to lycopene due to its antioxidant properties - of a by-product obtained from the production of a tomato puree and essentially made by skins and seeds.

To achieve a higher yield of the carotenoids it has been fundamental to pre-treat the by-product to make it more suitable for the interaction with the used extractive solvents. These pre-treatments can also contribute to preserve the by-product during the time. In particular, three pre-treatment techniques were tested on the by-product, namely freeze-drying, heat-drying and air-drying using a prototype; the performances in terms of treated product quality and some parameters for energy consumption estimation have been compared.

Different carotenoids extraction processes were performed both on the untreated and pre-treated by-products: a traditional one (solvent mixture: acetone/*n*-hexane) and two greener solutions (Deep Eutectic Solvents, DES: ethyl acetate/ethyl lactate and menthol/lactic acid).

The ethyl acetate/ethyl lactate mixture, in combination with the air-drying treatment, resulted as a very promising sustainable and green approach for the extraction for the carotenoids since it allowed to achieve similar yields in comparison to the ones obtained with traditional techniques.

Keywords
tomato by-product, lycopene, sustainable food technologies, green solvents, extraction

#220: Development of new healthy dairy products made from organically produced mare's milk

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Mare's milk is a new product to be incorporated into the Mediterranean diet. Its use in human nutrition is a very interesting research topic in relation to the specific characteristics of this drink that make it suitable for use in the nutrition of the general population and as an aid in the process of curing or improving various diseases (Magdalena Pieszka et al, 2016, M.C Curadi et al, 2016). However, it is a very complex product to work with at a technological level, due to its low casein and fat content, mare's milk is not suitable for cheese or butter production (Magdalena Pieszka et al, 2016). Its structure is unstable at temperatures above 40°C so mare's milk should be cooled rapidly and used in liquid form within 6-9 hours after milking (Danków et al., 2006 b). The aim of this work is to develop drinkable yogurts from organically produced mare's milk, expanding the range of dairy products available to new consumer profiles and extending the shelf life of this raw material. Four different yogurt formulations were developed, without added sugars and with low lactose concentrations to make them accessible to people with lactose intolerance, in conjunction with the addition of freeze-dried mare's milk and/or lactase. Physicochemical parameters (pH, titratable acidity, syneresis and dynamic viscosity), nutritional composition (fatty acid, lactose, protein and fat profile), antioxidant capacity (by ABTS and ORAC methods), enzymatic activities related to carbohydrate and fat metabolism (α-amylase, α-glucosidase and lipase) and microbiology as a measure of quality were evaluated. The results showed that the greatest differences were found between yogurts supplemented with freeze-dried mare's milk and lactase and those not supplemented in relation to the physicochemical parameters of % syneresis and moisture, in % protein and lactose (µg/mL), in antioxidant capacity by means of and in the enzymatic activities α-amylase, α-glucosidase and lipase. For the rest of the parameters, no significant differences were found between the formulations. This work has led to the development of a new range of functional and healthy dairy products, with no added sugars and low lactose content, to meet the needs of a wider range of consumers.

Keywords
dairy products, mare's milk, lactose-free, no added sugars, new products

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#224: Bio-based films produced with corn starch modified by the dry heat treatment (DHT)

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Starch modification is conducted to improve the native starch characteristics, in this sense, dry heating treatment (DHT) promoted molecular changes resulting in matrices with higher compactness. In this study, corn starch was modified by DHT, and films were obtained with and without microcellulose fibres (MCF) obtained from rice straw.

DHT was performed at 130 °C for 4 h and starch sample was sieved (150 µm) after treatment. Blend with corn starch, glycerol (30 g/100g of starch) as a plasticizer and, MCF (0 to 5 g/100g of starch) were prepared by melt blending in an internal mixer at 130 °C and, 50 rpm, for 10 min. Then, ground in a mill and conditioned at 25 °C and 53% RH for 7 days before compression moulding in a hot-plate press (pre-heating at 150 °C for 5 min, compression at 150 °C and 30 bars for 2 min, followed by 6 min at 130 bar and finally, a cooling cycle for 3 min until 70 °C). Films were conditioned at 25 °C and 53% RH for 7 days and, then characterized as to their mechanical, barrier properties, and transparency.

The dry-heating process increased the mechanical properties regardless the MCF concentration. As concerns the Young Modulus and tensile strength, the highest value was observed in the film's reinforcement with CMF (3 g/100 g of starch), whereas the elongation at break decreased. DHT reduced the WVP of the films by at least ~95 % regardless the MCF content. Therefore, DHT could be used to enhance the performance of corn starch films with or without MCF.

Keywords
dry-heating treatment; corn starch; biodegradable films.

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#225: Physical stability of emulsions formulated with milk fat globule membrane materials from different dairy by-products and prepared by ultra-high-pressure homogenization

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Buttermilk (BM) is a by-product obtained either from butter or butter oil processes and is used in food industry because of its emulsifying characteristics. However, BM have recently gained attention as source of proteins and polar lipids from milk fat globule membrane (MFGM) suitable to prepare functional ingredients.

The aim of this work was to characterize oil-in-water emulsions (O/W) made by ultra-high-pressure homogenization (UHPH) at 200 MPa or conventional homogenization (CH) at 30 MPa, and prepared from vegetable oils (10 %) rich in ω-3 fatty acids, and BM or a commercial dairy product enriched in MFGM (CMFGM) as emulsifier materials used at 7 and 3%, respectively. Emulsions were characterized in terms of particle size, zeta potential, rheological behaviour and physical stability.

The results showed that emulsions prepared by UHPH at 200 MPa with BM had mean particle sizes of ~400 nm and zeta potential values of –30 mV. In contrast, emulsions prepared with CMFGM showed smaller mean particle sizes and zeta potential values ranging from ~200 nm and –27 mV, respectively. For emulsions prepared with the CH system, the mean particle size ranged ~1 µm and the zeta potential values were –38 mV for those prepared with BM and –28 mV with CMFGM. Regarding the rheological behaviour, it was observed that all emulsions showed Newtonian behaviour. Analysing the emulsion stability, emulsions presenting the highest physical stability in terms of creaming and aggregation/flocculation were those formulated with BM and prepared by using UHPH at 200 MPa.

Keywords
oil-in-water emulsions, Buttermilk, Milkfat globule membrane, Ultra-high-pressure homogenization

Acknowledgements
Spanish Ministry of Science, Innovation and Universities for financial support

#227: Challenges in the application of unmalted raw materials in brewing

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The brewing industry employs a number of operations in processing raw materials to the final product - beer. Brewing process uses malted barley and/or unmalted cereals (adjuncts), hops, water, and yeast. Most brewers use malted barley as their primary raw material, but the malting process is energy intensive and uses large volumes of water. The use of high portions of unmalted grains instead of mated barley is mainly economically driven - when barley malt is fully replaced by raw barley, estimated total savings of €0.5–1.0/hL beer. Nowadays, this process of replacement is being accelerated by using interesting choices of different cereals, leading to the creation of unique beers. The most common choices for adjuncts are unmalted barley, wheat, corn, triticale... On the other hand, the use of adjuncts may require additional investment in commercial enzymes, if the adjunct don't have a sufficient enzymatic potential. Typically, adjuncts contribute starch, with no enzyme activity, but cereal like triticale is an exception. Triticale has a low gelatinization temperature and high enzymatic activity, which indicates its capability of degrading its own starch with efficiencies equal to those of barley malt, so it doesn't require additional thermal process, but usage of triticale can give viscous mash, which could lead to slower beer filtration.

The objective of this study was to evaluate the possibility of triticale application as partial substitute for barley malt in wort production. Two triticale varieties (NS Paun and Odisej) were used in a different ratios in wort production (10, 30, 50, and 70%) with or without utilization of altered mashing regime regarding temperature. Also, commercial enzyme – Shearzyme was applied in each mashing regime, in order to lower wort viscosity. Overall, our research showed that both triticale varieties, at every ratio, had higher wort extract, when altered mashing regime was applied compared to values obtained during standard mashing regime, with or without enzyme addition. Also, enzyme addition and altered mashing regime decreased wort viscosity, especially when higher triticale ratios in mash were used. Obtained results indicated that triticale could be used as a partial substitute for barley malt in wort production.

Keywords
Triticale, Malt, Beer

Acknowledgements
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#228: Release kinetics and antibacterial activity of phenolic acids from PLA-PHBV films

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Food packaging industry is facing the current challenge of developing biodegradable packaging materials to decrease the use of convenctional plastics, while the use of synthetic preservatives in food products should be reduced to respond to consumer demands. Active packaging materials, incorporating active compounds from natural origin could be developed.

Poly(lactic acid) (PLA) and poly (3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) are biodegradable polyesters obtained from natural resources, which could be used for producing active food packaging materials. To improve their functional properties they have been blended in the compunding phase. To increase the shelf-life and maintain the storage-keeping quality of the packaged foods, active compounds with reported antibacterial activity such as phenolic acids could been incorporated to the blend films.

PLA-PHBV blend films incorporating phenolic acids (ferulic acid, p-coumaric acid and protocatechuic acid) by melt blending and compression moulding were obtained. The films were evaluated as to the release kinetics of the phenolic acids in different food simulants. The Minimal Inhibitory Concentration (MIC) of these phenolic acids against Listeria innocua was obtained and the film antibacterial activity was tested in vitro.

In both simulants (A: 10% ethanol aqueous solution and D: 50% ethanol aqueous solution), the release rate and ratio were the highest for ferulic acid and the lowest for protocatechuic acid. In general, both release rate and ratio increased when the simulant polarity decreased. The three phenolic acids exhibited antibacterial activity against Listeria innocua, with MICs values ranging from 700 to 900 mg/L, the highest value being for p-coumaric acid. The antilisterial effectiveness of these phenolic acids when incorporated in the polyester blend films was significant, but the growth inhibition with respect to the control (phenolic acid-free films) was lower than 2 logs. This escarce antibacterial effect could be attributed to the low initial release rate and total amount released of actives from the films, especially in polar systems such as the culture medium.

Keywords

biodegradable active films, PLA, PHBV, phenolic acids

#229: Restoring 'Rocha' pear´s ripening capacity under 1-MCP evergreen effect: the role of temperature and ethylene treatment

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Fruit are vulnerable to several postharvest losses due to their production seasonality, growing conditions, perishability, unpredictable ripening, and postharvest disorders. For about forty years, the postharvest application of diphenylamine was an efficient strategy to protect fruit from postharvest problems. However, in 2011 its use was no longer allowed in the European Union. Currently, in combination with cold storage, 1-methylcyclopropene (1-MCP) is used as an alternative to prolong the self-life of fruit. However, the pear fruit (Pyrus communis L.) industry sector is facing a problem resulting from 1-MCP´s application which compromises producers' sustainability, because 1-MCP causes problems in the normal ripening, affecting its eating quality and increasing postharvest losses.

This study was designed to assess whether a storage temperature of 4 °C (higher than the current recommendations of -1 to 0 °C) or the application of exogenous ethylene, could restore the post-storage ripening of 'Rocha' pear treated with 1-MCP, while preserving the fruits from physiological disorders. Fruits were removed from storage after 15 days of storage, transferred to approximately 22 °C and assessed for ripening and quality at 0 and 7 day of shelf-life. Time course physiological and biochemical analysis revealed that ripening induction by the application of exogenous ethylene was more effective that storage at higher temperature. Exogenous ethylene treatment increased respiration rate about 60% and internal ethylene production compared to control, while fruit stored under (4 °C) ripened slowly. 1-aminocyclopropane carboxylic acid (ACC), ACC synthase (ACS) and ACC oxidase (ACO) activity were also evaluated and corroborate the effect of the storage treatments applied in this study.

The results provide information regarding how blockage caused by 1-MCP may be overcome and ethylene sensitivity can be regulated, thus opening avenues for reducing post-harvest losses.

Keywords

1-MCP, Ripening recovery, Postharvest losses

Acknowledgements

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#230: Technological effects of essential oils applied in chocolate

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Among the constituents of essential oils, monoterpenes have been studied for their ability to alter the molecular mobility of fat crystals and modify the crystallization behaviour of cocoa butter. Thus, the aim of this study was to evaluate the influence of the addition of thyme essential oils and the blend (thyme : lemongrass) on the fatty acid composition and crystallization isotherm of cocoa butter and its influence on the physical stability of dark chocolate. Parameters related to the chocolate along the storage were evaluated such as: the force required to break (snap), polymorphic habit by XRD, melting behaviour (DSC) the appearance of fat bloom by means of the whiteness index. The addition of essential oils did not change the fatty acid composition of cocoa butter, but slightly decreased the rate of crystal growth. The polymorphic transition from unstable crystals to the most stable form (βVI) was detected from 21 days of storage for the control chocolate sample and for the sample with thyme essential oil addition, while for the chocolate with essential oil blends the transition was detected from 30 days. The melting behaviour of the chocolates, indicated the presence of more stable polymorphic forms at 45 days of storage. The whiteness index increased significantly from 21 days, such change may be related to the polymorphic transition in the chocolates. Among the samples, it was possible to observe that the chocolate without essential oil addition showed a higher whiteness index than the samples with essential oil from 62 days of storage. This result indicates that the addition of essential oils provided the chocolate with a possible delay in the formation of fat bloom. Moreover, the addition of essential oil decreased the snap tension, giving more softness to the chocolate. These results indicate that the addition of thyme essential oils and the blend (thyme : lemongrass) do not alter the fatty acid composition of cocoa butter and do not influence the maximum solid content, but slightly decrease the crystalline growth rate and may contribute to the retardation of fat bloom in chocolate.

Keywords

chocolate, fat bloom, cocoa butter, monoterpenes

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#231: Assessing serving food waste in the food service – a case study

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The topic food waste (FW) has been gaining increasing importance in recent times and one of the causes pointed out for its occurrence is the lack of awareness, on the part of the operators of the food chain and of the consumers, about this problem.

Leftovers (LO) are, among the components of FW, the one that makes it possible to measure the effectiveness of food planning and preparation, since the quantity of leftovers is directly related to the number of meals served, the calculated capitations and the technical preparation of the food (Remini, 2018). As part of a comprehensive project on the study of the various aspects of FW in public cafeterias, the objective of this study was to determine FW, LO component, in a selected unit, using the method of quantification (QM) and observation. Data was collected during lunch distribution for 5 consecutive day, in a diverse menu, with few repetitions throughout the year. The QM was based on two studies (1,2). Capitations was provided by the Managing of this unit for the various age groups and was based on the recommendations for the daily energy intake considering the distribution of the value among the different meals. 893 meals were served, corresponding to approx. 530.7 kg of cooked food. The average LO were 17.5% (considered an unacceptable value). Although with variations (9% and 70%), soup was the item that, most often, contributed to LO value and in general, side dishes were the component with the least impact, varying between 1% and 30%. Meal planning were based on the expected number of customers considering the previous days and other types of variable factors. However, it was noticed that the capitation calculation was performed only for protein, which is the component made in greater quantity, and generally the most perishable food (meat / fish) requiring a previous defrost or order closer to the date (fresh products). In addition, not all dishes had their intake tabulated, making it difficult to calculate. It was possible to measure one of the components of the FW in the unit under study, guiding the implementation of measures for planning, waste reduction and optimization of productivity.

References

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Keywords

Food Waste, Food Service, Leftovers, Food planning

#233: Effect on the quality of chestnuts (Castanea sativa Miller) manually and mechanically harvested during industrial cold storage

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The European chestnut (*Castanea sativa* Mill.) is a typical seasonal product with high importance in Portugal. Due to the difficulty in finding labour to harvest this fruit, machines have been used that perform the harvesting mechanically. However, during the nut's mechanical collection, small stones or other materials can also be sucked, damaging the nut's surface. These damages may affect the quality of the fruit and possibly lead to the appearance of a more significant number of rotten fruits. Currently, the presence of chestnut rot caused by the fungus *Gnomoniopsis smithogilvyi* (*Gnomoniaceae*, *Diaporthales*) has been reported.

This study aimed to evaluate the effect on the quality of chestnuts manually and mechanically harvested during industrial cold storage for three months. Parameters such as the presence of bruises and minor cuts, the number of rotted fruits, loss of weight, total soluble solids (TTS), titratable acidity (TA) and reducing sugars were determined. The mechanical harvesting increased the frequency of bruises and small visible cuts. Moreover, in many fruits, it was observed the removal of the tuft. The number of rotted fruits did not increase along the storage time. During the three months of storage, the weight loss was never more than 10%, but it increased over time. Between the manual and mechanical harvesting, no significant differences in the weight loss, TSS and TA were observed in almost all situations. The reducing sugars were less than 0.65 g glucose / 100 g d.m., being fluctuations observed over time but without a definite trend.

In conclusion, mechanical harvesting caused minor damages to the chestnut surface. Still, in the physicochemical parameters evaluated, there were no significant differences between the two types of harvesting in the majority of the situations.

Keywords

Chestnuts, Impact injuries

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#237: Valorisation of food industry by-products: extraction, encapsulation, characterization and microstructural analysis

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Each year, 16 million t of food are lost and wasted in Argentina (FAO). About 90% is lost during production, while 10% is wasted by consumers. It is reported that vegetables and legumes by-products represent a good source of bioactive compounds with antioxidant properties. In this context, green and low-cost water-based extractions were proposed to recover phenolic compounds from agricultural leftovers of beet (Beta vulgaris), cowpea (Vigna unguiculata), and artichoke (Cynara scolymus L.). Each part of the leftovers (bracts, stems, leaves or pods) was analysed to determine the most suitable material for the extraction of phenolic compounds in terms of composition and efficiency. To improve their stability and bioavailability, extracts were encapsulated by ionotropic gelation in Ca(II)-alginate beads. Loading efficiency of total phenolic compounds (L.E.TP) and remaining antioxidant activity (R.A.A.ABTS+) of each system were measured by Folin-Ciocalteu and ABTS+ scavenging methods. Macro and microstructural parameters were studied by image analysis and SAXS. Extracts with high concentration of bioactive compounds were successfully encapsulated, obtaining L.E.TP between 22-48% and R.A.A.ABTS+ between 11-43%. Acceptable values of roundness for food industry were obtained (0.84-0.95). SAXS fractal analysis allows for the observation of changes in the microstructure of beads related to the incorporation of the extracts. Significant changes were detected at the supramolecular level (100 nm) where extracts from cowpea and beet greatly increased the interconnectivity of the alginate network while artichoke extracts had a slight opposite effect. At the molecular level (1-10 nm) all the extracts improved the compactness of the structure and reduced the size of the nanometric alginate basic unit. However, for its density, contrasting results were found between beet and artichoke and cowpea. Thus, the differences in the phenolic composition and concentration of cations in the extracts, had a profound impact on the microstructure of the gels. We hereby demonstrated that the green extraction of bioactive compounds from these by-products and their subsequent encapsulation in Ca(II)-alginate beads is a feasible and transferable method to the food industry for applications in added-value products.

Keywords
SAXS, leftovers, bioactive compounds, extraction methods, antioxidant capacity

Acknowledgements
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#240: Using the Low Pressure Superheated Steam Drying (LPSSD) Method Which is a New System For Drying Fruits And Vegetables

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The food industry has aims such as increasing the storage and shelf life of agricultural products by reducing the change in physical, chemical, sensory properties and microbial activities. In addition to these, it has many goals such as achieving safe and healthy food production with maximum preserved nutritional quality by improving processing methods. Today, the most widely used food preservation method in the food industry is preserving food with heat applications. However, some losses occur in the sensory, chemical and physical properties of foods (such as colour, odour, flavour, texture, nutrient) in the thermal preservation of foods. Today's consumers, on the other hand, demand foods that are less processed, preserved in sensory and nutritional content, and have high quality and close to fresh. For such reasons, the importance of different drying methods and non-thermal food processing and preservation methods is increasing. The main purpose of these new food preservation methods is limiting and minimizing of the quality losses in foods that occur with thermal applications. One of the striking applications in the drying process is the Low-Pressure Superheated Steam Drying (LPSSD) method. Superheated steam acts as both the heat source and drying medium to remove evaporated water. When air or other gases are used to dry a product, the removed moisture vapours diffuse into a static gas film until they reach the mass gas stream. Since this film has a great resistance to mass transfer, the drying rate depends on the diffusion rate of the moisture vapor. When superheated steam is used as the drying medium, the mass transfer resistance in the vapor phase is prevented and the drying rate depends only on the heat transfer rate. The drying rate in steam is greater than when air is used as the drying medium. In this study, studies in which fruits and vegetables were dried with LPSSD drying system were compiled.

Keywords
LPSSD, Drying, Fruits and Vegetables

#241: Modification of Starch of Fruit Origin – Physical Processes and Application

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Starch modification from fruit sources using physical methods such as high pressure, ultrasound, microwaves, electric pulses, extrusion, heat moisture treatment, annealing and autoclaving-cooling cycles are presently gaining significant consideration due to their non-chemical and environmentally compatible modification techniques. Extrusion and pregelatinisation physical modification techniques caused destructurization of starch granules, thereby leading to starch with enhanced functional properties of water absorption and solubility upon dispersion in cold water. Hydrothermal treatment modification techniques of heat-moisture treatment and annealing did not bring about destructurization of starch granules. However, initial disruption of the crystalline structure, dissociation of the double-helical structure, accompanied by the rearrangement of the disrupted crystals were observed. The Heat-moisture treatment gave rise to the rearrangement of amylopectin branch chains, the interaction between amylose and amylopectin chains as well as the formation of amylose-amylose, amylose-amylopectin and amylose-lipid complexes. Annealing modification techniques did not enable starch gelatinization but produced starch with an increased granular size that is more susceptible to enzymatic hydrolysis. The paper therefore, elucidates the various methods employed in the modification of starch from different fruit sources and their end-use application.

Keywords
Starch, Fruit Starch, Physical Modification, Hydrothermal Treatment, Non-thermal Modification

#242: PortFIR – a space for dialogue and multi-stakeholder cooperation to support Sustainable Development Goals implementation

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Introduction: The 2030 United Nations Agenda for Sustainable Development is a universal plan of action based on 17 Sustainable Development Goals (SDGs) with a view of eradicate poverty, end hunger and malnutrition and promote economic, social and environmental development on a global scale. It is recognized that improved nutrition and food system transformation are essential for achieve several SDGs. To support implementing these SDGs, the Portuguese Food Information Resource (PortFIR) has been promoting a new dynamic of dialogue and joint efforts of a multiplicity of stakeholders and developing several works, namely in food data composition and contamination.

Material and Methods: PortFIR manages networks of knowledge in food safety and nutrition, supported in thematic Working Groups (WGs) that involve actors from governmental and non-governmental organizations, academia and private operators of food, health and economy sectors. PortFIR members develop work in close cooperation and continuous exchange of efforts, knowledge and data, on nutritional composition, chemical contamination and microbiological information, making it available to stakeholders and general population, serving multiple purposes.

Results: PortFIR provides access to the Portuguese Food Composition Table (TCA), allowing public access to the nutritional value of foods, and in the future, it will comprise data on chemical, microbiological and consumption domains. In parallel, the WGs have been working to produce relevant documentation for stakeholders, namely guidelines for establishment of food portions for nutrition labelling and for establishment of microbiological criteria. In addition, they defined priorities to update national TCA and promoted the implementation of a resource centre for effective communication in food and nutrition.

Conclusions: The increase of national information and knowledge on the referred areas, through PortFIR, can positively contribute to improved food literacy and nutrition, to expand and optimize risk and risk-benefit assessment, to achieve better food safety, and to provide a sound scientific basis for nutrition and public health advices and policies. This directly impacts legislation, regulation, industry, trade, population life and health and contributes for the national SDGs.

Keywords

Portuguese Food Information Resource (PortFIR), Dialogue and joint efforts, Food data and knowledge on composition and contamination, Improved food literacy and nutrition

#243: Anaerobic spore-forming bacteria in the spices and herbs

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The purpose of the work is to determine the level of contamination of the spices and herbs with anaerobic spore-forming bacteria.

The objects of study were 17 samples of spices which are used for retail sale. The content of mesophilic and thermophilic spore-forming anaerobic microorganisms was determined using Kitt-Tarozzi medium. Semi-liquid glucose agar was used to obtain individual colonies of anaerobic bacteria. The number of mesophilic aerobic and facultative anaerobic microorganisms was determined using a nutrient broth with glucose. Thermostating was at a temperature of (30±1)°C and (55±1)°C not less than 5 days and not less than 3 days for mesophilic and thermophilic microorganisms respectively.

The research results showed that all the spices and herbs were contaminated with mesophilic spore-forming anaerobic bacteria, the number of which ranged from 1.0×100 CFU/g (cloves) to 1.1×103 CFU/g (ground coriander and ground bay leaf). The number of mesophilic aerobic and facultative anaerobic microorganisms ranged from hundreds (coriander seeds, bay leaf, cumin) to millions (ground parsley) of CFU/g of product. Thermophilic microorganisms were not found in the samples of spices and herbs.

The data obtained by us on the level of contamination of spices and herbs are consistent with the information in the literature. Enterprises packing these products for retail trade need to carry out incoming control of each batch by to microbiological indicators and, if necessary, use physical methods of decontamination to ensure that incoming raw materials comply with legal requirements.

Keywords

Spices, herbs

Acknowledgements

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#244: Pistachio oil production from aflatoxin contaminated nuts: a risk assessment

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The potential transfer of the aflatoxin into the pistachio oil which is produced by contaminated nuts was investigated. Literature results obtained mainly from other plant-derived oils have shown that aflatoxin can be transferred to the final oil product in case that is present in the oilseed material, but its concentration is reduced depending on several parameters such as the level of the initial concentration.

In this study, pistachio oil was produced from naturally and artificially aflatoxin contaminated samples of dried pistachios coded as NC and AC, respectively. The NC samples were purchased from several local processing units during handling or storage; while the AC samples obtained by inoculation of the pistachios with aflatoxigenic strains of the causative fungi Aspergillus flavus. A total of 30 samples of finely ground pistachios of several levels of contamination were used. The respective pistachio oil samples were extracted from each sample by petroleum ether, a non-polar solvent using a Soxhlet apparatus. The fat content and the aflatoxin concentration were determined both in ground nuts and the produced oil by HPLC using a fluorescence detector and a post-column derivatization.

The average fat content of the pistachios was measured 58% (w.b.) and the aflatoxin concentration ranged from 16,5 – 1652 μg/Kg nut in the solid samples. Respectively, the 70% of the total oil samples was contaminated with aflatoxin ranged from 5,8 – 163,5 μg/Kg oil. However, a reduction of 65% of the total aflatoxin was shown in samples that their initial concentration was <100 μg/Kg while a reduction of 95% was evident in the oil that derived from highly contaminated pistachios. All B and G aflatoxins were detected in the oil but B1 aflatoxin was dominant.

The transfer portion of aflatoxins during pistachio oil production using an extraction solvent was evaluated. The results of the present work offer evidence that a proper control of the processing parameters may favor the aflatoxin reduction in the final oil product serving as an alternative management solution for the utilization of rejected pistachio batches due to aflatoxin contamination.

Keywords

pistachio, aflatoxin, seed-oil, nut, solvent extraction

#250: A Different Approach for Healthy Snacks: Increased Vitamin C, Mineral Contents and Consuming Desire of Dried Carrots

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The food industry searches for novel food products with long storage periods without preservatives. Moreover, conscious consumers take care of their health and look for tasty food products. Thus far, varied vegetable snacks have been prepared by different methods due to health benefits. However, snacking trends change day by day, depending on consumer needs. Thus, dried carrot is a healthy snack alternative with high carotenoid content, being oil and gluten-free.

This study aimed to prepare dried carrot snacks enriched with fruit juices to increase vitamin C and mineral contents. Besides, carrot snacks were evaluated for sensory characteristics.

4 coloured carrot samples (purple, orange, yellow and white carrots), 3 fruit juices (sour cherry, chokeberry and apple juices) and sucrose solution (as control) were applied. Dried carrot slices were enriched with fruit juices to improve sensory acceptance and health benefits. Dried carrot snacks were prepared by osmotic dehydration, convective drying and vacuum-microwave finish drying techniques. After these processes, vitamin C, mineral contents and sensory evolution tests were applied. Sensory characteristics of carrot snacks were evaluated by the Hedonic scale.

The highest vitamin C contents were determined in orange carrot-chokeberry juice snack > purple carrot-sour cherry juice snack > orange carrot-apple juice snack. Besides, sodium (Na), potassium (K), calcium (Ca), iron (Fe) and magnesium (Mg) contents of carrot snacks were determined.

Orange carrot-chokeberry juice snack was one of the desired product for dried carrot snack production because its taste was evaluated as chokeberry and it had the highest vitamin C content with one of the highest K content as well. Nevertheless, orange carrot-sour cherry juice snack, which demonstrated the highest smell acceptance with high Fe content, can be applied to prevent and/or treat iron-deficiency anaemia for children and female adults with acceptable aroma.

Therefore, dried carrot snacks can be good alternatives for healthy snacking in all age groups.

Keywords

colourful carrot snacks, fruit taste, sensory characteristics

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#253: Effect of gelatin based edible coating on banana slices

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The global food service market is expected to grow to US$ 4.2 Trillion by 2024. Therefore, the requirement for food packaging material will rise further in future. However, the packaging material used at present that is plastics obtained from non-renewable sources is lethal to the environment due to its non-biodegradability. Hence, serious environmental concerns along with consumers awareness towards sustainable products is driving the research towards biodegradable packaging materials.

The aim of this work was to create a biodegradable gelatin-based edible coating which can extend the shelf life of banana slices without the use of conventional non-biodegradable packaging materials.

Each banana slice was coated with 3 layers of edible coating and then monitored for 4 days for weight loss, total polyphenol content, antioxidant capacity, and the results obtained were compared with uncoated control samples.

Regarding the appearance of banana slices, clearly the coated patterns proved to be more durable. Citric acid added to the coatings successfully delayed tanning and microbiological deterioration, as expected. However, it was only effective until day 2, after which these samples also started to tan. In contrast, uncoated samples underwent significant tanning as early as day 0.

The coatings successfully retained the moisture of the bananas until day 2, when the weight loss of the bananas started linearly. Uncoated bananas lost weight at a much faster rate as the days progressed.

At the end of the measurements, the total polyphenol content and antioxidant capacity of the coated as well as the uncoated samples showed a clear decreasing trend. For total polyphenol content approximately 30% reduction was observed between the initial samples and the stored samples. While the antioxidant capacity of coated samples decreased to a lesser extent than that of uncoated samples.

Keywords

edible coatings, biodegradable, gelatin, banana fruit, citric acid

Acknowledgements

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#255: Hydrolates of bay laurel, rosemary and sage as a source of volatile compounds

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The essential oil manufacture produces a significant quantity of co-products. These potentially valuable hydrodistillation residues include hydrolates contain a remarkable source of bioactive molecules. In this study, we have focused on aromatic Mediterranean plants rich in volatile compounds: bay laurel, rosemary and sage. Their essential oils are frequently used, but hydrodistillation residues produced in parallel with these essential oils are much less explored. Despite rich bioactive content, these fractions are often underexploited or even considered waste. Increasing market demand for essential oils resulted in the development of many innovative methods for improvement of their yield and composition. Traditional extraction technologies prior hydrodistillation mainly related to the high temperature mainted for long extraction periods and the consumption of hazardous organic solvents as well as low extraction efficiency of desired compounds. So, we have analysed different pretreatments prior to hydrodistillation i.e. reflux extraction, ultrasound and enzyme assisted extraction on chemical composition of hydrolates in bay laurel, rosemary and sage. GC-MS analysis showed that the hydrolates of all plants were richest in oxygenated monoterpenes: up to 46%, 42% and 30% of total peak area in bay laurel, rosemary and sage hydrolates, respectively. Sesquiterpenes were also well represented: up to 42%, and 10% of total peak area in rosemary and bay laurel hydrolates, respectively. Dominant compounds were confirmed: 1,8-cineole, camphor, borneol and berbenone in rosemary hydrolates, 1,8-cineole, linalool, camphor, α- and β-terpineol, methyleugenol and eugenol in bay laurel hydrolates and 1,8-cineole, camphor, borneol and berbenone in sage hydrolates. In general, the pretreatments didn't significantly affect the volatile compounds of hydrolates ($p<0.05$), i.e. the composition was comparable to the no-pretreatment control, as confirmed by Spearman´s test. Our results point out that hydrolates remaining after hydrodistillation of bay laurel, rosemary and sage are valuable source of oxygenated monoterpenes and sesquiterpenes and can find their application in many fields of food industry.

Keywords
bay laurel, rosemary, sage, hydrolates, monoterpenes

#256: Thermosonication applied to kiwi peel - a healthy source of nutrients

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The peels of many fruits are not commonly consumed being, however, important sources of nutrients. Finding approaches to add value to such non-edible parts and preventing them from being discarded is interesting. This may include the development of processes that allow the retention of nutrients and guarantee the product´s safety from a microbiological point of view. The objective was to apply thermosonication processes to kiwi peel and evaluate the impact on several key nutrients and Listeria innocua survival, which was used as a non-pathogenic surrogate of L. monocytogenes.

Kiwi (Actinidia deliciosa cv. Hayward) peels were manually removed and cut into small pieces, which were artificially inoculated with L. innocua by immersion in a suspension of about 107 cfu/mL. Thermosonication treatments were performed at 55 °C (US+T55) and 60 °C (US+T60) with three sampling times till 30 and 15 min maximum, respectively. Thermal treatments were performed for control using the same temperatures and times (T55 and T60). All treatments were repeated three times independently. L. innocua on kiwi peel was enumerated before and after each treatment.

Proteins, fibers, and minerals (Ca, K, Mg, Na, and P) were analyzed in fresh and treated kiwi peels. A Weibull model with a decimal reduction time (D-value) was successfully used in L. innocua survival data fitting by regression analysis procedures. D-values obtained for thermal treatments were 1.60 ± 1.71 min (T55) and 2.82 ± 0.90 min (T60). When thermosonication was used, those values decreased respectively to 0.97 ± 0.54 min and 0.73 ± 0.29 min, showing that temperature coupled to ultrasound is more effective in L.innocua inactivation.

All treatments significantly increased protein content, which was 9.22 ± 1.20 mg/g (on a dry basis, d.b.) in the fresh peel. The most effective was US+T60, which allowed an 84% increase.

The total fiber content in kiwi peel was 305.57 ± 10.18 mg/g d.b., of each 297.85 ± 4.63 mg/g d.b. were insoluble. After thermosonication those values increased significantly, up to 75% after US+T60 and doubling after US+T55. Minerals were not significantly affected by thermosonication. Applying thermosonication to kiwi peel is more effective than thermal treatments in reducing L. innocua loads while allowing retention and even increasing essential healthy nutrients.

Keywords

Listeria, proteins, fibers, minerals, fruit wastes

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#257: Solid hydrodistillation residues of bay laurel, rosemary and sage as a source of polyphenols

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Solid hydrodistillation residues produced in parallel with essential oils of bay laurel, rosemary and sage are much less explored or even considered waste despite rich polyphenolic content. Prior to hydrodistillation, plant material is often treated with ultrasound, microwaves or enzymes, in order to disrupt the cell wall and improve the access of solvent to the cell content, thus enhancing the release of bioactive compounds. When comparing different extraction procedures used to process solid hydrodistillation residues like enzyme assisted or reflux extraction, ultrasound application is considered gentler in comparison with other extraction procedures, working at lower temperature and for shorter time, which makes it more suitable to preserve polyphenols from thermal degradation. HPLC analysis showed that the solid hydrodistillation residues of all plants were richest in polyphenols. In bay laurel solid hydrodistillation residues extract, procyanidins represented the dominant components, with procyanidin trimer, dimer and tetramer as major compounds. Among other components, epicatechin, epicatechin-hexoside and epicatechingallate were also detected in significant quantities. In sage solid hydrodistillation residues extract, salvianolic acid I and K were major compounds, followed by luteolin-3-O-glucuronide. Finally, in rosemary solid hydrodistillation residues extract, rosmarinic acid was the most represented component. Applied solvents didn't show significant variations ($p<0.05$) in polyphenolic composition resulting in considerable concentrations of polyphenols in the final bay laurel, rosemary and sage extracts. In general, the pretreatments didn't significantly affect the polyphenolic composition of solid hydrodistillation residues ($p<0.05$), i.e. the composition was comparable to the no-pretreatment control, as confirmed by Spearman´s test. Our results point out that solid residues remaining after hydrodistillation can also be exploited as secondary raw material for obtaining different polyphenolic compounds using ultrasound assisted extraction with different solvents and obtained plant extracts are valuable source of polyphenolic compounds and can find their application in many fields of food industry.

Keywords
bay laurel, polyphenols, rosemary, sage, solid hydrodistillation residues

#258: Application of high resolution ICP-MS analysis for assessment of coffee and coffee by-products as source of minerals

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Coffee is one of the most appreciate beverage in the world. Its production and consumption generate a large amount of waste and by-products throughout steps of coffee processing. For instance, coffee silver skin (CSS) and spent coffee ground (SCG) are the wasted fractions generated by roasting of green coffee, and by the treatment of roasted and grounded coffee powder with hot water to obtain brew. Although CSS and SCG are usually discharged into the environment they could be used as valuable resources of different phytochemicals and nutrients. In that connection, this work shows their exploitation as the sources of micro-nutrients, i.e., minerals, essential to human health. Besides them, in this study are also quantified non-essential and toxic elements using high resolution inductively coupled plasma mass spectrometry (HR-ICP-MS). With the aim to validate the quantities of selected metals in CSS and SCG the comparative study on green and roasted espresso coffee was also performed.

Results showed that coffees and its by-products contained high mass fractions of essential macro-elements, in particular K (2387-35 993 mg/kg) and Mg (1263-5298 mg/kg). Among essential trace elements, prevails Fe (41.8 do 728 mg/kg), followed by Cu, Mg and Zn. Ultra-trace essential elements (Li, Mo, Cr, Co and Se) are found in quantities of 0.02-2.42 mg/kg. Regarding non-essential elements, e.g., Pb, As, Cd and Sn with harmful effects on health is showed that their mass fractions in coffees and its by-product (0.01-0.25 mg/kg) are below permitted levels. Thus, by consuming them, as well as other potentially toxic metals quantified in this work (U, Cs, Sb, V and Ni) it is not possible to provoke any of toxic effects. Overall, gained results revealed that coffees and its by-products are the rich sources of elements. Particularly, the coffee silver skin contains the highest mass fraction of the major essential elements quantified in this work. Thus, the possible uses of CSS as a low-cost, novel source for minerals intakes should be valorised.

Keywords
coffee, coffee by-products, essential, non-essential elements, toxic elements, HR-ICP-MS analysis

#259: Fatty acid profiles in coffee (green and roasted) and its wasted fractions (spent coffee ground and silver skin)

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The re-utilisation of spent coffee ground (SCG) and coffee silver skin (CSS) has gained a large interest due to increasing of awareness for waste reduction and environmental protection, and to opening the possibilities for isolation of various value-added compounds. The concept of re-utilization of these low-cost biomasses was undertaken in this study with the aim to evaluate the recovery of fatty acids (FAs). For comparison purposes the FAs are identified and quantified in green and roasted coffees from which these residues are generated. After trans-esterification of fatty acids extracts obtained after Soxhlet treatment of coffees and its by-products the analyses were done using GC-FID analysis.

The results showed that palmitic acid (C16:0) with contents of 34.1 and 40.32 % is the most abundant saturated fatty acids (SFA) in roasted and green coffees, followed by stearic (C18:0) with the mass fraction of 7.39 and 9.36 %, respectively. Among monounsaturated fatty acids (MUFA), the roasted and green coffees contained the oleic (C18:1-9c) with mass fractions of 11.53 and 12.71 %, respectively. Regarding the polyunsaturated fatty acids (PUFA), the major one is linoleic (C18:2-6, cis) with contents of 41.38 % (roasted coffee) and 25.31 % (green coffee). The results also revealed that SCG contains the similar quantities of palmitic (34.36 %), stearic (7.65 %) and oleic (10.15 %) as roasted coffee, which points out that processing of roasted coffee to obtain brew did not influence on degradation of these FAs. In comparison with coffees and SCG, in the CSS dominates behenic (C22:0) with quantity of 21.03 %, followed by palmitic (18.75 %), arachidic (18.40 %), stearic (5.1 %) and lignoceric (C24:0) in quantity of 5.12 %. The CSS in comparison with other analysed samples contained the minor amount of oleic (7.15 %) as MUFA. Although the linoleic is major PUFA in SCC, its content is lower than that found in roasted coffee.

Overall, the results showed that total mass fractions of saturated and un-saturated FAs in evaluated samples are 70.72 and 24.26 % for CSS, 55.05 and 39.64 % for green coffee, 45.68 53.43 % for roasted coffee and 45.88 and 53.46 % for SCG, respectively. Thus, considering the obtained values it could be concluded that not only coffees, but also the residues generated from them are useful, beneficial sources of FAs.

Keywords
coffee, coffee by-products, fatty acids, GC-FID

#260 Evaluation of different drying methods of vegetables from the Northern Portugal: comparative analyses of physicochemical and sensory parameters, and consumer acceptance

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Vegetables are often overproduced and discarded, generating large amounts of waste. Vegetables have high moisture content and deteriorate over a short period. One possibility to take advantage of these products is through the drying process. The vegetable final quality is highly dependent upon the drying method, as well as their composition and physical properties.

The aim of this study was to compared the chemical and sensory characteristics and consumer acceptance of dehydrated vegetables from the Northern Portugal: Tomato (Solanum lycopersicum), Turnip (Brassica rapa L.), Courgette (Cucurbita pepo L.) and Cucumber (Cucumis sativus L.), using two different drying methods: convective air-drying (CD) and freeze-drying (FD).

In this work moisture, ash, protein, carbohydrates and fibre content were determined. Acceptance and preference tests were carried out, as well as a consumer characterization, in relation to the product developed. The data were obtained by a survey carried out in North of Portugal with a sample of 101 consumers.

Results showed that carbohydrate content was higher in CD than in FD vegetables (except for cucumber). On the contrary, it was found a slight decrease on protein content between fresh and dried vegetables. It was also found that FD scored higher protein content compared to CD, for all vegetables, with the exception of cucumber. Concerning the crude fibre and ash contents there were no differences between CD and FD vegetables.

Through surveys on consumption habits, it was found that the majority of the surveyed population consumes dehydrated fruit and vegetables, and 48.5% showed interest in consuming a 100% natural dehydrated vegetable, and 76% are willing to by this product. From the acceptance test (appearance, taste, flavour, texture and colour), it was concluded that FD vegetables showed greater acceptance by the consumers, with cucumber and tomato being the preferred vegetables, 30% and 29%, respectively.

In conclusion it was demonstrated that both dehydration methods are effective in keeping the nutritional properties, being an useful alternative to extend the vegetables shelf-life and consequently to reduce food waste in the primary sector fresh vegetable industry. However, the FD process showed to be a better process because it provides vegetables that are more similar to the fresh product, in terms of colour and texture.

From this work it was concluded that drying processes can be a good alternative to obtain a commercial value-added product allowing obtaining stable products with high rich nutritional values, allowing their re-use by re-introducing the vegetables that were waste, contributing to the circular economy.

#268: Inactivation kinetics of Listeria innocua in thermosonicated kiwi juice

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In fruit juice processing, traditional heat treatments such as pasteurization are usually used. However, this processing method may often induce undesirable quality changes in fruit juices. Alternatively, thermosonication has been found to have a great potential in microbial inactivation and fruit juices' quality retention.

The objective of this study was to evaluate thermosonication and thermal treatments' influence on the inactivation kinetics of *L. innocua* 2030c (a surrogate of the pathogenic *Listeria monocytogenes*) in kiwifruit (*Actinidia deliciosa* cv. Hayward) juice.

The kiwi peel was manually removed with a peeler to prepare the juice, and then flesh was sliced with a stainless-steel knife. The juice was extracted using a domestic centrifuge. The obtained juice was artificially inoculated with *L. innocua* subculture (~10^9 CFU/mL). The kiwi juice was adjusted to a pH of 3.6 by adding Cantaloupe melon (*Cucumis melo* L. var. *reticulatus*) juice, a natural component. Thermosonication was carried out in a water bath coupled with an ultrasound homogenizer at a constant frequency of 20 kHz, 80% amplitude and discontinue pulsation (10s on, 5s off). The juice samples were submitted to thermosonication treatments at 45, 50 and 55°C for 15, 10 and 3 minutes, respectively. At the same temperatures, thermal treatments were performed as a control for 60, 25 and 10 minutes. Each experiment was repeated three times.

The Weibull model was used to fit all *L. innocua* log-survival data, based on regression analysis.

For thermal treatment at 45°C, the first decimal reduction time (δ) obtained was 23.31 ± 3.51 min, while with thermosonication, the value was significantly reduced to 3.19 ± 0.59 min. The same happens to the other temperatures, with δ for thermal treatments at 50 and 55°C being 5.06 ± 1.73 and 2.50 ± 0.70 min, whereas, with thermosonication, the δ decreased respectively to 1.47 ± 0.59 and 0.46 ± 0.21 min. These results proved the existence of a synergistic effect between temperature and ultrasounds, making it possible to apply mild heat treatment processes and improve the final product's quality.

Since thermosonication treatment was effective in *L. innocua* inactivation, this technology can be considered a successful alternative to fruit juices' conventional thermal treatment.

Keywords

thermosonication, kiwifruit juice, thermal treatment, inactivation kinetics, L. innocua

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#269: Effect of defoliation at different phenological stages on yield and quality characteristics of maize

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The efforts for a sustainable agriculture are focused on novel methods and practices that could contribute to the reduction of irrigation water use, without affecting the quantity and quality of the production. A field experiment was conducted from March 2019 to September 2019. A completely randomized experimental design was used with two factors (irrigation, stage of defoliation) with 3 replications. Defoliation applications were made on whole plants on 4 phonological stages (Zadoks scale stages 73, 75, 77 and 83) and 2 soil moisture levels (saturation point of the field capacity and 50% of the field capacity). After their cultivation and harvest, the obtained corn grains were characterized in terms of color, texture, sphericity and mean geometrical size and then they were grounded and the occurred corn flours were evaluated in terms of moisture, ash, protein and crude fiber content.

Defoliation at 73, 75, 77 and 83 Zadoks stage reduced total dry weight of maize (15966, 22133, 21880 and 26543 kg ha-1, respectively) with statistically significant differences compared to control (3190 kg ha-1). Regarding maize grain, undefoliated plants gave the highest yield (18689 kg ha-1) with statistically significant differences compared to the treatments of defoliation (11542, 14062, 17096 and 17629 kg ha-1 respectively). The defoliation did not significantly affect the characteristics of the whole corn grains. On the other hand, defoliation resulted in corn flours of improved quality characteristics in terms of total protein and crude fiber content. More specifically, the corn flours harvested from defoliated maize plants consisted of approximately 4% higher total protein and 65% higher crude fiber contents compared to the control ones of undefoliated plants.

The results suggest that targeted leaf removal could be an easy to apply technique for improving the grain yield and the quality properties of corn grains and flours.

Keywords

defoliation, maize, yield, quality characteristics

#271: Influence of fermentation temperature on antioxidative activity of winery effluent based kombucha

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Kombucha is a symbiotic culture of bacteria and yeasts. Traditionally, it is prepared by aerobic fermentation of sweetened black or green tea. It is considered as general tonic attributed with various health benefits. In this experiment, winery effluent was used as substrate for the fermentation. Typically, this wastewater is disposed of in the communal sewerage system.

Wastewater was collected from local winery. The clarification of the grape must was done by floatation using gelatin. Grape belonged to Riesling variety. Wastewater was filtrated and sterilized. To prepare fermentation media initial substrate (IN) was diluted to 70 g/L of total sugar. Initial substrate contained 154.33 g/L of total sugars measured spectrophotometrically as reducing maters using DNS method. Fermentation was performed at three temperatures: 20, 25, and 30 °C and lasted for 9 days. The 3rd day was determined as consume day by tasting the beverage. Analyzed samples included IN, 0, 3rd, 6th, and 9th day. Radical scavenging ability of DPPH (RSA_{DPPH}) was measured spectrofotometrically. Hydroxyl radical scavenging ability (RSA_{OH}) was measured using spectrofotometrical method.

All samples had extremely high RSA_{DPPH} (around 95%), while the IN had much lower (54%). Fermentation temperature did not affect RSA_{DPPH} at all.

High temperature decreased RSA_{OH} with lowest value measured at 30 °C after 9 days (12.93%), while the highest was measured at 25 °C after 9 days (35.97%). Initial substrate had lower RSA_{OH} than all consumable samples. RSA_{OH} at 25 °C was increasing over time, while at 20 °C changes were inconsistent.

Keywords

kombucha, antioxidant activity, winery effluent, sustainability

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#274: Assisted extraction of acemannan bioactive polysaccharide from Aloe barbadensis Miller by application of conventional and novel technologies

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Aloe vera (Aloe barbadensis Miller) gel is considered as a material of great importance for the food and pharmaceutical industry, representing a source of bioactive compounds with a health-promoting profile. The gel contains high amount of water (>98%) and polysaccharides, among which acemannan that is the dominant one (over 60% w/w). Acemannan is composed of acetylated mannose units linked by β-(1 → 4) glycosidic bonds and plays a key role in the physicochemical properties and biological activity of Aloe vera gel. In the food industry, the application of Aloe vera gel has been extended, in the preparation of functional drinks and other beverages. Extraction of the essential bioactive components from Aloe vera gel such as acemannan, would be of significant convenience and value for its direct incorporation in functional final food products.

The aim of this study was to investigate the effect of different pre-treatments such as conventional heating (HT), ultrasound (UT) and high-pressure (HP) treatment on the assisted extraction of acemannan from Aloe barbadensis Miller. Different processing parameters including temperature (HT/UT:25-80°C; HP:25°C), time (HT/UT: 5-30min; HP:5min) and pressure (200 and 400MPa) were examined. Isolation and purification of acemannan was performed by application of a series of steps including precipitation with 95% ethanol, centrifugation, vacuum pump filtration (Millipore) and lyophilization. The quality parameters such as colour, water activity, total soluble solids (°Brix), as well as the extraction yield, the total polysaccharides content, the concentration of acemannan and its gel strength were appropriately analysed for all the studied cases (different pre-treatments applied). The results indicate that the physicochemical properties of the isolated acemannan is dependent on the conditions (pressure, temperature and time) used during the pre-treatments application. HT and UT pre-treatments improved the extraction yield of bioactive polysaccharides and in particular acemannan.

In general, acemannan could be efficiently extracted applying appropriate protocol and pre-treatment technologies, allowing for its incorporation in food products, enhancing their functionality.

Keywords

Aloe vera, Acemannan, Ultrasound, High Pressure, Extraction

#275: Debittering acceleration of olive paste by application of high pressure technology

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Olive paste is widely known for its high nutritional value and the consumer acceptance. Nevertheless, untreated olive paste has a characteristic bitterness mainly attributed to the presence of oleuropein, the major phenolic compound. Debittering –associated to oleuropein content decrease- should be performed to olives prior pasting by addition of NaOH solution for several days. Within this study, an alternative approach is proposed by application of high pressure (HP) as olive paste debittering process acceleration.

Conventional debittering was carried out using tap water at three different solid:liquid ratios (1:2, 1:4 and 1:6 g/mL) under agitation at room temperature. HP debittering of olive paste was performed at 200-600 MPa, for 5-60 min. Oleuropein content, total phenolic compounds and antioxidant activity of olive paste were determined, along with sensory evaluation. The obtained results were compared with corresponding results obtained from the conventional debittering technique.

In general, HP led to debittered olive paste in short processing time with minimal effect on quality indices, compared to conventional debittering. Oleuropein content was decreased up to 45% after 6 h conventional debittering. On the other hand, HP (200 MPa) treatment for only 15 min resulted in equal oleuropein content reduction (up to 45%). Longer treatment (60 min) resulted in more than 70% oleuropein decrease. HP treatment did not significantly affect the total antioxidant activity of the paste, in contrary to conventional technique that a 40% decrease was measured.

HP as a novel debittering technique was found to be suitable and applicable in minimizing debittering time of olive paste and limiting the loss of natural antioxidants and other components from olive paste, thus ensuring maximum health benefits for the consumers.

Keywords

olive paste, de-bittering, oleuropein, High Pressure

#276: Physical and consumer acceptability profile of Moringa oleifera leaf powder effervescent beverage granules

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Moringa oleifera leaf powder (MOLP) through a good source of protein, minerals, vitamins, and various phenolic compounds is poorly soluble in water. Formulating MOLP into effervescent granules can result in improved taste, accelerated dissolution, enhanced solubility, and increased food industry application. Therefore, our objective was to investigate the potential of developing solid-dispersed MOLP (SDMOLP) with improved solubility into functional effervescent granules. Three different SDMOLP effervescent granules were developed using a wet granulation technique. The resulting granules were evaluated for particle size, flow properties (bulk and tapped densities, angle of repose, Hausner's ratio, Carr's index), effervescent solubility time, pH, and moisture content. Furthermore, consumer acceptability of 65 g effervescent granules in 1000 ml water was assessed for appearance, colour, aroma, taste, texture, and overall acceptability using a 5-point hedonic scale, ranging from 1 (dislike very much) to 5 (like very much.) using 53 consumer panellists. The mean particle size for the granules was > 250 µm for all formulations. Bulk and tapped densities ranged from 0.40-0.44 g/mL and 0.46-0.51 g/mL, respectively. There was no significant ($p > 0.05$) difference in angle of repose 30.20-30.86^{o}, Hausner's ratio, 1.13-1.18, and Carr's index, 11.21-14.86% among the three formulations as they all exhibited good flow properties. Effervescent solubility time was <5 min. The formulations differed in pH (6.04-6.65), and moisture content, 1.82-3.43%. These variations can be attributed to differences in acid concentrations incorporated into the formulations. Moreover, significant differences existed ($p < 0.05$) in colour among the formulations. The mean hedonic scores of sensory attributes ranged from neither like nor dislike to like moderately for appearance (3.19-3.92), colour (3.23-4.04), aroma (4.00-4.13), taste (3.08-3.77), texture (3.04-3.66) and overall acceptability (3.40-4.00). Three of the novel formulas met the good chemical test requirements, and the sensory results indicated a remarkable sensory acceptance with the potential for improvement.

Keywords

Moringa oleifera leaf powder, solid-dispersed Moringa oleifera leaf powder, solubility, effervescent granules, wet granulation, flow properties, hedonic test

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#277: Thermal and non-thermal orange juice pasteurization: The impact of ultrasound, thermosonication and heat treatment on S. aureus kinetic inactivation behaviour

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Staphylococcus aureus survival is a serious issue in the food field, which has pushed researchers to develop safe inactivation processes and, at the same time, not affect the food product's nutritional value. All of this to meet the increasing consumer demand for safe and quality food. One of the non-thermal preservation methods that is used as a powerful disinfection technology is sonication. It is considered an efficient process since it satisfies the Food and Drug Administration requirements for a 5-log reduction of microbial cells in fruit juices.

This study was designed to investigate *S. aureus*'s kinetic inactivation behaviour when subjected to the combination of ultrasound and temperature (thermosonication) and heat treatment alone. Commercial pasteurized orange juice was inoculated with *S. aureus* ATCC 29213 to attain an inoculated juice with a final concentration of approximately 10^{12} CFU/mL. Cells were heat-treated and processed by ultrasound at 20 kHz at 20, 30, 40, 50, and 60 °C. For heat processing, the treatment times were 90, 60, 60, 60 and 35 min, while for ultrasound treatments, the times were 90, 60, 60, 35 and 30 min, respectively. *S. aureus* cell viability and sublethal injury were evaluated using two different platting media. SEM analyses were applied to identify the morphological appearance of *S. aureus* cells.

Results showed that ultrasounds at 20, 30 and 40°C reduced the viable bacterium counts by approximately four log cycles at the end of treatment. On the opposing, sublethal temperatures without sonication did not affect *S. aureus* survival. Microscopic images exposed that cells undergo membrane damage during sonication. Thermosonication treatments at 50 and 60 °C were the most effective ones resulting in higher *S. aureus* inactivation rates and lesser treatment times than the heat treatments alone. This was proved by the higher presence of single-pore and flatted cells in thermosonicated samples at these temperature ranges. Hence, a synergistic effect was observed between thermal and ultrasound treatments, noted by increased cells susceptibility to cavitation effects. Therefore, thermosonication can be a promising processing technology for orange juice pasteurization.

Keywords

S. aureus, heat treatment, thermosonication, inactivation behaviour, orange juice

Acknowledgements

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#280: Salmonella Enteritidis survival in Açorda de Camarão: a traditional culinary preparation from Portugal containing raw eggs

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In Portugal, Açorda de Camarão (bread stew with shrimp-panada) is a type of culinary preparation that is much appreciated and consumed. It consists of soaked bread added with various types of ingredients, such as meat, fish, seafood and raw eggs. One of the most traditional forms of consumption is to add a previous prepared bread mix to the seafood and, immediately before serving, the addition of a raw egg.

Based on salmonellosis has been linked to the consumption of preparations containing raw eggs, concerns about the safety of Açorda de Camarão has raised. The objective of this study was to investigate the survival of S. Enteritidis artificially inoculated in raw eggs added to the Açorda de Camarão.

The methodology consisted of preparing 500g-samples of seafood bread mix, which is the portion recommended for two persons, and kept them at three different temperatures: 70 ºC, 75◦C and 80◦C. After that, a raw egg previously inoculated with S. Enteritidis ATCC 4300 was added to each 500g-sample for 30 seconds. The samples kept at 70 º C were inoculated with 7.60 log cfu/g, samples kept at 75 º C were inoculated with 8.08 log cfu/g, while samples kept at 80 ºC were inoculated with 8.45 log cfu/g. Five samples were tested in each temperature, totalizing fifteen samples tested.

Results demonstrated Salmonella survival rates varying from 0.00 to 7.06 log cfu/dose, with median of 4.30 log cfu/dose and average of 2.72 ± 2.71 log cfu/dose. At 70 ºC, the survival numbers varied between 0.00 and 7.06 log cfu/dose, while at 80 ºC, the survival counts varied between 0.00 and 5.70 log cfu/dose. The temperature at which there was less survivals was 75 º C, with values between 0.00 and 5.15 log cfu/dose, which means reduction rates of approximately 2.75 log cfu/g.

It can be concluded that the temperature of 75ºC was able to reduce around 2.75 log cfu/dose of S. Enteritidis in raw eggs added to Açorda de Camarão. However, the safety of this culinary preparation is dependent on using safe raw eggs, because the survival rates of Salmonella were expressive, when highly contaminated eggs were used.

Keywords

Salmonella, bread stew, experimental inoculation, shrimp, egg

#281: Cold plasma technology applied to barley malt production

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Barley is one of the most important cereals, being the malt production highlighted mainly by beverages production, like beer and whisky. However, recently, the application of malt is diversifying, with use in bakery products, candy and even in cosmetics. This work evaluated the application of cold plasma (CP) technology in malt production. Processing was designed based on previous studies focused on microbial inactivation, thus evaluating if that treatments would impact malting. For these purposes, the plasma application was evaluated in two moments: 1) in barley grains (before hydration) and 2) in hydrated barley grains (after hydration). The plasma was produced with a dielectric-barrier discharge reactor with two stainless steel electrodes coupled in a high voltage source. Air at atmospheric pressure and ambient temperature was employed as ionizing gas. The plate with sample was positioned on the lower electrode of the reactor at a distance of 2 mm from the upper electrode and submitted to electrical discharges at 30 and 74 kV, 140 and 200 Hz for 30, 60 and 120 s. The hydration process was carried out placing the barley grains in distilled water at 20 °C for ~11 hours. The germination was carried out placing the hydrated grains covered by moistened paper towels in Petri plates which, in turn, were placed in an incubator at 16 °C for four days. All treatments were carried out in triplicate. Results showed higher hydrophilicity of the grain husk treated with plasma: the water drop placed on the grain instantly spread, while the control grain remained with the drop intact on it. Despite the plasma effects on barley husk hydrophilicity, the hydration and germination kinetics were not impaired. All treatments presented germination rate greater than 90%. It is possible to state that these plasma effects were mainly superficial what can be interesting to remove harmful microorganisms without affecting the technological quality of the grain.

Keywords
Malt quality, Contamination reduction, emerging technologies

Acknowledgements
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#283: Extraction and purification of exopolysaccharides from Porphyridium cruentum industrial production

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Porphyridium cruentum microalga is a source of compounds with nutritional and biological value, rich in health-promoting lipids and sulfated polysaccharides. These compounds present interesting biological and rheological properties with potential use in the food, cosmetic and pharmaceutical industries. Europe has some companies that cultivate microalgae on an industrial scale, where a great part of the compounds is excreted into the culture medium and later discarded when biomass is separated. The main objective of this study is to add value to the wastewater of P. cruentum through the recovery of polysaccharides by different methods for future biotechnological applications. To obtain the exopolysaccharides (EPS) the exhausted culture media was submitted to precipitation with cold ethanol and the mixture was kept overnight at -18 °C, followed by the recovery of the precipitate by centrifugation and then freeze-dried (EETO). Purification of the precipitate was next performed by dialysis against distilled water (EETD) and in another experiment, by using trichloroacetic acid (ETCA) before ethanol precipitation. The yield of recovery was significantly higher for EETO (3.12 g L-1) but the purified sample (EETD) presented more total carbohydrates (1.37 %). Fourier transform infrared (FTIR) analysis provided a similarity in the distribution of the peaks (C-O-C, C-OH e C-H) to EETO and ETCA samples. The particle size is related to the purification technique, where deproteinization and dialysis provide a decrease in size, as well as for zeta potential values. These can be influenced by the concentration and type of the polysaccharide present since the change in surface charges is associated with the aggregation of the compounds present. Microalgal polymeric by-products are a sustainable source to recovered valuable compounds, being important to choose the appropriate purification method to obtain different yields and monomeric composition.

Keywords

Natural polymers, Polysaccharides, Recovery, Microalgae, Characterization

Acknowledgements

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#284: Upcycling of wheat bran by solid state fermentation into heathy ingredients for the bakery industry

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Wheat bran, the main waste of milling industry, is mainly employed in feed and biofuel manufacturing. Within the current circular economy approach for the achievement of a sustainable food system, the recovery and valorisation of agri-food side streams using innovative techniques is becoming a relevant matter of research. Lactic acid fermentation in solid state is a green technology which uses the metabolism potential of lactic acid bacteria to modify the overall characteristics of the food matrix [1]. Beside nutritional features, the organoleptic profile of food is a relevant aspect that plays an important role on the final consumer acceptance [2]. The present study aimed to assess the feasibility of a previously fermented wheat bran (BFB) [3] as food ingredient in home-made breads with the nutritional claim "high in dietary fibre". Breads were formulated using fermented wheat bran (BFB), and raw wheat bran (BRB) and white bread (BB) were used as controls. Breads were in vitro digested and the overall antioxidant capacity (OAC) and total phenolic content (TPC) in the soluble fraction containing bioaccessible compounds were analysed and correlated to the content of phenolic acids (PA). Glucose absorption behaviour was also assayed in intestinal cell model to evaluate the influence of bread on sugar uptake. Moreover, the complex aroma formation caused by fermentation was analysed and the judged by 10 trained panellists for confirming the feasibility of fermented wheat bran as food ingredient. Interestingly, BFB soluble digested fraction obtained a significantly higher ($p<0.05$) OAC, TPC and phenolic acids content compared to those of BRB and BB soluble digesta, suggesting an improved health-promoting potential of the food. Glucose uptake was also inhibited up to 26% by BFB digesta. Furthermore, in terms of aroma compounds, fermented bran was characterised by an acidic, floral and fruity odour perception. Although panellists did not recognize the latter as relevant organoleptic features of BFB, the oxidative and bitter sensory notes typical of bread containing bran fraction was less noticed in BFB than in BRB. The results herein reported confirm that the fermentation bioprocessing applied to wheat bran is a valuable technique for its respectfully valorisation contributing to the zero-waste approach.

Keywords

bread sensory quality, circular economy, bread nutritional value, solid state fermentation, wheat bran

Acknowledgements

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#286: A fruit snack including grape and tomato pomaces – assessment of the effect of temperature on drying characteristics and quality during storage

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A fruit snack bar was created, composed of 36.4% of tomato and grape pomaces and other foods like oats, chia, and quinoa. Grape pomace is rich in dietary fibre and is a source of protein, and tomato pomace has a great nutraceutical value since it has a high content of carotenoids. The snack was developed, taking into consideration the comments of a focus group that attended three questionnaire sessions.

The fruit snack was processed in a convective tray dryer using an air velocity of 0.54 m/s and three different temperatures of 50°C, 60°C and 70°C. After drying, the samples consisted of a sheet of 20 x 30 cm and were cut uniformly in bars of 3 x 10 cm.

Several models were attempted to adjust to the experimental drying data, with the best fit being presented by the Midilli-Kucuk model.

The snack bars were packaged with a 0.04 mm foil of reversible metalized polypropylene in envelopes of approximately 5 x 12 cm and stored for 5 weeks. The following quality parameters were evaluated over storage: water activity (aw), total colour difference (TCD), and texture (hardness, cohesiveness, springiness, chewiness, and resilience). It was concluded that drying temperature did not influence the quality of the final product, as the water activity and texture parameters measured were stable along with storage. Consequently, it was assessed that the fruit snack was stable over the 5 weeks of storage.

This fruit snack contributes to the transition to a sustainable circular economy by decreasing food waste. It incorporates by-products from the food industry, simultaneously offering economical and ecological benefits.

Keywords

by-products, tomato and grape pomaces, fruit snack, convective air drying, quality

Acknowledgements

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#288: Stinging nettle (Urtica dioica L.): a potential indigenous source to unlock technologically adaptable nutritional and functional additives?

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United Nations (UN) reports that about 26.4 % of population is affected by food insecurity with COVID-19 pandemic worsening the challenges towards sustainable food systems. Vegetables are a critical part of food and nutritional security being the prime sources of micro- and bioactive nutrients. But they are commercially restricted to few species making food systems vulnerable, thereby requiring strategies for food source diversification, positively impact dietary choices and create niche food markets. A UN recommended strategy is to promote indigenous and wild edible plants to diversify and localize food production and consumption. This can also help alleviate issues of food losses, continuous supply, and availability due to transport disruptions.

Of the various spontaneous crops, stinging nettle (Urtica dioica L.) is a prime choice owing to its proved nutritional richness, health benefits and ubiquitous growth. However, its use as such or in products is stunted due to its stinging nature, seasonality, and market stigma. Thus, the objective of this work was to utilize organic nettle leaves to produce low-cost additives to develop enriched, functional bakery products (e.g., crackers).

Briefly, two types of additives were obtained using water-blanched (90 °C, 1 min) nettle leaves: flours either convective-dried (CD) or freeze-dried (FD); freeze-dried extracts either non-encapsulated (NE) or maltodextrin encapsulated (ME), respectively. The additives were used at 3 and 5 % (w/w) levels in preparation of unsalted, leavened wheat flour crackers. The physico-chemical analyses showed an increase in bioactive components (chlorophylls, Chl a/ b; total carotenoids, TC; total phenols, TPC) as expected without detrimental effects on product texture. Particularly, crackers with FD and ME at 5 % level had significantly higher bioactive contents (ANOVA, $\alpha \leq 0.05$) with values ranging from 7.25-11.85 mg, 1.91-3.93 mg, 2.30-3.24 mg, and 17.17- 19.57 mg GAE compared to 0.05 mg, 0.05 mg, 0.12 mg, and 2.71 mg GAE of Chl a, Chl b, TC and TPC for 100g of product, respectively.

The results obtained not only show potential of processed nettle but also provide a platform to promote the indigenous production and use of these value-added additives to improve the nutritional state of individuals.

Keywords
Organic additives, enriched products, nutritional security, under-utilized crops, Crackers

#289: Mathematical models for the prediction of microbial growth and microbial interaction in fermented food matrixes

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Fermentation processes can be found in several types of food including meat and fish, among others. Foodborne disease outbreaks have been reported worldwide due to pathogenic bacteria in these products (Zhen, et al., 2020; Gao et al., 2019). Natural food microflora of fermented products include lactic acid (LAB) in addition to pathogenic bacteria. Interactions between the bacterial populations may have many consequences, but of particular interest in this field, is the feature that a population of pathogenic bacteria can be suppressed through competition with a benign species of bacteria such as LAB (Pleasants et al., 2001). Mathematical models have proven to be useful tools to predict and describe the this complex behaviour of microbial populations (McDonald and Sun, 1999). Eleven different mathematical models from the scientific literature were studied and compared considering interaction terms between species at five different temperatures. Parameters from each of the models were fitted by using simulated data considering a standard error of 0.5 log CFU/g (common in a microbiology laboratory) and at 5 storage temperatures for each model. The fitted model predictions was assessed by bias and accuracy factors according to Ross (1996) and modified by Baranyi, Pin, and Ross (1999). It was found that the model proposed by Valik et al. (2009) is the one with the best bias factor of 1,0129 and 1,0093 for LAB and Listeria monocytogenes respectively while the model proposed by Jia et al. (2020) has the best accuracy factors, 1.1366 and 1.1948, respectively for each species.

Keywords
Predictive microbiology, Mathematical Modeling, Fermented food, Food Safety

#291: Investigation of the effects of drone powder (male subjects of Apis melifera) on wheat dough and bread quality

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Different levels (5 and 10%) of male subjects of the European honey bee (Apis melifera), known as drone, in powder form, were incorporated into wheat flour and their impacts on dough properties and bread quality characteristics were investigated. Results revealed that protein, fat and total dietary fibre content of drone powder were significantly higher than wheat flour. Similar water absorption values were recorded in the control wheat dough and the fortified doughs. The incorporation of drone powder to wheat flour caused a decrease in the extensibility and energy of the dough in the extensograph, and an increase in dough maximum resistance. The elongational viscosity values of dough supplemented with drone powder were significantly higher than in the control wheat dough attributed to the high protein content of drone powder. No significant differences ($p<0.05$) were found in the baking properties i.e. weight, loaf volume and specific volume among the control bread and breads containing 5 or 10% drone powder.

The impact of drone powder on bread staling was evaluated using Texture Profile Analysis (TPA) and Differential Scanning Calorimetry (DSC). Upon storage, the addition of drone powder in wheat flour bread increased the crumb hardness and gumminess but decreased the adhesiveness. Besides, a significant crumb moisture loss was also recorded in fortified breads with drone powder over 6 days of storage. DSC analysis verified the results obtained from texture profile analysis. Generally, it is suggested that the incorporation of the drone powder to wheat flour for the preparation of bakery products, could improve the nutritional value and enhance aspects of overall quality. Sensory evaluation requires consideration of additional ethics concerns or issues, therefore was not performed.

Keywords

Apis melifera, drone powder, dough rheology, bread quality

#292: Cultivated O.tauricum vegetable rennet as a sustainable alternative for cheesemaking

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The study was aimed at evaluating the use of milk coagulants obtained from cultivated thistles as valid substitutes for animal rennet in cheese-making, thus safeguarding the wild species. In detail, two different ecotypes of cultivated O. tauricum were compared by evaluating their technological properties. The response surface methodology (RSM) approach was used to assess the effect of three independent variables (temperature, pH, and Ca ions concentration) on the ewe's and goat's milk clotting performance of the aqueous extracts obtained from wild (REW) and two cultivated ecotypes of O. tauricum (REM and REU, from the Marche and Umbria Region, respectively). Different behaviours, in terms of milk clotting time (MCT), were observed for the three different extracts in both types of milk. REM showed the lowest MCT (60 - 194 and 43 - 140 sec in ewe's and goat's milk, respectively), while the highest values (142 – 432 sec) were measured in goat's milk for REW. The results overall collected showed that cultivated central Italian ecotypes of O. tauricum have a high potential for exploitation as a vegetable rennet for manufacturing of ovine cheeses allowing the respect of biodiversity. This research was supported by the European Union (CALL PRIMA2018- Section 2 (H2020) PROJECT TITLE: "Valorisation of thistle-curdled CHEESEs in MEDiterranean marginal areas" (https://veggiemedcheeses.com/).

Keywords
technological properties, milk clotting time, cultivated ecotypes, goat's and ewe's milk

#294: Pasta enriched with encapsulated carrot waste extract: microbiological, textural, and sensorial properties

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Innovative technologies in the food industry are focused on creating novel food and/or functional food products which, in addition to the basic nutritional values. A smart approach for designing such a new product is by enriching traditional foods with natural additives. Carrot waste has attracted considerable attention in recent years, because of the potential health benefits of lipophilic bioactive compounds, mainly carotenoids, and tocopherols. However, non-polar structures render carotenoids susceptible to oxidation and isomerization during processing or storage, resulting in loss of bioactive properties and sensorial attributes. The encapsulation technology is an effective approach for the protection of sensitive compounds within edible materials.

The possibility of producing durum wheat semolina pasta enriched with encapsulated carrot waste extract, obtained by freeze-drying (FDE) or spray drying techniques (SDE), was explored. Five types of pasta were prepared: (i) control; (ii) enriched with 10% freeze-dried encapsulate (10% FDE); (iii) enriched with 10% spray-dried encapsulates (10% SDE); (iv) enriched with 20% freeze-dried encapsulate (20% FDE); (v) enriched with 20% spray-dried encapsulates (20% SDE). The microbiological profile, cooking performance, texture, and sensory attributes of pasta were determined and compared.

All pasta samples were microbiologically safe to consume since the number of aerobic and mesophilic bacteria was below the allowable threshold for this type of product. The number of Staphylococcus aureus as part of the normal flora of the human skin, nose, and mucus membrane, and Enterobacteriaceae as faecal indicators was under detection limits, it can be suggested that the pasta production process was hygienically adequate. One of the most significant foodborne pathogen Salmonella spp. was not detected. The pasta enrichment affected the increase of the optimal cooking time and decrease of cooking loss, weight increase index, water absorption, and pasta surface stickiness. Overall sensory acceptability of 10% enriched pasta was satisfactory and comparable to those of the control durum pasta, so it has potential as innovative products for consumers which tend to a good balance of health and hedonistic features.

Keywords

carrot waste, pasta production, carotenoids

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#295: Pharmacodinamic study of antimicrobial activity of Satureja kitaibelii Wierzb. ex Heuff. subcritical water extract

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Satureja kitaibelii Wierzb. ex Heuff. is an endemic species of the Carpathian mountain chain on the Balkan Peninsula and is used as an herbal tea for stomach discomforts, regulation of menstrual cycle and fertility, muscle relaxation, and in the treatment of the upper respiratory tract infections. According to the literature review, *S. kitaibelii* subcritical water extraction (SWE) has not been studied until now. Usually, traditional medicinal plants are used in form of water extract, but recent investigations show that the SWE technique enables final extract with better biological properties. Considering this fact, research was aimed to verify the previously established antimicrobial activity of *S. kitaibelii* SWE through pharmacodynamic kinetic study.

Minimal inhibitory concentrations (MIC) of S. *kitaibelii* SWE was ranged between 1.04-8.325 mg/ml. Therefore, the time-kill kinetics models for 1, 2, and 4-time MIC of *S. kitaibelii* SWE for sensitive bacteria, yeast, and fungi were done. The time-kill kinetics profiles for *Bacillus cereus* and *Listeria monocytogenes* indicated the rapid bacteriostatic effect of the extract. On the other hand, a bactericidal effect was observed after 6h between the extract and *Enterococcus faecalis* at single and multiple MIC values. The bactericidal effect of MIC for *Staphylococcus aureus* was observed after 24h, while 2x and 4xMIC values were present the same effect after 12h. Comparing the obtained results for *Candida albicans*, it can be observed that the killing rate was slower at MIC and 2xMIC values in which fungicide activities were seen after 48h, compared with the highest tested concentration, in which the fungicide effect was observed 12h earlier. In the case of *Saccharomyces cerevisiae*, the killing rate was slower at the MIC value compared to the higher tested concentrations. A faster fungicide effect against *Aspergillus brasiliensis* was observed at 2xMIC and 4xMIC values. In summary, *S. kitaibelii* SWE strongly affects the viability of sensitive microorganisms at the initial contact phase using MICs, while biocide/bacteriostatic effects can be achieved only after prolonged contact time with the extract. The obtained results of antimicrobial activity strongly indicate the potential of use *S. kitaibelii* SWE as the antimicrobial substance in food technologies.

Keywords

antimicrobial activity, Satureja kitaibelli, subcritical water extraction, pharmacodynamic potential, minimal inhibitory concentration

Acknowledgements

Ministry of Education, Science, and Technological Development (contract no. 451-03-9/2021-14/200134)

#296: Valorisation of cherry seeds as protein and dietary fibre source: Formulate fruit-based snacks and quality assessment

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Nowadays, manufacturers realized the potential benefits of plant-derived wastes, and consumers have turned to functional foods with high nutritional value. Food scientists have put their effort into assessing the food and nutritional values of many different fruit seeds. In this frame, the utilization of plant-derived wastes has become a current issue for sustainable production and economic aspects. Fruit processing waste and by-products, which are generally regarded as not valuable, have great potential for valuable compounds such as protein, dietary fibre, and phenolic substances. Valorisation of these materials means more nutrients or bioactive compounds and addresses the environmental problem caused by discarding these “waste” materials. Every year approximately 1000 tonnes of sweet cherry and sour cherry seeds, and 250 tonnes of their stems are discarded at IQF-fruit processing plant. The purpose of this study is to produce high-valued protein isolates and dietary fibres by performing enzyme application (ET) and ultrasound (US) pretreatments from cherry seeds that can be used in various fields, to determine techno-functional properties of protein isolates and dietary fibres, to investigate the availability for the use in the production of fruit-based snacks, and to evaluate quality characteristics of fruit snacks. Formulation studies were conducted to produce fruit snacks that are high in protein or fibre content, and sensorial acceptability was assessed. The determination of the effect of different pretreatments on the efficiency of the protein and dietary fibre extraction and quality and comparing functional features of soybean protein and chicory fibre used commercially have been investigated in this study. Besides, it is thought that the development of valorisation strategy and its transfer to the food industry provides excellent knowledge for further studies.

Keywords

Food industry by-products, value-added ingredients, protein isolates, dietary fibers, extraction

#297: Potential of Avocado (Persea americana) seeds flour as a gluten-free additive for bakery industries: effect of drying temperature on functional, nutritional and antinutrient characteristics

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Avocado fruit is widely consumed all around the world due to its nutritional benefits. Avocado seeds make up 12-21% of the whole fruit weight, thereby generating large amounts of food waste. A potential application of this by-product can be its transformation into a gluten-free flour for the bakery industry. The objective of this study was to evaluate the impact of drying temperature on the seed flour functional, nutritional and antinutrient parameters.

Seed slices of 2 mm thickness were convectively dried at 40ºC, 50ºC and 60ºC, respectively for 300 min, 250 min and 200 min, at 1.5 m/s. Percentage size characterization showed that avocado seed flour was predominantly in the range of 250-150 µm.

Functional flour seed parameters behaved differently with drying temperature. Drying at 60°C showed higher swelling index, bulk density, emulsifying stability and water absorption index values than at 50°C or 40°C. This may be due to the gelatinization of avocado seeds starch at a higher temperature. Whereas drying at 40°C had higher values of water solubility index and oil absorption capacity, which may be due to the increase of a non-polar side chain. Flour obtained at 50°C had the highest values for water absorption capacity and emulsifying activity.

Avocado seed flour was found to be very rich in total phenolic compounds: 15.69, 14.32 and 12.98 mg GA Eq /g, when dried at 60°C, 50°C and 40°C, respectively. Also, the flour dried at 40ºC showed higher chlorophylls content compared to 50°C and 60°C. Seed flours also had quite high amounts of phosphorus, potassium, calcium and magnesium, especially for drying at 50°C. Avocado seed flour contributed to more than 10% for phosphorus, 30% for potassium and 20% for magnesium towards recommended daily intake. Total tannins of flours dried at 60°C, 50°C, and 40°C amounted to 62.30, 38.90 and 33.33 mg TA Eq./g, respectively. Further classification of total tannins showed that avocado seeds had mainly condensed tannins (>53% of total tannins), and this trend was the same irrespective of the drying temperature. This shows that avocado seeds drying should be done at a lower temperature for a longer duration for safer consumption, as the amount of antinutrients is reduced.

Keywords

Avocado seeds, Drying, Flour, Functional properties, Nutritional characteristics

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#299: Mycotoxin removal from dried fruits by innovative non-thermal technologies: Current applications and perspectives

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Mycotoxin contamination in fruits and their industrialized products is an important threat to human health. Mycotoxins are natural contaminants produced by certain species of *Aspergillus*, *Fusarium*, and *Penicillium* spp. that may contaminate fruits in the field and/or when the storage conditions are improper. The mycotoxin contamination resulted in economic losses for dried fruits. Many countries have set legal limits for these toxic metabolites to limit their intake. When the dried fruit processing plants are considered, dried figs have been suspected to be contaminated by mycotoxins, mainly aflatoxin B_1 and G_1, approximately 500 tonnes of fruit per year are discarded due to the higher aflatoxin level. Moreover, raisins and dried mulberries can be contaminated by ochratoxin A, and 50 tonnes of raisins and 90 tonnes of mulberries were discarded due to the out-of-limits every year. As an alternative to traditional fruit decontamination technologies for removal of mycotoxins such as chemical washing using bases (ammonia, hydrated oxide), non-thermal decontamination technologies such as UV-C light (UV-C), high-intensity pulsed light (HIPL), cold plasma, and ultrasound (US) have been evaluated to ensure the sensory and nutritional quality of food products in shorter process times and lower temperature conditions, to enhance food safety and extend the shelf-life of various fruit products. Besides, innovative decontamination technologies have different efficiency in removing mycotoxins, depending on processing parameters, the type of mycotoxin, and the food matrix. Considering the needs of the industry, non-thermal technologies can remove different mycotoxins from dried fruits as a postharvest control with their potential benefits and limitations, the main purpose of this study to summarize the effects of non-thermal decontamination technologies on the mycotoxin removal from dried fruits, to evaluate their decontamination efficiency as used alone or in combination, and the changes in quality characteristics. Future studies are needed to address the effectiveness of nonthermal decontamination applications for mycotoxin and pesticide removal from fruit-based products on an industrial scale.

Keywords

Mycotoxin, degradation, detoxification, dried fruits, non-thermal technologies

#300: Effect of Temperature and pH on colour stability of prickly pear colorants used in beverages

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Prickly pear, a member of the Opuntia genus of succulents, has a strong presence in the Mediterranean region. Interestingly, Opuntia was named after the Ancient Greek region of Locris Opuntia, whose capital city was known as Opus. Despite the fact that it is one of the most widespread genera of cacti, it remained an understudied plant up until recently. However, current studies have revealed the important nutritional benefits and technological functionalities of its fruit. Specifically, prickly pear fruit contains high levels of antioxidants and phenolic compounds. Additionally, it is a rich source of betalains, which are the pigments responsible for its vivid colour that can act as natural colorants in the food industry. Therefore, it becomes apparent that there is an increasing interest for the development of physical cactus pear fruit processing techniques in order to produce naturally coloured foodstuffs, that will address the need for novel functional foods and beverages. Spray drying has been proposed as a physical method for the production of powder colorants with higher storage stability compared to liquid alternatives.

In this context, the aim of our study was to evaluate prickly pear as an important source of betalains and to identify the stability of the powdered colorants produced with spray drying used in beverages. The simulation of beverage stability at multiple storage conditions was designed (different pH: 3, 4, 5, 6 and Temperature conditions: 4^{o}C, 20^{o}C, 40^{o}C). Moreover, the speed of discoloration at different Temperature and pH conditions in absolute darkness was obtained measuring the absorbance values spectrophotometrically at the wavelengths of 483 nm (betaxanthins) and 535 nm (betacyanins) respectively. Our results showed that the lower the pH, the more unstable the colour. Additionally, we observed an increase in the degradation of colorants with an increase in Temperature. In conclusion, our work provides basic information for further understanding the properties and widespread applications of prickly pear fruit.

Keywords
opuntia, betalains, food colorants

#302: Effect of freeze-drying on organic Urtica dioica bioactive compounds

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Stinging nettle, *Urtica dioica* L., provides a great quantity of bioactive compounds (polyphenols, flavonoids, vitamins) and minerals needed to maintain human health. Therefore, due to their short availability on the market, different conservation techniques are required in order to cover the market necessity until next harvest.

Freeze-drying technique is the most used nettle drying method because it better preserves the nutrient quality and it is used especially for medicinal purposes such as production of nettle encapsulated products. In general, the low temperature of the freeze drying process slows down the degradation reactions and efficiently preserves the nutrient content of food. Due to increased nutrient content, these natural products with high value are required more and more by industry and consumers.

Nettle samples were obtained from spontaneous flora, in a non-polluted village area of Cuca, Arges, Romania (44.9326°N 24.5166°E). Fresh nettles were washed with tap water, packed and frozen at -80 °C, preceded by freeze-drying at -55°C temperature. Freeze-dried nettles were grinded for a few seconds until more than 50 % of powder had particle size between 0.020-0.200 mm, then were stored for characterization. Both fresh and freeze-dried nettle samples were characterized by dry matter (DM), total soluble solids, chlorophyll and carotenoid pigments, ascorbic acid, total polyphenol content, total flavonoid content, antioxidant activity, and mineral elements. The average mass loss due to freeze-drying for the nettles was 84.36 %.

All bioactive compounds increased in concentration for freeze-dried organic nettle except for ascorbic acid. Ascorbic acid content decreased with about 30 % compared to fresh nettle, but still maintained a high value of 134.15 ± 13.41 mg ascorbic acid / 100 g of DM. The total chlorophyll content increased from 65.60 ± 5.72 mg / 100 g DM in fresh stinging nettle to 73.38 ± 1.30 mg / 100 g DM in freeze-dried nettle, despite the decrease of Chlorophyll b content with 14.14% in freeze-dried samples. Nettle samples showed high content of Ca, K, Mg, Na, Fe. Based on the results obtained we can state that freeze-drying is a good process to obtain nettle products with high added value.

Keywords

freeze-drying, compound characterization, powder, stinging nettle

Acknowledgements

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#304: Impact of high hydrostatic pressure on microbiota and rheological properties of liquid egg white, a kinetic study

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Liquid egg white (LEW) and egg white - based products are usually regarded as functional foods for their excellent source of high-quality proteins, trace minerals, and for the ability of their components to coagulate, and to form foams when whipped. HHP is one of the most promising minimal processing technologies in the food industry, but only a few scientific results are available about HHP treatment and its effects on egg products. This research investigated the potential of HHP treatments at different pressure levels. Pressure was increased stepwise from 150 MPa up to 600 MPa for 5 min, with 50 MPa in a RESATO FPU-100-2010 equipment.

Aerobic mesophilic microorganisms were measured in 24 hours after HHP treatment and rheological properties were examined with Anton Paar Physica MCR 51 rheometer. Our results show that microbiological state of liquid egg white decreased from 5,2*104 to undetectable levels 450 MPa or higher pressure applied. Rheological properties were highly influenced by pressure increasing. Hershel-Bulkley model was well fitted to characterize the changes in viscosity of liquid egg white.

Industrial relevance of our results is the determination of an effective pressure of HHP treatment in aspects of microbiological load and at the same time rheological stable, industrial well adaptable product.

Keywords
HHP, liquid egg white, rheological properties, microbiological food safety, shelf-life extension

Acknowledgements
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#305: PrO4Bake - Optimizing production processes in European SME bakeries

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Per capita, bread and bakery products are among the most consumed foods in Europe. However, European SME bakeries face many challenges in the production and sale of baked goods: A high energy consumption in the production process, low margins in the sale prices, or the limited shelf life of many of the produced specialities. In addition, technology uptake is relatively slow in the bakery sector.

The EIT Food project PrO4Bake uses a holistic approach to minimise energy consumption and food waste in European SME bakeries, through the use of artificial intelligence, Industry 4.0 technologies, and co-creation with SME bakeries and consumers. In order to achieve this, the project is developing a tool for optimal scheduling of production processes and forecasting of daily product demand. To ensure a robust design of the tool, production data is collected in multiple SME bakeries across 7 European countries. Additionally, preferences regarding consumption are identified with consumer questionnaires and focus group interviews. A training and consultancy service will facilitate the uptake and integration of the tool in SME bakeries.

By optimising the production plan and forecasting demand, bakeries are able reduce CO_2 emissions and avoid overproduction and its consequences. Thus, the amount of food waste, energy and raw material is significantly reduced. This also reduces the associated costs, without the need to purchase new equipment or machinery for the SMEs. Technical support and a continuous exchange between the project partners and the participating bakeries will ensure the application of the tool in a real production environment. Adapting the quantity and range of bakery products produced to consumer demand and optimising bakery production processes both represent essential parts in improving the competitiveness and sustainability of SME bakeries. This is an important step towards more resource-efficient food production in the European bakery sector, which also offers great potential for transferability to many other sectors.

Keywords
Food Waste Reduction, Optimization, Bread and Baked Goods, Consumer Engagement, Sustainability

#306: Portuguese Autochthonous Poultry Breeds: Physicochemical Characterization (pH, moisture and colour) of raw meat

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The conservation of autochthonous breeds is a topic of great importance for the maintenance of local animal genetic resources, contributing to sustainable productive systems and the preservation of a unique genetic heritage. In recent years, due to the concern in animal welfare and consumer demand for high quality products, interest in autochthonous breeds and local products has significantly increased. The first reference to the Portuguese poultry breeds is recent, in the 30s of the last century. Autochthonous hens are produced in a smallholding context, and traditionally, the production of local chicken breeds (breeding, fattening and then slaughtering of males) has been for gastronomic purposes.

Integrated in a project of valorisation (AVITECH) of the 4 Portuguese autochthonous poultry breeds (Amarela (AM), Branca (BR), Pedrês Portuguesa (PP) and Preta Lusitânica (PL)), particularly the products characterization, quality parameters: pH, moisture content, and colour CIELAB L* a* b* of the breast and drumstick in both sexes, 24 hours post mortem, were compared.

Significant differences ($p<0,05$) between breeds, sexes and meat pieces were verified. As regard to the breed effect, the AM presented ($p<0,05$) the lowest pH (5,84 ± 0,11), the highest luminosity L* (68,32 ± 8,79), a* (+2,01 ± 3,26) value and the minor b* (-9,90 ± 10,80) value. AM breed a*positive (+ red) and b*negative (+ blue) quadrant values, demonstrate a raw meat colour significantly different to other breeds. Significant higher moisture content was observed in the AM, comparing to BR breed (72,49 and 71,66%, respectively).

Regarding sex, the male pH is significantly higher ($p<0,05$) in the AM (5,87 vs 5.80) and PL (5,98 vs 5,87) breeds. Male moisture content is higher ($p<0,05$) for all breeds and for colour, AM males presented significantly higher luminosity (74,17 ± 6,79), and a brighter meat.

The breast pH is significantly lower ($p<0,05$), compared to drumstick, in all sexes and breeds. Moisture content was significantly higher in all breast females' breeds and higher drumstick luminosity in BR and PL males and PP females was observed ($p<0,05$). AM breed results parameters underline promising indicators to the breed productive characterisation, specially to its differentiation and meat aptitude valorisation.

Keywords

Autochthonous hens, Local products, Poultry breeds, Meat valorisation

Acknowledgements

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#307: Valorisation of endogenous wild fruits from Alto Minho region: Centesimal composition of Rubus Ulmifolius Schott

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The species Rubus ulmifolius Schott is known for its fruits - the wild blackberry. The berries are eaten fresh or as products derived by their delicious flavour. In Portugal, there are more than a dozen species of blackberries. Interest in wild species has gradually increased due to its rich nutritional composition and bioactive compounds of interest, crucial for the proper functioning of the organism. The potential value of Rubus species is high, increasing consumer interest in the search for these healthier fruits.

This work aims to contribute to the valorisation of the natural heritage, wild fruits of Alto Minho region, in the Northern of Portugal, and raise awareness of the need for preservation of endogenous species. This study evaluated the nutritional composition of these fruits. The results showed that the fruits of Rubus ulmifolius Schott have a high moisture content (77.72%), low values of total ash (0.92%), fat (0.37%), protein (1.67%) and a significant crude fibre content (3.19%) and carbohydrates (19.33%). The energy level, a value of 396.06 kcal/100g was determined for these samples. The nutritional profile showed that blackberry is an energetic fruit, and carbohydrates are the most abundant macronutrient. Rubus ulmifolius Schott wild berries have an enormous potential for valorisation not only for its nutritional value but also for its wealth of bioactive compounds.

Keywords

wild berries, endogenous, wild blackberry, nutritional value, healthy foods

#309: Effect of processing method on the drying kinetics of cactus cladodes (Opuntia ficus-indica). Comparison of conventional hot air drying with foam mat drying

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Cactus (Opuntia ficus-indica) cladodes are considered a nutritious raw material that could be utilized in a variety of food applications as source of fibres or as a thickener. In addition, it is a plant that can be adapted to arid regions, providing economical, environmental and social benefits. In the present study, the drying kinetics of cactus cladodes during hot air drying were studied in different temperatures (40, 55 and 70 ^{o}C). Four different approaches were investigated – cutting cladodes in half with the inner surface exposed (Control), peeling both sides (Pe), grinding the cladode into pulp (Pu) or adding whey protein concentrate (5% w/w) in the ground pulp, in order to produce a foam upon mixing (F). In all cases, samples of same dimensions (30*30*6 mm) were used. Moisture ratio (MR) data were fitted to Newton's model: MR = exp (-kt), where k (h^{-1}) is the drying rate constant. Both drying temperature and sample processing had a substantial impact on the drying rate. Control samples exhibited the lowest k values in all temperatures, ranging from 0.31 to 0.75 for 40 and 70 ^{o}C, respectively, while the complete removal of the epidermis improved these values to 0.42 and 0.95, respectively. Pu showed little difference to Pe, while F had the faster drying rate for all temperatures. The time required for reaching desired moisture values (<10% w.b.) was approximately double for Control in comparison with the F samples. In conclusion, foam mat drying could be utilized for the production of cactus cladode powder, in order to minimize time and cost of drying.

Keywords
Cladodes, drying kinetics, foam mat drying, Hot air drying

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#315: Valorisation of brewer's spent grain - a source for plant proteins

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Brewer's spent grain (BSG) is one of the major side streams of the brewing industry, with annual waste production of 300.000 tons in the EU. This residue based on barley, wheat or combinations of both, is currently mostly used as feed. However, it contains valuable components such as proteins and dietary fibres. The aim of this study was to optimize a fractionation process and to estimate its potential for production of food ingredients. Analytical composition of 12 BSG batches revealed protein contents in the range of 20% to 30% of dry matter and about 50% to 60% of total dietary fibres, which was mainly insoluble. Fundamental investigation on protein solubility were conducted in various extraction settings (variation of pH, salt type, salt concentration, presence of ethanol to facilitate prolamin extraction). Highest protein solubility (13%) was found in water at elevated pH-value (11) and increased temperature (60 °C). At these optimized extraction conditions a concentrate with a protein content of about 50% based on dry matter was achieved. The colour of the concentrate turned darker (L*< 42) than for pure BSG samples (L*value > 55). Sensory evaluation revealed a cereal-like aroma and taste in pure BSG samples, which changed to a more spicy-like flavour in the concentrate. Due to the low protein solubility and low protein content in the concentrate, further approaches to optimize the extraction were needed. Therefore, the addition of proteolytic and cell wall lytic enzymes was studied. Pre-treatment of BSG with protease at pH 8.0 and 50 °C achieved about 80% of soluble protein after 1 h of incubation. After enzymatic treatment, chromatographic analysis showed the increase of free amino acids up to 60 mmol/L and the increase in acetic, malic, lactic and propionic acid concentrations. The current results display the potential that enzymatic pre-treatment could be a promising approach to improve the quality of the protein concentrate, which will now be further evaluated regarding the industrial feasibility. Additional functional investigations on dietary fibres obtained as extraction residues were conducted and indicate promising application potential in food products. By this means, a complete utilization strategy for BSG could be realized.

Keywords
BSG, solubility, concentrate, enzymatic incubation, sensory evaluation

#316: Development of dry natural additives from stinging nettle (Urtica dioica) and evaluation of their quality and stability

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Urtica dioica L., known as stinging nettle, is a wild plant used mainly as herbal medicine and traditional food purposes, and as colouring agent for the extraction of chlorophylls. Recently, it has gained interest for its nutritional value and as potential source of bioactive molecules, that include, besides chlorophylls, also carotenoids and phenolic compounds. Despite its popular use, limited is the knowledge and information on the preparation and stabilization of nettle derivatives like juices or extracts that could favour its application in food and non-food sectors. Development and optimisation of mild extraction drying and encapsulation processes to produce stable and high quality ingredients easy to handle and rich in nutritional and health compounds could represent an interesting opportunity to valorise nettles.

Aim of this study was to develop nettle-based powders additives obtained by freeze-drying. Mechanically extracted nettle juice was freeze-dried without (NJ) and with the addition of maltodextrin (5 %, w/v) as encapsulating agent (NJ-MD). Powders were characterized for water solubility, moisture sorption-isotherms, thermal properties, colouring power, total phenolic content (TPC), ferric reducing antioxidant power (FRAP) and carotenoids, chlorophyll a and b content. Stability at four different temperatures (4°C, 22°C, 35°C and 50°C)for 95 days was evaluated.

Results showed that NJ-MD has higher solubility than the non-encapsulated juice (NJ) as well as lower values of all bioactives and antioxidant power, due to “the dilution effect “given by the maltodextrin addition. Both powders showed similar moisture sorption sigmoidal profile (type II).

During storage, solubility, luminosity L*, hue angle, TPC and FRAP did not change at all temperatures, while at 50 °C chroma (C*) and a* colour parameter decreased and increased respectively, resulting in a shift of colour from the bright green to a paler green colour. The content of carotenoids and chlorophylls decreased during storage at 35 °C and 50°C, showing first-order degradation kinetics and increasing rate with increasing temperature.

Results highlight the feasibility to obtain new nettle powders by freeze-drying and maltodextrins encapsulation to be used as ingredient for innovative food formulated products.

Keywords

nettle juice, encapsulation, food additive, polyphenols, antioxidant activity

#318: Development of a multi-step valorization scheme of P. tricornutum biomass based on green, high-pressure techniques

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Due to the uprising global food demand, energy crisis, environmental issues, and depletion of natural resources, microalgae have gained scientific attention as potential feedstocks to deliver profitable bioproducts with potential applications such as food, pharmaceuticals, nutraceuticals, and beauty care products. The pennate diatom, *Phaeodactylum tricornutum*, is a good source of polyunsaturated fatty acids (PUFA), such as EPA and DHA and carotenoids, especially fucoxanthin. Supercritical carbon dioxide (SFE-CO_2) and pressurized liquid extraction (PLE) are extraction techniques considered to fit all requirements for green sustainable recovery of functional products from various sources.

This study aimed to develop a multi-step biorefining process to recover high-added value products from *P. tricornutum* biomass. Towards this end, response surface methodology (RSM) and central composite design (CCD) were employed to establish the optimal extraction conditions. Extraction parameters such as temperature, pressure, and the amount of ethanol as a co-solvent were optimized for the total lipophilic product yield and carotenoid content in SFE-CO_2. Total lipophilic product yield varied from 4.8 to 11.7 g/100g DW, whereas carotenoid content ranged between 14.6 and 40.6 mg/g of extract. Under optimal conditions (30 MPa, 30°C and 9.2% ethanol) the yield obtained was 9.8 g/100g DW and total carotenoid content was 35.1 mg/g of extract.

Moreover, the fatty acid profile of the oil extracted under optimal conditions was analyzed employing GC-FID, which revealed a high PUFA content. In the next step, defatted biomass was subjected to PLE with increasing polarity solvents (acetone, ethanol, water). Extraction temperature and time were also optimized via a CCD, to obtain extracts with high yield, strong radical scavenging capacity, and total phenolic content chosen as response factors. Finally, the phytochemical composition of obtained extracts was assessed using UPLC-ESI-TOF-MS. Conclusively, it can be said that this study underlines the potential of this underutilized feedstock and sustainable extraction techniques for the recovery of a stream of products with multiple applications.

Keywords
microalgae, carotenoids, high-pressure extraction, sustainability, PUFA

#319: Valorization of lingonberry (Vaccinium vitis-idaea L.) pomace into functional ingredients by multistep high-pressure extractions

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Due to a very short shelf life significant part of berry harvests should be processed into various preserved products, generating huge amounts of by-products annually. Large amounts of berry pomace (by-product of juice pressing industry) currently are discarded as a waste, although retains a wide variety of bioactive constituents with potential food, pharmaceutical and nutraceutical applications. Effective biorefining scheme was developed to recover valuable nutrients from lingonberry pomace by consecutive supercritical carbon dioxide (SFE-CO_2), pressurized liquid (PLE) and enzyme assisted (EAE) extractions with green solvents. Towards this end, SFE-CO_2 and PLE were optimized for effective non-polar and polar fraction isolation by response surface methodology (RSM) based on central composite design (CCD). SFE-CO2 at optimized parameters (47 MPa, 53°C, 75 min) yielded 11.8 g/100 g of lipophilic fraction, containing α-linolenic (43.3%) and linoleic (37.4%) fatty acid rich oil. PLE with ethanol (10.3 MPa, 70°C, 45 min) and water (10.3 MPa, 130°C, 30 min) additionally recovered 59.4 and 2.4 g/100 g of polar pomace constituents, respectively. The combined SFE-CO2 and PLE recovered 47.9 mg of GAE, 116.2 (ABTS) and 98.1 (ORAC) mg Trolox equivalents per 1 g of pomace, and reduced antioxidant capacity of starting material by up to 94%, showing that proposed biorefining scheme is efficient to recover the major part of the antioxidants from lingonberry by-products. The major portion of the antioxidants (89-94% in different assays), anthocyanins (231 mg/100 g pomace) and proanthocyanidins (15.9 g/100 g pomace) was recovered in PLE-EtOH extract. Cyanidin-3-galactoside was the major anthocyanin (146.9 mg/100 g pomace). High-pressure fractionation was more efficient for obtaining bioactive pomace constituents as compared to conventional and enzyme-assisted extractions. In conclusion, the results of this work may be considered as another case study demonstrating that multistep high-pressure fractionation may be successfully applied to convert cheap agro-food processing by-products into the higher added value functional ingredients with multipurpose applications.

Keywords

Lingonberry pomace, High-pressure extraction, PUFAs, Anthocyanins, Proanthocyanidins

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#321: Changes in quality indicators of fish preserves during storage

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In order not to lose their consumers and ensure product recognition by its inherent organoleptic characteristics, it is important for processing enterprises to know its term of storage, during which the sensory characteristics of the product remain practically unchanged.

The purpose of the work was to determine the term of storage of herring fillet preserves. The objects of study were samples of preserves, namely: fillet with skin of Atlantic herring, slightly salted in oil (sample No. 1); slightly salted Atlantic herring fillet "Matias" "Original" in oil (sample No. 2); slightly salted Atlantic herring fillet "Russian Sea" "Traditional salting" (sample No. 3).

The samples were stored in a refrigerator at a temperature from minus 3 to plus 5 ° C and a relative humidity of no more than 75%, during the shelf life, i.e. 144 days. Sampling was carried out immediately after manufacture, and then after 24, 48, 72, 96, 120 and 144 days.

The subject of the research were the organoleptic and physicochemical indicators of herring fillet preserves, namely: colour; taste; smell; consistency; mass fraction of sodium chloride; total acidity; the content of sodium benzoate and potassium sorbate in combination. Physicochemical indicators were determined by standardized methods, organoleptic - by a profile method. Organoleptic analysis was carried out by fives selected assessors from one of the fish processing enterprises using a five-point scale to assess each property.

The analysis of the obtained research results showed that within 48 days of storage the characteristics of taste, smell, colour and consistency changed insignificantly (from 5 to 4.7 points), which may not be detected by the consumer. Storing preserves for three months led to some deterioration in sensory characteristics (average score was 4.1) and an increase in total acidity by 27–38%. Obvious signs of negative changes in taste, smell, colour and consistency were recorded after four months of storage, and the total acidity almost reached the upper established limit. Thus, 48 days is the optimal term of storage for herring fillet preserves, but not more than three months.

Keywords

fish preserves, storage term

Acknowledgements

Research was carried out within the framework of the thesis

#322: How are health and sustainability adressed in studies of public meals?

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The world is facing a number of challenges related to food consumption. Food conduces to far-reaching health effects as well as environmental impact. System changes are needed to meet a sustainable, healthy food production and consumption. Public and institutional meals play a vital role in promoting health and sustainability. In many countries public meals, in this study defined as meals taking place in institutional settings, constitutes a substantial part of food consumption, and may exert a a normative influence on peoples' food habits. The aim of this study was to exploratively review how, and if, health and sustainability are addressed in the European scientific literature dealing with public meals. Of >3000 papers, 20 were found to satisfy the criteria and included in the review. The results showed that schools and hospitals are the most dominant arenas where both health and sustainability have been addressed. Three different approaches in combining health and sustainability. In the first "Health as embracing sustainability" health is the point of departure and sustainability is included as part of health. This is emphasized in relation to health promotion initiatives and how these could also be more sustainable, claiming that health should embrace both aspects. In the second, "Sustainability as embracing health" sustainability is in focus and health is seen as part of sustainability. This was for example illustrated when focusing on sustainable food procurement which is then also motivated by better nutrition in terms of knowing where the food comes from and how it is produced. Last, for "Health and sustainability as separate concepts" the link between heath and sustainability was unspecified or undefined. This could be exemplified by the stated, but not inter linked or combined, role of the school meal to tackle societal challenges related to health and sustainability. In general, a clear motivation for addressing both health and sustainability is most often missing. This indicates a need for more research within all public meal arenas regarding issues of health and sustainability, for example in order to provide a more comprehensive foundation for decision-making.

Keywords
health; sustainability; public meals; Europe

Acknowledgements
We acknowledge the authors Caroline Lindö and Arwa Mustafa for valuable contribution to this study.

#326: Food waste valorisation potential: Sustainable protein recovery, structural, functional and bioactive properties of expired dairy and non dairy milk protein via liquid biphasic floatation

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Food waste is not a new concept; nevertheless there is a positive increase in recognition that reduction in food waste represents key aspects of ensuring future with a sustainable and healthy diet for the global population. United Nations (UN) Sustainable Development Goals (SDGs) Target 12.3 to shrink the global food waste up to 50% near to 2030, would assist in "zero-hunger", along with significantly improving the environmental footprint of food production. Amid the coronavirus pandemic, the short shelf life of dairy products have resulted in an increase in loss of valuable nutrients which could potentially be recovered with efficient technologies. The main emphasis of the current study is focused on protein recovery and studying the quality and function of the extracted protein on the appliance of membrane technology via liquid biphasic floatation. The study also aims in highlighting the valorisation potential by up scaling to industrial use. Expired dairy milk (commercial UHT grade cow milk) and non-dairy milk (soy milk) were analysed on OFAT (one factor at a time) model validating the effect of alcohol (50, 75 and 100%, food grade methanol and ethanol) and salt (50, 100 and 150g/L of Ammonium sulphate, Dipotassium phosphate and Magnesium sulphate) concentrations, keeping the pH (4.5) and floatation time (20 minutes) constant. Protein recovery was recorded as high as 91.69% in expired cow milk and 84.66% in soy milk (ethanol 75%, ammonium suplhate 50g/L). 81.77% and 63.01% protein was recovered on up scaling 10x the laboratory scale. Additionally, analysis of qualitative structural changes using Fourier transform infrared (FTIR) spectra and Scanning electron microscopy (SEM) predicted less denaturation of protein in both sample sets. These results are in conjunction with the Differential Scanning Calorimetric (DSC) thermal analysis. Water absorption capacity (WAC) was higher in expired soy milk samples across all parameters. However, emulsifying index (EI) and foaming capacity (FC) was higher in all the expired cow milk samples extracted via methanol and salt union. For all the tested bioactive assays, it was observed that ethanol and ammonium sulphate concentrations were the most effective for extracting bioactive compounds with antidiabetic, antioxidant and anti-inflammatory potential from both.

Keywords

Food waste, Protein recovery, Liquid Biphasic Floatation, Food waste valorisation

#327: Valorisation of food by-products into functional “primo sale” cheese

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The increasing amount of wastes and by-products generated during food processing poses several issues for their management and disposal due to their environmental impact. However, many plant-derived by-products have a high potential being rich in nutrients such as proteins, lipids, starch, micronutrients, as well as bioactive compounds and dietary fibres. In addition to some technological properties, e.g. texturizing, emulsifying and antioxidant, some by-products can have antimicrobial activity towards pathogens or prebiotic activity due to the stimulation of the beneficial intestinal microflora. Their valorisation into food additives and ingredients is therefore an opportunity to reduce food wastes while enhancing food security and developing functional foods. In this work citrus by-products, pomegranate residues and horsetail (*Equisetum arvense*) were studied to assess their possible use as multi-functional ingredients for a fresh cheese. They were preliminarily tested for antimicrobial and prebiotic activity in model system against foodborne pathogens and on the faecal metabolic profiles of 3 healthy individuals, respectively. Thereafter, they were used as ingredients of a fresh cheeses – “primo sale” - added also with probiotic lactic acid bacteria (LAB). During a 11-days storage, the fate of the LAB and the spoilage microbiota, the antioxidant activity (DPPH test), colour and volatilome (GC-MS-SPME) were evaluated.

Results showed that the by-products promoted the growth both of the faecal microbiota in the model system, which accumulated healthy volatiles such as short chain fatty acids, and of the probiotic LAB in the cheeses. By contrast, a lower growth was observed for *Listeria monocytogenes* in the functional cheeses with the LAB and the food residues. Compared to the control cheeses, their antioxidant activity was improved already in the early stages of storage, and the profile of the volatile compounds was enhanced resulting in higher acceptability, aroma and taste as assessed by a preliminary panel test.

Keywords

functional ingredients, probiotic bacteria, antimicrobial activity, soft cheese, food quality

#329: Optimization of the recovery of pectin from fruit peel waste using response surface methodology

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Fruit processing industries generate a significant quantity of residual material. Fruit peel waste, usually discarded, is a very useful natural resource as it contains many reusable substances of high commercial value such as pectin, which is widely used as a thickener, texturizer, stabilizer and gelling agent in the food industry. Therefore, extraction of pectin can be considered as a good valorization method for the otherwise discarded fruit peel residues. The objective of the present study was to develop a viable methodology for a high yield pectin recovery from a blend of fruit peels by optimizing the extraction conditions and to compare the quality characteristics of the extracted pectin to commercial pectin.

A blend of fruit peel residues (banana, mango, pineapple, citrus, watermelon, avocado, papaya, soursop and passion fruit) was collected from a local fruit juice manufacturer. Citric acid and hydrochloric were used as extracting solvents and pectin precipitation was done according to the alcohol precipitation method. Response surface methodology (RSM) was used to determine the optimum conditions for pectin extraction. The central composite design (CCD) was employed and the effects of temperature (60, 70 and 80 0C), pH (1.5, 2.5 and 3.5) and extraction time (30, 45 and 60 minutes) were studied. The optimum conditions for extraction were identified as 800C for 60 minutes at pH 1.5 according to the response surface analysis. A higher pectin yield (~ two times) was obtained by the extraction with the citric acid. The extracted pectin was analysed for the physicochemical characteristics of equivalent weight, methoxyl content, degree of esterification and total anhydrouronic acid content. The obtained values were 411.11, 3.12%, 29.04% and 60.78% respectively. A texture profile analysis was performed (Brookfield CT3 texture analyser) to compare the gel strength of extracted pectin incorporated, commercial low methoxy (LM) pectin incorporated and a market sample of gelatin incorporated set yoghurt. The extracted pectin can be categorized as LM pectin which would be ideal to use in low-calorie products and to make stirred type yogurt.

Keywords

Fruit peel, Waste valorisation, Pectin, Response surface methodology, Texture analysis

#331: Antimicrobial activity of nanoencapsulated oregano essential oil against Staphylococcus aureus in tomato juice and green juice

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Consumers are currently looking for safe, fresh and less processed products, suggesting the need to develop new food preservation techniques. There is an increasing interest in food industries for essential oils (EOs) because they exhibit antimicrobial properties. However, EOs are chemically unstable when exposed to certain environmental conditions, which can cause the loss of their antimicrobial properties. An alternative to protect EO properties against degradation and interaction with other food components, is to use encapsulation techniques. On the other hand, juices are products that have a short shelf life because they are susceptible to microbial and enzymatic deterioration. In addition, these products can be vehicles of pathogenic microorganisms. In this study, the antimicrobial activity of oregano essential oil (OEO) nanoencapsulated by emulsification, against Staphylococcus aureus, in tomato juice and green juice was evaluated. Juices were characterized by their physicochemical properties. The nanoemulsion was prepared using 5% (w/w) of OEO, 10 % (w/w) of agave inulin as a stabilizing agent and 3 % (w/w) of Tween 80 as an emulsifying agent. The antimicrobial activity of OEO nanoemulsion was evaluated by obtaining the minimal inhibitory concentration (MIC) and microbial inhibition curves, which were fitted with Weibull model. The nanoemulsion of OEO effectively decreased the bacterial population of S. aureus in juices after 10 to 20 min of being applied. It was observed that the total inhibition of S. aureus (6-log) was faster in green juice than in tomato juice. The Weibull model was adequately adapted to the inhibition curves of S. aureus. This study contributes to the knowledge of the behavior of the application of nanoemulsions against bacteria in food systems.

Keywords
essential oil, nanoencapsulation, antimicrobial activity

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#332: Oregano essential oil encapsulated by complex coacervation, homogenised by ultrasound or microfluidization, as food powder against Escherichia coli in green juice

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Oregano essential oil (OEO) has volatile compounds that have antimicrobial and antioxidant properties, which can be protected by complex coacervation. This encapsulation technique consists in the interaction of opposite charges between two biopolymers. Complex coacervates can be affected by the homogenization method and can be stabilized by spray drying. Moreover, there are a few studies of complex coacervates applied in food products as antimicrobials. Hence, the aim of this work was to evaluate the effect of homogenization by ultrasound or microfluidization in the physicochemical properties and antimicrobial activity of powders of complex coacervates with OEO. Complex coacervates were prepared with gelatine type B and chia mucilage, as encapsulating agents, at mass ratio of 2:1 with a solid concentration of 0.2% (w/w), 7.5% (w/w) of OEO, 2.5% (w/w) of Tween 80 as emulsifying agent, and 20% (w/w) of maltodextrin. Complex coacervates were spray dried with an inlet temperature of 160°C and a feeding rate of 5 g/min. Powders were characterized by their physicochemical properties (moisture content, water activity, solid yield, encapsulation efficiency and particle size). Moisture content, water activity and particle size showed significant difference ($p < 0.05$) between samples. Solid yield obtained was > 70%, meanwhile encapsulation efficiency was > 90% for both samples, showing no significant difference ($p > 0.05$). Antimicrobial activity of the reconstituted powders against Escherichia coli ATCC 29922 in green juice was determined by the minimum inhibitory concentration (MIC). MIC obtained for the reconstituted powder of the complex coacervate homogenized by ultrasound was 274 ppm, and 367 ppm for the one homogenized by microfluidization. Even if their physicochemical properties are different, powders of complex coacervates with OEO, homogenized by ultrasound or microfluidization, could be used in food products as an alternative against bacteria.

Keywords

oregano essential oil, complex coacervation, ultrasound, microfluidization, antimicrobial activity

Acknowledgements

The authors acknowledge the financial supports from CONACyT (CB-2016-01-283636; SRE-CONACyT-278363) and UDLAP.

#335: Unsaturated lipids from foods are growth accelerators for Listeria monocytogenes at low temperature

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Nutritional recommendations aimed at increasing the ratio between unsaturated fatty acids (UFA) and saturated fatty acids (SFA) in foods. These recommendations are now well accepted by consumers but also by manufacturers who tend to reformulate their products. The objective of this work is to assess the impact of these recommendations on microbiological food safety. It aims in particular to characterize the effect of dietary lipids, according to the type of fatty acids and their level of esterification, on the growth of Listeria monocytogenes at low temperature.

The inter-strain growth variability within 46 strains of Listeria monocytogenes was first monitored at 5 ° C in the presence or absence of oleic acid (UFA) for 10 days. The 46 strains were classified according to their ability to grow faster at low temperatures in the presence of oleic acid. For the most reactive strain, the overgrowth at low temperature was then characterized in the presence of different types of fatty acids, free or esterified. In order to understand the physiological mechanisms involved, biochemical analyses of membrane phospholipids were carried out. The overgrowth is very important in presence free UFA whatever they are, but a little less for dispersed esterified lipids. The overgrowth is concomitant of membrane incorporation of the exogenous UFA which probably allows the pathogen to saver energy during growth at low temperature.

The balance of lipid type (UFA versus SFA) in foods can have a significant impact on the growth of Listeria monocytogenes at low temperature. The reformulation should cause a re-evaluation of the shelf-life of these products.

Keywords

foodborne pathogens, Listeria, dietary lipids, fatty acids

#342: Quality and stability of olive leaves extract encapsulates, an innovative ingredient

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In the recent years a constant effort is given to improve the food systems efficiency, to reduce the environmental impact and the transition towards more sustainable practices including the valorisation of waste and co-products. Olive leaves are an important waste stream from olive oil production and their extracts showed antioxidant, anti-inflammatory and antimicrobial activity due to a high content of polyphenols. Despite the increasing interest, in the application of olive leaves extract (OLE) in food formulations to improve healthy properties, quality and stability, the sensitivity of these bioactives towards environmental factors during the food processing and storage impairs their technological functionalities and applicability. Hence, stabilization actions such as encapsulation are increasingly used to enhance quality and stability of OLE.

Aim of this study was to assess the quality and stability properties of OLE encapsulated amorphous powders obtained by freeze-drying, made of trehalose (100TRE), maltodextrin (100MD) or their mix (1:1, 50MD) as carrier agents. Control samples, systems made of only the carrier without OLE were also prepared. OLE stability and physical properties of the powders under different conditions (% RH and temperature) and moisture-powder interactions were evaluated.

Powders made of 100MD and 100TRE showed the highest and lowest glass transition temperature, respectively, while the 50MD had an intermediate one. Moisture sorption isotherms of the amorphous powders made of OLE and 100MD or 50MD showed a sigmoidal shape with a constant increase of water adsorption at increasing % RH fitting the GAB model. On the contrary, 100TRE powders were characterized by crystallization phenomena when equilibrated at 55 % RH and above. Control samples adsorbed higher amount of water compared to the corresponding OLE-containing powders to indicate a role of the OLE extract in affecting water-matrix interactions. OLE showed very high stability when exposed to different combinations of moisture and temperature (up to 60°C and 75% RH) in all systems with no significant variation of total phenolic content, radical scavenging ability and oleuropein concentration over 28 days.

These results could contribute to valorise OLE extracts and their usage in food products and nutraceuticals.

Keywords

microencapsulation, olive leaves extract, waste valorisation, polyphenols, amorphous matrix

#344: Characterization and geographical differentiation of yellow prickly pear produced in different Mediterranean countries

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The aim of the present study was to differentiate yellow prickly pear according to geographical origin based on the combination of mineral content, physicochemical parameters, vitamins and antioxidants. A total of 240 yellow prickly pear samples from Cyprus, Spain, Italy and Greece were analyzed for pH, titratable acidity, electrical conductivity, protein, moisture, ash, fat, antioxidant activity, individual antioxidants, sugars and vitamins by UPLC-MS/MS as well as minerals by ICP-MS. Statistical treatment of the data included multivariate analysis of variance followed by linear discriminant analysis. Based on results, a correct classification of 66.7% was achieved using the cross validation by mineral content while 86.1% was achieved using the cross validation method by combination of all analytical parameters.

Keywords
geographical differentiation, prickly pear, chemometrics, analytical techniques

Acknowledgements
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#346: Functional properties of flours, doughs and breads from grains and seeds used in the ancient and present cuisine

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This study examined the physicochemical characteristics of flours, doughs and breads made from grains and seeds employed in the past culinary practice as revealed by the archaeobotanical knowledge gained from PLANTCULT project (ERC, Consolidator Grant 2016-2021, No 682529) and from present breadmaking grains to explore the potential use of ancient grains for the future bakery products. Six grains and seeds (einkorn wheat, barley, seed from acorn, lentil, poppy seed and linseed) were coarsely ground using replicas of prehistoric grinding tools constructed for the PLANTCULT project; breads were made from einkorn flour alone or its mixtures with the above grains (80:20) as well as from barley, spelt wheat and common wheat (Triticum aestivum, T70) commercial flours. All breads were prepared using a matured sourdough as a leavening agent that was made from commercial barley flour after fermentation and multiple back-slopping (refreshment) stages of a mother sourdough prepared for the PLANTCULT project; a control bread from einkorn flour alone without sourdough was also made. Microscopy, volumetry, calorimetry, rheometry and texture analysis was used for the study of flours, doughs and breads. Sieve analysis of flour particle size distribution showed that 40% of the particles of einkorn flour had size >0.4mm, while the sizes of all particles of commercial barley and common wheat flour were smaller. The starch gelatinization endothermic peak of flour slurries was around 55-80°C, with the lentil flour dispersions exhibiting the highest gelatinization temperature and the lowest apparent gelatinization enthalpy among the tested flour samples. Mechanical spectra showed a typical solid, elastic-like, behaviour for all doughs with the elastic modulus being greater than the loss modulus over the whole frequency range. Furthermore, fortified breads with linseed and barley flours had the softest and hardest crust, respectively, among all tested formulations; nevertheless, common wheat bread had significantly higher loaf specific volume compared to all other bread samples. Moreover, barley sourdough inclusion into einkorn dough did not affect the extent of starch retrogradation in the baked product. In general, incorporation of ancient grains and seeds into contemporary bread products seems to be feasible.

Keywords

Ancient grains, Ancient seeds, Breadmaking, Dough physicochemical properties, Bread quality parameters

Acknowledgements

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#347: Fortification of Wheat Bread with Plant Protein Isolates

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Incorporation of legume protein isolates into bakery products can improve their nutritional value because they contain lysine-rich proteins compared to cereals. Moreover, with such fortification, bakery items can qualify for the claim 'high in protein product'. However, inclusion of protein isolates into wheat bread formulations is very challenging, since it negatively affects their physicochemical and sensorial attributes. Commercial protein isolates from legume seeds, pea, and fava bean, as well as from potato, were incorporated into wheat bread formulations at 5% and 10% and the effects on dough dynamic rheology and bread quality characteristics (volume, texture, sensory attributes and staling) were evaluated. Addition of protein isolates at the examined levels did not have any significant effect on the specific volume of the loaves, with the exception of 10% fava bean protein addition, which resulted in loaves with 15% lower volume. A softer crumb was recorded for 5% pea protein level and was similar to that of control. Similarly, the staling rate of breads, as assessed by evaluating the crumb hardening rate, was similar to the control in the case of 5% pea protein addition. Sensory evaluation was also conducted in the samples with 10% legume protein addition. Besides control, breads with 10% pea protein isolate were scored highly according to the overall acceptability scale. The lowest scores were recorded for the potato protein isolate addition; a high variability was also seen in all cases and was attributed to the fact that the evaluation was based on a subjective basis (overall acceptability scores). The findings suggest that protein isolates from certain plant sources can be used in order to improve the nutritional value of wheat bread, without significantly affecting the texture and product acceptability.

Keywords

Bread, Legumes, Plant Protein Isolates, Bread Quality Parameters, Nutritional Value

Acknowledgements

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#349: Reverse and Diverse. Reverse food waste to probiotic food, improve health and diverse diet in Nigeria

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Africa is a diverse continent with its abundance of natural resources, yet an irony of challenges exists when it comes to food security and food loss in the value chain of vegetables and fruits. The objective of "Reverse and Diverse" is to tackle food waste in the early stages of the food supply chain, particularly in Nigeria. The intended solution is to reduce food losses through a cost-effective and beneficial method of preservation, called probiotic fermentation. Probiotic food belongs to a category of food called "functional foods" that are known to have a positive effect on health. We hope that by developing this project we will give the infrastructures, resources and product that will provide a sustainable solution for food waste in Nigeria. More than food waste, implementing this system, will help fight the loss of biodiversity and food hunger in the continent.

Keywords
Biodiversity, Nigeria, Probiotics, Food Waste, Agriculture

SESSION 3: SOCIETY ENGAGEMENT – SDGS: GOOD PRACTICES AND THE WAY FORWARD

Session 3: Oral presentations

Science-driven innovations targeting more sustainable food systems

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Food systems are at the heart of at least 12 of the 17 Sustainable Development Goals (SDGs). The wide scope of the SDGs calls for holistic approaches that integrate 'siloed' food sustainability assessments in order to develop solutions able to change complex food systems. Despite numerous developed solutions the problems associated with the excessive use of natural resources for food production and food waste are not solved. Such problems are considered as one of the most crucial for our global food systems and sustainable development.

The alliance of novel production technologies with integrated sustainability assessment in real time and further data integration into national food systems through nutritional, environmental and social indicators could be a basis for the holistic development of more sustainable food systems. For emerging production systems, holistic life cycle sustainability assessment, aligned with introduced process innovations, can evaluate the suggested solutions on a multi parameter base, in terms of sustainability of improved food production. Life Cycle Sustainability Assessment (LCSA) in this perspective could potentially evaluate all environmental, social and economic impacts and benefits in the context of decision-making processes towards the development of sustainable products throughout their life cycle, if holistic data sets would be available. The integration of advanced sustainability assessment with nutritional properties can provide new assessments of the real value of innovative food products enabled by emerging production technologies. This allows for an improved and fair comparison between new food products against other sources, taking into consideration the respective technology readiness levels of new production processes and their economy of scale. Environmental Life Cycle Assessment (LCA) as part of LCSA relies on attributional modelling for the estimation of the most impacting stages and on consequential modelling for the estimation of potential benefits or risks for the agrifood system.

Based on this system understanding, focus for innovative system changes is laid on alternative protein rich foods and food waste reduction by considering more sustainable food processing and production. Advanced approaches relying on innovative raw materials from insects and single cells, with a case study on microalgae, and their connected biorefinery concepts are the basis of these actions. By using novel proteins from algae and insects, cultivated on side or waste streams, food security and sustainability of the protein supplies could be significantly improved. Selected implementation initiatives of these science-driven innovations with relevant industry partners and start-ups demonstrate the impact and relevance for the food sector.

Keywords

Sustainable Development Goals, Sustainability, Food Systems, algae, insects

#345: How gender equality, innovation and excellence in research are highly correlated? Practices, Tools & Methods

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How gender equality, innovation and excellence in research are highly correlated? Can the integration of gender in agrifood science lead to opportunities for the future? Did you know that the quality and accountability of research in any field is affected negatively when sex and gender are not taken into account? 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. The project Gender SMART (Horizon 2020) focuses on goal number 5 of the SDGs and it aims 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. Specifically, the inclusion of the gender dimension in funding, research and teaching is a dynamic concept when developing concepts and theories, formulating research questions, collecting and analysing data and educating the next generation of scientists. How and why it's important to integrate the gender dimension in research and academic institutions, which practices, tools and methods are appropriate to achieve institutional change for gender equality will be presented from the experiences acquired from leading agrifood related academic institutions in Europe.

Keywords
gender, gender in research, agrifood, sustainable goals, gender equality

Acknowledgements
Gender SMART Project (Horizon 2020)

#182: Challenges and opportunities to increase sustainability, productivity, and quality in pasta, bread, and bakery products production chains: a comprehensive approach from cradle to grave

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Bread, pasta, and baked products are considered worldwide as staple foods, essential for human nutrition. In particular, ancient wheats and whole wheat flours, despite being able to provide health benefits via bioactive compounds, present significant rheological and technological problems. Moreover, both the food industry and consumers are increasingly sensitive to environmental impacts, highlighting an urgent need for sustainable innovations and improvement strategies, from cradle to grave, for these production chains. Bread, pasta, and bakery products are mainly influenced by the three major production stages; the milling, the kneading, and the baking (or drying) processes. For this reason, in order to suggest specific innovations and improvement strategies, a comprehensive approach, from wheat cultivation in field to the final product, is needed. As a results, the correct management of the wheat cultivation stage was found to be essential since it represents the most impacting phase for the environment. Moreover, it significantly influence the final product quality. Successively, particular attention needs to be paid to the milling process, the kneading phase, and, finally, to the strategies able to reduce environmental pressures.

With respect to the milling phase, the correct management of wheat conditioning, the rediscovery and modernization of traditional stone watermills, the wheat debranning before milling combined with the stabilization of bran, middlings, and germ, and the use of the break, sizing, and reduction systems for improving roller milling technology, flour differentiation, and reducing the impacts, seems to be the most interesting improvement strategies. With regard to the kneading process instead, the most interesting, eco-friendly, improvement strategies are avoiding dough warming during kneading using alternative refrigerants (like carbonic snow), delay the addition of bran, middlings, and germ during whole wheat dough kneading, and, finally, develop automatic and adaptive kneading machines able to optimize the kneading process. Last but not least, in order to reduce the environmental impacts, the use of alternative sources of proteins (e.g. insects and legumes), and the use of LCA for comparing local and global dry pasta production scenarios, proved to be effective.

Keywords

stone and roller milling, dough kneading, ancient wheat and whole wheat flours, LCA, environmental sustainability

Session 3: Poster presentations

#181: MYPACK - Best markets for the exploitation of innovative sustainable food packaging solutions

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Due to the low production costs, better barrier capabilities, protection properties during transportation, and consumer convenience, plastics are a widespread first material of choice when it comes to packaging applications. However, plastic pollution and its influence on the environment result in increasing concerns among the population as well as governmental organizations and academic society. This creates pressure to seek comprehensive solutions that combine sustainable packaging technologies, food waste minimization, as well as the preservation of natural resources.

To achieve these goals, the efforts of partners from six European countries are united in the scope of the Horizon 2020 project 'MyPack'. The main aim of MyPack is to help sustainable packaging technologies to reach their markets. The research is focusing on seven packaging technologies. Each technology corresponds to one of the following objectives:

- promotion of the development of bioplastic packaging: bio-based and biodegradable materials and multilayer film technology, heat resistant PLA, PEF renewable substitute of PEF;
- promotion of the development of elaborated packaging technologies: high oxygen barrier packaging, breathable packaging, SiOx inert barrier, antimicrobial packaging.

The study aims at creating general guidelines for the selection of the best markets for new technology and at ensuring the best commercial development. These guidelines will help packaging and manufacturing industries to select appropriate commercial development strategies by providing tools and methodologies. The elaboration of strategies will take into account environmental efficiency (direct impacts of packaging, food waste impacts, optimized recycling, and preserved consumer health), consumer adoption, and optimized industrial feasibility. This approach will contribute to the achievement of the SDG Responsible consumption and production.

Keywords

bioplastics, sustainable packaging, biodegradable materials

#191: Where is the Poultry Industry in the United States heading on its path to sustainability?

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In this transitional stage in the egg industry, producers are scrambling to address public concerns of the day. How does sustainability relate to cage, cage-free or free-range production? These changes impose recognition of bias, risks on business, economics, and affects their sustainability decisions. Sustainability definitions have changed significantly over the last 45 years. The first definition was “to keep up or keep going, as an action or process; or to supply with food, drink, and other necessities of life”. Three recent publications have supported this original definition. The laying hens today are smaller, better livability, higher and persistent levels of production, produce larger eggs with better shell quality, and with better feed efficiency resulting in less waste production. These documented changes have taken place over time, as breeding companies applied quantitative genetic selection to improve performance of their hens. These sustainability changes were due to genetic selection, understanding of nutrition, and improved vaccinations for diseases that have taken place over the years. However, today’s definition of sustainability as “the ability to maintain at a certain rate or level and the avoidance of the depletion of natural resources in order to maintain an ecological balance” is changing the US egg industry’s systematic assessment of production system sustainability. The public focus, driven by the 25 to 35 year age group is having a dramatic effect on the egg industry in the US. Sustainability for them means being responsible stewards of land, water and feed management, and maintaining and advocating for the humane treatment of our most important asset: our chickens. The goals of the egg industry is to meet the needs and expectations of the future generation and to feed the earths growing population with less land and reduced use of resources. How to balance hen well-being with increasing food demands, decreasing environmental impacts, improving the social and economic well-being of agricultural communities are imperative while helping improve human health as components of sustainability.

Keywords

Egg Industry, Egg production, Sustainability, Societal Influence

#194: SMARTCHAIN: Smart Solutions in Short Food Supply Chains

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Over the last years, the European conventional agri-food system has become more complex bringing several issues to light regarding transparency, environmental policy, worker's rights and food ethics. Today most of the population in the EU buys food from large supermarket chains. However, a range of alternatives have been developed to improve competitiveness including many different models of short food supply chains (SFSCs), where farmers sell their produce directly to consumers or with a minimum of intermediaries, both in rural and urban areas. There is undoubtedly a need for innovative re-organizations of the current food supply chains, being SFSCs of considerable interest, responding to a number of needs and opportunities, both of farmers and consumers, and being able to act as a driver of change and a model to increase transparency, trust, equity and growth throughout the agri-food chain.

The central objective of SMARTCHAIN project is to foster and accelerate the shift towards collaborative SFSCs and, through specific actions and recommendations, to introduce new robust business models and innovative practical solutions that enhance the competitiveness and sustainability of the European agri-food system.

SMARTCHAIN is a 3 years project with 43 partners from 9 European and 2 associated countries including key stakeholders from the domain of SFSCs as actors in the project, in particular, 18 case studies of widespread SFSCs in Europe with remarkable social, economic and ecological impacts on rural, peri-urban and urban communities. To strengthen co-creation and collaboration between partners and stakeholders, 9 SMARTCHAIN Innovation & collaboration Hubs have been established in France, Germany, Greece, Hungary, Italy, the Netherlands, Serbia, Spain and Switzerland.

As a starting point, the project has developed an operational framework for the comparative analysis of 18 selected case studies (SFSCs) from different perspectives: (1) technological and non-technological innovations, (2) social innovations, (3) consumers perceptions, (4) environmental & socio-economic impact, (5) business and (6) European policy framework.

Keywords
sustainability, innovation, short food supply chains, H2020

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#234: Bioactive amines in the cocoa-chocolate processing steps

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Among several changes that occur in the cocoa fermentation process, protein hydrolysis is relevant for flavour formation. The low pH achieved during cocoa fermentation is responsible for the bioactive amines formation. Studies indicate that bioactive amines can have positive or negative health effects. However, there are few studies in the literature demonstrating the levels of bioactive amines during the cocoa to chocolate production stages, which is the objective of this study. Cocoa fruit (Parazinho variety) was harvested, fermented and dried at Bahia, Brazil and processed to obtain nibs, liquor and chocolates (60 % cocoa). The bioactive amines were extracted from samples were collected from cocoa pulp, unfermented seed, cocoa beans during fermentation (every 24 hours) and after drying, roasted nibs, liquor and chocolate and determined by Reversed-phase Ion-Pair HPLC. The only amine found in the pulp was putrescine (12 mg kg^{-1}), that was also found in the unfermented seed (4.58 mg kg^{-1}) and after 72h of fermentation (1.59 mg kg^{-1}). Tyramine (2.40 mg kg^{-1}) and Phenylethylamine (1.20 mg kg^{-1}) were the only amines found in the chocolate. The first one was also present at the beginning of fermentation (3.09 mg kg^{-1}) and its amount increased (43.91 mg kg^{-1}) until 132 h, the final fermentation time. At the same fermentation time, Cadaverine (1.70 mg kg^{-1}), Spermidine (12.31 mg kg^{-1}) and Tryptamine (3.16 mg kg^{-1}) were also found. Serotonin was found just in the unfermented seed, while tyramine, agmatine, spermidine and phenylethylamine were only present from the fermentation process, and already in the initial time.

There was a variation between the types of bioactive amines present, as well as the quantities along the processing stages evaluated. In general, bioactive amines can be generated and eliminated during processing, with the main differences verified during the fermentation stage. Regarding the amines found in chocolate, tyramine, at low concentrations, such as those found, can modulate vessel and neural activities. Phenylethylamine is a catecholamine-releasing agent, stimulating the hypothalamus, inducing pleasurable sensations, affecting the levels of neurotransmitters in the brain, improving mood lift and sexual impulses.

Keywords
Biogenic amines, Theobroma cacao, Cocoa variety

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#246: The smart sustainable development of food drying

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The globalization of markets requires a constant availability of food resources. Consequently, the development and innovation of products, processes and systems along the food supply chain were mainly focused on foods with longer shelf-life, higher organoleptic quality, nutritional value, safety, and wholesomeness. In fact, governments, businesses, civil society, and people have not really paid concrete attention to the sustainability of the food system at all stages, despite its well-known tangible impact on the quality of life of present and future generations. Nowadays, food research still maintains a consumer-centric approach, but is increasingly focusing on developing more environmental-friendly solutions by increasing energy efficiency of processes, saving water, and reducing food losses and waste, as well as greenhouses gasses emissions.

Among food processing technologies, food drying is an effective and viable industrial solution that ensures the constant availability of foods with improved shelf-life, organoleptic quality, nutritional value, safety, and market value. Drying technologies are varied from simple sun drying to emerging trends like hybrid technologies. However, they are limited by high energy demands and specific raw material requirements that directly affect the process efficacy and sustainability. Although hybrid drying is extensively studied for energy efficiency, it does not ensure product quality, commodity value and lacks wide industrial adaptation. This is partly due to the involved costs and partly due to the failure of traditional analytical methods in describing the complex drying process affected by the material properties, regulatory compliance and production conditions and scales. Emerging drying technologies aim to alleviate these issues by simultaneously maintaining product quality, value and increasing sustainability.

'Smart-drying' is a promising technology involving the use of Process Analytical Technologies (PAT) for measuring core parameters in the production process. Although smart processes are evidenced to be cost-effective in both real-time monitoring of food quality and dynamic controlling of operating conditions, their potential in increasing the sustainability of food processes still waits to be fully expressed.

Keywords

artificial intelligence, deep learning, sustainable development goals, smart drying, quality-by-design

#252: Energy savings during drying of different fruits at changeable thermal conditions

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Intermittent drying, an alternative to reduce the energy consumption of conventional drying, covers various procedures in which the process parameters are changed during the operation. Thermal intermittent drying (TID) consists of using higher temperatures at the drying initial periods, while the surface is saturated with water; then, as the surface becomes unsaturated, the temperature is reduced to minimize damages to the food. This work aimed to evaluate and compare the energy consumption between TID and continuous drying (CD) of fruits. Apple, mango, and papaya slices were subjected to CD and TID in two convective fixed bed dryers. TID trials were conducted in two-stage drying. The first one, performed at 95 °C, had duration of 45 (apple), 40 (mango) and 15 min (papaya), which were determined by monitoring the sample surface temperature through thermocouples until they reached 60 °C. TID second stages and CD were held at 60 °C. Energy consumption was calculated from mass and energy balances, considering adiabatic drying. Papaya surface temperature rose faster than those of mango and apple. The distinct behaviours were related to composition and structure of each fruit. During the initial period of drying, the high porosity of apples facilitated the water transport towards the surface, slowing down its heating and extending the first stage, which reduced the overall drying time due to the increase in water removal rates. Conversely, the low papaya porosity led to a short first stage, while its low sugar content seemed favour the moisture diffusion during CD. Mangoes presented intermediate behaviour between both, papayas, and apples. When compared to CD operation, the overall drying time of TID was reduced in about 33% for apple and mango, which represents important energy saving by the air blower. This reduction for papaya was only 13%. Regarding heat input, TID provided an energy saving of 28% for apples, 15% for mangoes and 7% for papayas, in comparison to CD. It was concluded that TID conditions must be carefully determined considering particularities of each fruit, as porosity, composition, or water sorption properties, because they affect the operation in different ways. Suitable choices for TID applying can bring advantages in terms of energy savings, making it a more environmentally sustainable drying technique.

Keywords

intermittent drying, two-stage drying, convective drying, energy consumption

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#266: Computer vision technology for improving quality and sustainability of food drying systems

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Drying is one of the most viable and effective preservation technologies to improve the shelf-life of foods. Carrots are among the most consumed vegetables, owing to their nutritional profile as well as their wide use in dried foods, ready-to-eat and ready-to-use convenience products like snacks, meals, and soups. As for the dried products, the quality of produce depends on the timely recognition of the dehydration state. Traditional off-line analyses in combination with drying rates to identify the end-time of the process can fail in identifying process discrepancies and avoiding product degradation. The use of computer vision (CV) as a Process Analytical Technology (PAT) tool in the drying system can be of interest to monitor the drying process and product quality, improving the sustainability of system by reducing energy consumption. The objective of this study was to study the drying behaviour of carrot slices during drying at 35 °C for 36 h using a smart dryer augmented with computer vision system and load cell. The system developed was effective in measuring the weight, size, and colour of the untreated (control) and pre-treated (blanched) carrot slices along the drying time. The image analysis and the weight loss of the slices enabled the prediction of relative moisture content (MC) using linear and thin-layer (Newton-Lewis) models in comparison. The applicability of the models was further evaluated by use of different pre-treatments (i.e. blanched at 90 °C for 2 min or not blanched). The results showed promising prediction capability for the linear models, which was independent of time with a Root Mean Square Error (RMSE) similar to the thin-layer models, an adj. $R^2 > 0.99$ as well as both Mean BIAS Error (MBE) and reduced χ^2 tending towards zero. The blanching treatment affected the model parameters but negligibly affected the model performances.

Keywords
in-line monitoring, computer vision, blanching, thin-layer drying model, linear model

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#303: Evaluation of techno-functional and sensorial properties of an egg white based apple flavoured milk substitute after HHP treatment

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Today's consumers are suffering from several food allergies and intolerances. One of the most common allergic food group is the dairy products. Whey protein allergy and lactose intolerance are the most common problems for European population.

The substitution of dairy products with plant-based products are today well-known, but these products have worse sensorial and nutritional quality than dairy products. An appropriate option is the development of egg white based dairy substitute products. Egg white has a high nutritional value, as long sensorial attributes can be easily modified. The aim of this study was to develop an egg white based milk substitute product flavoured with freshly squeezed apple juice. A cowmilk analog product was developed from egg white using enzymatic reactions and heat treatment. This product was flavoured with freshly juiced apple juice to reach a sensorial quality like yogurt drinks. After flavouring, the product was treated with high hydrostatic pressure (HHP) at 400 MPa, for 5 min in a Hiperbaric H 135 equipment at room temperature.

In this study the rheological properties and sensorial attributes of the apple juices flavoured milk substitute product are investigated during a storage time of 4 weeks (28 days). The rheological measurements were carried out with an Anton Paar MCR 92 rheometers investigating the shear stress of samples, applying a CC27 system in rotation method between 10 and 1000 1/s shear rate. Sensorial attributes (smell, texture, colour, flavour, taste and over quality) were investigated by a trained panel (n=10).

Our results show that HHP treatment led to a thinner texture, so a significant apparent viscosity decrease was observed compared to untreated control sample. Herschel-Bulkly model was well fitted to the flow curves of control and inulin enriched samples (R^2=0,99).

The investigation of sensorial attributes, like taste and texture pointed out this "thinner" texture of apple juices flavour samples as well.

Our results show that fruit flavoured yogurt drinks can replaced with an egg white based drink, as long the sensorial and techno-functional properties are enhanced too. This product development may allow a healthier opportunity to replace dairy products.

Keywords

functional food, dairy substitue, egg white, HHP, shelf-life

Acknowledgements

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#313: Mathematical tools and food engineers for the future

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There are many (and some time unexpected) interconnections among mathematics and food: equations for food properties predictions, formulas for food process calculations, software for governing food logistics.

How these interconnections will further develop in the future? What their role will be in the future of the food industry? Will artificial intelligence (based on data analysis as well as on predictive mechanistic modeling) truly play a role in new food product design?

The proposed talk is aimed to answer these questions, presenting the milestones along the path that mathematics and food engineering have walked together in the past years and discussing how innovative companies can surf the waves and the trends to use mathematics, food science and food engineering to shape the future of the food industry.

Keywords

food for future, future for foods, mathematical tools, artificial intelligence, start up

#348: More sustainable, resilient, and competitive food systems through the development of intermediate food supply chains: The FAIRCHAIN project begins

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There is a pressing need to transform existing food systems to address economic, social, environmental, and health-related issues. Dominant agri-food systems are based on long supply chains, which present certain advantages such as resource efficiency, economies of scale, mass production and lower prices. However, chains in this model are typically globalised, lead to the concentration of profit and involve high-tech processing. On the other end of the spectrum, short food value chains offer geographical proximity, a fairer price for farmers and the development of local economies. Nevertheless, volumes and distribution are often limited, convenience is low, and prices for consumers are generally higher.

To address these shortcomings, the FAIRCHAIN project (www.fairchain-h2020.eu), will contribute to the development of intermediate food value chains, which combine elements from both short and long value chains, to achieve food systems that are more sustainable from an environmental, social, and economic perspective.

The project strategy is focused on six case studies from the fruit, vegetable, and dairy sectors. These case studies cover the entire value chain, with a concentration on postharvest steps as power imbalances are primarily here: in the processing and retail sectors in conventional supply chains. The concept of intermediate-food supply chains will be publicised by the FAIRCHAIN project as will the technological, organisational, and social innovations put in place to get there.

Keywords
fruits and vegetables, dairy products, food systems, food innovation, intermediate food value chain

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#351: Van family farm market; possibilities and challenges

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Family farm at national and EU level promotes a more sustainable family farm sector. They are the backbone of the EU agriculture. The issue of family farms loom large, especially for their dominated presence in small farms. Along these lines, theys make a significant contribution to food security by ensuring a continuous supply of high quality and varied products that also reach consumers via short supply chain, e.g. farm markets.

In many countries, there are specialized markets trading in 'locally produced' products. On these markets producers sell their locally grown food . Such Family Farm Markets (FFM) promote face-to-face interaction between producers and potential consumers and inspire, inform, engage and interact with goals set by the social economy. However, not only policymakers but producers and consumers should pay l attention to the socio-economic role of FFM in helping to revitalize local food systems. It is important to note the economic and social benefits that are obvious for family farmers going to FFM because of the direct supply of products in shortening the food supply chain.

Three key elements that FFM organizations need to take care of are rents, donated space and access to internal services. They are important investments that communities and municipalities make in development of FFM, not only to collect rents. Sanitary policies and strict regulations affect not only the physical structure and location, but also social and economic life of these markets. One of the most common practice in developed countries in Europe is, farmers going by vans to FFM (VFFM). They provide conditions that are more comfortable for farmers and meet measures that are more sanitary for consumers, especially during a pandemic. Such vans make it possible the farmers tour from one market place to other. As VFFM is one form of direct marketing, such as supply of agricultural products needs more exchange about its benefits based on further research. Such research compromises the positive effect on consumer health and social interaction, the educational potential about agricultural products and food quality, the need for extension services as well as incentives for a sustainable development of this supply opportunity.

Keywords
Family, farm, market, food chain, food safety, sustainable.

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6th 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 6th ISEKI-Food Conference was *"Sustainable Development Goals in Food Systems: Challenges and Opportunities for the Future"*. The conference aimed to promote a wide and constructive discussion on the current status and achievements of the SDGs.

www.iseki-food2020.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

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