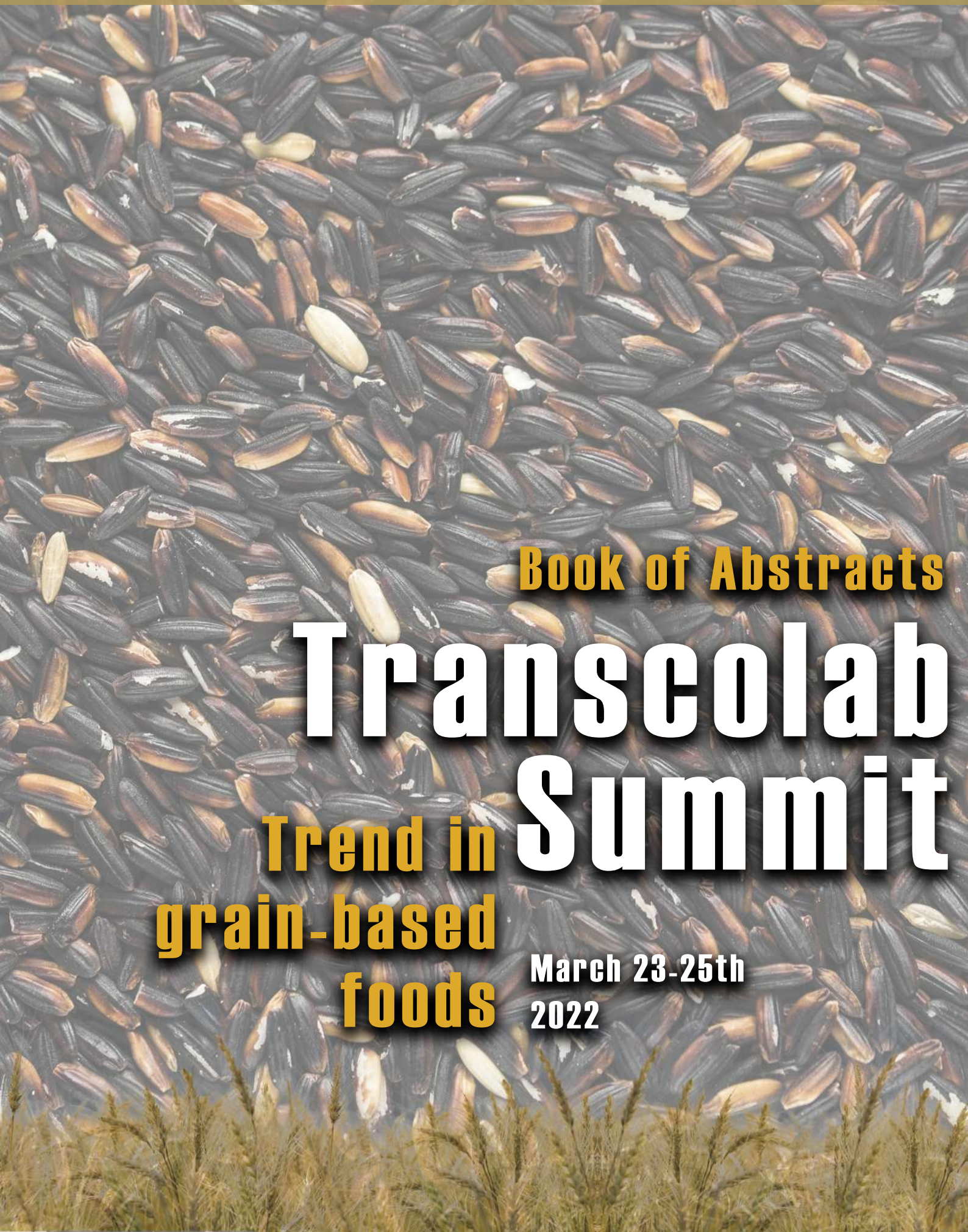

Book of Abstracts

Transcolab Summit

Trend in grain-based foods

March 23-25th 2022

Title

Trends in grain-based foods

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1° Trends in grain-based foods

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Trends in grain-based foods

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About

TRANSCOLAB is a European project that brings together universities, research centres, foundations, and companies from Castilla y León and Northern Portugal. This project intends to strengthen the connection between research institutions and companies, identifying the challenges and needs of the cereal industry and the existing scientific-technological capacities of the participating entities. It also aims to generate novel products, promote knowledge and innovation transfer, and develop a series of actions to promote innovative products and processes in the cereal sector, particularly in bakery and pastry.

Therefore, and because the project is coming to an end, the TRANSCOLAB partners organised an international congress, bringing together researchers and professionals to share innovative ideas in this field. The congress is divided into four different topics:

1. Past as key to the future (ancient grains, wholemeal products, and sourdoughs)
2. New Ingredients in grain-based products (Pseudocereals, pulses, and new flour sources)
3. Novel technologies, processes, and products
4. Sustainability and Circular economy.

The TRANSCOLAB SUMMIT team would like to thank you for your application to the congress, contributing to its success, with more than 170 registrations. The submitted works were received, processed, divided into two main categories (Oral Communications and Posters), and later distributed according to the aforementioned topics. In total, 34 Oral and 42 Panel Communications will be presented, joined by three Technical Communications and six plenary lectures. Moreover, the TRANSCOLAB SUMMIT will start with a Traditional and Innovative Bakery workshop, with 45 participants. On the SUMMIT's last day, we will have a discussion panel regarding "Myths and truths regarding cereal consumption". Once again, we would like to thank you all for attending our congress, and we hope to see you again at future research events.

The TRANSCOLAB SUMMIT team.

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Keynote Information

Trends in grain-based foods

SUSTAINABLE INGREDIENTS, PROCESSES AND PRODUCTS

Past as key to the future

(ancient grains, wholemeal products, and sourdoughs)

Alessandra Marti, Ph.D

Associate Professor at the Department of Food, Environmental and Nutritional Sciences at the Università degli Studi di Milano, Italy.
Her main research activity focuses on understanding the effects of processing on the interactions among starch, protein, fibre and water - the main components in grains and related products – as well as their role on the quality of final products with particular attention to bread and pasta. Furthermore, she's involved in the development of fibre-enriched products, gluten-free products and in the exploitation optimization of legumes, minor cereals, pseudocereals, and perennial crops

Carlo Giuseppe Rizzello, Ph.D

Full Professor in Food Microbiology at La Sapienza University of Rome, (Department of Environmental Biology), Italy.
His area of expertise includes proteomics and enzymology of lactic acid bacteria; bioactive compounds; nutritional and functional aspects of fermented foods; fermented food biotechnologies; biotechnological protocols for the food wastes valorisation
He is member of the editorial boards of International Journal of Food Microbiology and Foods, and guest associate Editor for Frontiers in Nutrition, Frontiers in Microbiology and Fermentation. Moreover, he was scientific responsible for technology transfer projects (ca. 60) with many industries af the agri-food sector.

Trends in grain-based foods

SUSTAINABLE INGREDIENTS, PROCESSES AND PRODUCTS

New Ingredients in grain-based products
(Pseudocereals, pulses, and new flour sources)

Claudia Monika Haros, Ph.D

Graduated in Chemist, MSc in Bromatology and Food Technology and Biology Analysis and Ph.D in Chemistry. She's permanent staff of CSIC and continues her investigation in the Cereal Group, Department of Food Science of IATA.
The major theme in Dr. Haros's research is the utilization of different strategies to improve nutritional and/or functional value of cereal by-products or cereal ingredients. These strategies include use different physical, biochemical, or biological treatments during milling cereal process; development new cereal by-products by including novel ingredients. In recent years her research focused on: Nutritional studies of vegetable raw materials and/or their by-products on their biological activity for their subsequent integration into new food matrices.

Laura Román, PhD

She's a Novo Nordisk postdoctoral scientist working at the Department of Food Science at Aarhus University. Her current research efforts center on the understanding of the molecular details of structure formation in plant-based food systems. Her work lies at the interface between molecular structures and physical chemistry of biomaterials.
Her current project focuses on physicochemical studies of protein-starch interactions in complex biopolymer matrices, with a multidisciplinary approach. The overall goal is to understand the conformational and supramolecular mechanisms that lead to the interactions between plant-based proteins and starch during processing, critical to develop more sustainable and nutritious functional plant-based foods.

Trends in grain-based foods

SUSTAINABLE INGREDIENTS, PROCESSES AND PRODUCTS

Novel technologies, processes, and products

Mario Martínez, Ph.D

He's adjunct Assistant Professor at the Whistler Center for Carbohydrate Research (Purdue University, IN, USA) and at the Department of Physics of the University of Guelph (ON, Canada). Developed a research portfolio on food carbohydrates and associated metabolites that can be encompassed by three distinct competence areas (glycomics, structuring and health-promoting compounds).
Since 2017, Mario works on the fundamentals aspects related to the molecular and supramolecular architecture of glycans, structuring technologies of plant-based foods, health-promoting compounds, and glycan-based packaging solutions. All in all, Mario ´s team relies on coherent and focused food system approaches to find common ground for health and environmental sustainability.

Sustainability and Circular economy

Maria Manuela Estevez Pintado, ph.D

She's currently Associate Professor of the College of Biotechnology of the Portuguese Catholic University (ESB-UCP), Associate Director of School of Biotechnology from Universidade Católica Portuguesa (ESB-UCP, Porto, Portugal) and the director of CBQF (Chemistry and Biotechnology Center – State Associate Laboratory). In research field she is Leader of Biobased and Biomedical Group and Head of Bioactive and Bioproducts Research Laboratory.
The research can be summarized into: (i) development, compositional characterization and validation of bioactivity of functional and bioactive ingredients (ii) by-product and new resources valorization through bioprocesses (iii) application of the above research developments to other Biotechnological fields

Schedule

Trends in grain-based foods

SUSTAINABLE INGREDIENTS, PROCESSES AND PRODUCTS

MARCH 24TH, MORNING

9:00-9:30 OPENING SESSION
LILLIAN BARROS - SUMMIT CHAIR
NUNO RIBEIRO - DIRECTOR OF ESTIG
LUÍS PAIS - VICE-PRESIDENT OF IPB
ISABEL FERREIRA - STATE SECRETARY OF INLAND IMPROVEMENT

9:30-13:00 SECTION 1: PAST AS KEY TO THE FUTURE
CHAIRS: SANDRINA HELENO AND MÁRCIO CAROCHO

09:30-10:00 PLENARY SESSION 1: ALESSANDRA MARTÍ

10:00-11:00 ORAL SESSION 1

10:00-10:10 RITA BELTRÃO MARTINS
"ACORN FLOUR: AN INGREDIENT FROM THE PAST READY FOR THE FUTURE"

10:10-10:20 KATERINA ATHINAIOU
"TECHNOLOGICAL AND NUTRITIONAL CHARACTERIZATION OF WHEAT FROM ANCIENT CROPS"

10:20-10:30 VANÉZIA ROCHA
"BROADENING FOOD SECURITY THROUGH GRAIN-BASED SOLUTIONS: AFRICAN MILLETS AND THEIR CABO VERDE AN WILD RELATIVE"

10:30-10:40 CARLA BRITES
"RICE AUTHENTICITY & TRACEABILITY, ELEMENTS OF SUSTAINABILITY AND QUALITY DIFFERENTITION"

10:40-10:50 MANUEL AYUSO
"COMPARATIVE ANALYSIS OF THE CHEMICAL COMPOSITION OF DIFFERENT PORTUGUESE BREAD"

10:50-11:00 MARIA OTILIA CARVALHO
"THE IMPACT OF TRIBOLIUM CASTANEUM INFESTATIONS ON QUALITY OF WHEAT FLOUR FOR BREAD-MAKING"

11:00-11:30 COFFEE BREAK AND POSTER SESSION

11:30-12:30 ORAL SESSION 2
CHAIRS: ELIANA PEREIRA AND ANGELA FERNANDES

11:30-11:40 ANA CATARINA RIBEIRO
"YEAST PROTEIN EXTRACT AS AN ALTERNATIVE PROTEIN IN THE FORMULATION OF MAYONNAISE"

11:40-12:00 STEFAN LUNDGREN (PERKINELMER)
"MEASURING INGREDIENT PERFORMANCE, CHARACTERIZING PROCESSING EFFECTS, AND DODGING BULLETS IN THE PLANT PROTEIN WILD WEST"

12:00-12:15 ISABEL REINAS
"INNOVATION IN BAKERY AND PÂTISSERIE INDUSTRY - THE CASE OF TECPAN"

12:15-12:30 JUAN CARBAJO AGUIRRE
"COLLABORATE TO MOVE FORWARD"

12:30-13:00 PLENARY SESSION 2: CARLO GIUSEPPE RIZZELLO

Trends in grain-based foods

SUSTAINABLE INGREDIENTS, PROCESSES AND PRODUCTS

MARCH 24TH, AFTERNOON

15:00-18:30 SECTION 2: NEW INGREDIENTS IN GRAIN-BASED PRODUCTS
CHAIRS: MANUEL AYUSO AND FILIPA REIS

15:00-15:30 PLENARY SESSION 3: CLAUDIA M. HAROS

15:30-16:30 ORAL SESSION 3

15:30-15:40 MARIA INÊS DIAS
"NON-CONVENTIONAL SEEDS FOR THE DEVELOPMENT OF NEW BAKERY PRODUCTS: A NEW TREND OR MYTH?"

15:40-15:50 CARLOS SHIRAISHI
"FIG (FICUS CARICA L.) BIORESIDUES AS SOURCES OF BIOACTIVE COMPOUNDS AND NATURAL PIGMENTS FOR THE FOOD INDUSTRY"

15:50-16:00 MARTA MESIAS
"RISK/BENEFITS OF NEW INGREDIENTS ADDED TO NOVEL CEREAL-BASED FORMULATIONS"

16:00-16:10 ANABELA RAYMUNDO
"MICROALGAE AS A VALUABLE INGREDIENT FOR BREAD ENRICHMENT: INFLUENCE ON THE DOUGH RHEOLOGY AND BREAD MAKING PERFORMANCE"

16:10-16:20 MARÍA FRANCO
"PSYLLIUM: A NATURAL BAKERY IMPROVER"

16:20-16:30 YAMINA ABSI
"MINERAL AND PROXIMATE COMPOSITION OF COMMERCIAL PLANT-BASED FLOURS"

16:30-17:00 COFFEE BREAK AND POSTER SESSION

17:00-18:00 ORAL SESSION 4
CHAIRS: BRUNO MELGAR AND MIGUEL PRIETO

17:00-17:10 JESÚS MARÍN SÁEZ
"CEREALS AND PSEUDOCEREALS CONTAMINATED WITH TROPANE ALKALOIDS: ANALYTICAL TOOLS TO ASSURE FOOD SAFETY"

17:10-17:20 BEATRIZ NUNES SILVA
"OPTIMISATION OF HYDROCOLLOIDS DOSES IN GLUTEN-FREE BREAD MADE OF FLAXSEED AND RED LENTILS FLOUR BLEND"

17:20-17:30 FERNANDA FERREIRA
"A BREAKTHROUGH ON BREAD FORMULATION: NATURAL MINERAL WATER AS A NOVEL FUNCTIONAL INGREDIENT"

17:30-17:40 ELEOMAR PIRES
"HYDROETHANOLIC EXTRACT OF OCIMUM BASILICUM 'CINNAMON' AS A NATURAL PRESERVATIVE FOR THE FOOD INDUSTRY"

17:40-17:50 VANESSA VIEIRA
"THE POTENTIAL OF AROMATIC EXTRACTS TO ENHANCE THE SENSORY PERCEPTION OF BREAD"

17:50-18:00 ISABEL SOUSA
"DAIRY GLUTEN-FREE BREAD: TECHNOLOGICAL, NUTRITIONAL, AND FUNCTIONAL ENHANCEMENT BY CURD CHEESE SUPPLEMENTATION"

18:00-18:30 PLENARY SESSION 4: LAURA ROMÁN

20:30 DINNER

Trends in grain-based foods

SUSTAINABLE INGREDIENTS, PROCESSES AND PRODUCTS

MARCH 25TH, MORNING

9:00-12:30 SECTION 3: NOVEL TECHNOLOGIES, PROCESSES, AND PRODUCTS
CHAIRS: MARIA INÊS DIAS AND CARLA PEREIRA

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9:30-11:10 ORAL SESSION 5

9:30-9:40 RICARDO N. PEREIRA
"ELECTRIC FIELDS - A PROMISING TECHNOLOGY TOWARDS SUSTAINABLE PROCESSING OF GRAIN-BASED FOODS"

9:40-9:50 ERIKA N. VEGA
"EXTRUDED FORMULATIONS BASED ON RICE AND CHICKPEA: DIETARY FIBER AND OLIGOSACCHARIDES"

9:50-10:00 LIEGE PASCOALINO
"BREAD FREEZING AS A NEW ALTERNATIVE TO CONSUMPTION"

10:00-10:10 CAROLA CAPPA
"STUDY OF THE TURBO-TECHNOLOGY POTENTIAL IN THE PRODUCTION OF GLUTEN-FREE INGREDIENTS AND POTATO-BASED PASTA"

10:10-10:20 ÁNGEL L. GUTIÉRREZ
"APPLICATION OF SHORT-TIME HIGH HYDROSTATIC PRESSURE TREATMENTS TO WHOLE BUCKWHEAT GRAINS TO MODULATE THE FUNCTIONAL PROPERTIES OF THE RESULTING FLOURS"

10:20-10:30 ANTONIO J. VELA
"PHYSICAL MODIFICATION OF RICE FLOUR VIA ULTRASONICATION. INFLUENCE OF TREATMENT TIME AND TEMPERATURE"

10:30-10:40 NATALIA P. VIDAL
"IMPROVING THE NUTRITIONAL VALUE OF COLD-PRESSED OILSEED CAKES THROUGH EXTRUSION COOKING"

10:40-10:50 COSTANZA CECCANTI
"ENRICHMENT OF FRESH EGG PASTA WITH ANTIOXIDANT EXTRACTS OBTAINED FROM WILD ITALIAN PLANTAGO CORONOPUS L. AND CHICORIUM INTYBUS L. AND QUALITY CHARACTERISATION OF THE FRESH END PRODUCT"

10:50-11:00 ROSALIA LOPEZ-RUIZ
"NEW INGREDIENTS IN THE PREPARATION OF COOKIES TO MITIGATE ACRYLAMIDE CONTENT"

11:00-11:10 MIRIAM HERNANDEZ-JIMENEZ
"APPLICABILITY OF NEAR INFRARED SPECTROSCOPY ON WHEAT FLOUR SUPPLEMENTED WITH LENTIL FLOUR"

11:10-11:30 COFFEE BREAK AND POSTER SESSION

Trends in grain-based foods

SUSTAINABLE INGREDIENTS, PROCESSES AND PRODUCTS

MARCH 25TH, MORNING/AFTERNOON

11:30-12:50 SECTION 4: SUSTAINABILITY AND CIRCULAR ECONOMY
CHAIRS: CRISTINA CALEJA AND JOSÉ PINELA

11:30-12:00 PLENARY SESSION 6: MANUELA PINTADO

12:00-12:10 ISABEL MARIA FERREIRA
"FLOURS MADE FROM FRUIT BY-PRODUCTS AS SUSTAINABLE INNOVATIVE INGREDIENTS: ARE THEIR MINERALS BIOACCESSIBLE?"

12:10-12:20 ROSSANA CARDOSO
"CEREAL MILLING BY-PRODUCTS AS SOURCES OF NUTRIENTS AND ANTIOXIDANT PHENOLIC COMPOUNDS"

12:20-12:30 HANINE HACHED
"RESPONSE SURFACE METHODOLOGY APPLIED TO ESSENTIAL OIL EXTRACTION OF EUCALYPTUS LEAVES"

12:30-12:40 TERESA SIGÜENZA-ANDRÉS
"DEVELOPMENT OF A FERMENTED PLANT-BASED BEVERAGE FROM DISCARDED BREAD FLOUR"

12:40-12:50 FILIPA MANDIM
"STUDY OF THE PHENOLIC PROFILE AND BIOACTIVE POTENTIAL OF CARDOON BRACTS AS A PROMISING FUNCTIONAL INGREDIENT"

13:00-14:30 LUNCH TIME

14:30-16:00 DISCUSSION PANEL: "MYTHS AND TRUTHS ABOUT CEREAL CONSUMPTION"
CHAIR:
SILVIA BRANDÃO
SPEAKERS:
ELISABETE FERREIRA
MARIA FRANCO
JORGE PASTOR MORENO
MANUEL GOMES PALLARES
EDUARDO VILLAR ROMO
GEMMA DEL CAÑO
EDUARDO TALLON

16:00-16:30 CLOSING SESSION AND CLOSURE OF THE TRANSCOLAB PROJECT (LANGUAGE: SPANISH & PORTUGUESE)

16:30 PORTUGUESE WINE

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Plenary Session

Plenary Session

SPROUTING UNDER THE SPOTLIGHT

Alessandra Marti[1,*], Gaetano Cardone[1], Diego Suárez-Estrella[1,2]

[1]Department of Food, Environmental and Nutritional Sciences, Università degli Studi di Milano, via G. Celoria 2, 20133 Milan, Italy.[2] Grupo de Investigación en Quimiometría y QSAR, Facultad de Ciencia y Tecnología, Universidad del Azuay, Av. 24 de Mayo 7-77 y Hernán Malo, Cuenca, Ecuador.[*] alessandra.marti@unimi.it

This presentation will provide an overview of the most recent insights on sprouting, with a focus on the effects of the process on macromolecule functionality and its relationship with breadmaking performance. Four case-studies will be presented: besides common wheat (i.e., the ideal and widely used raw material for bread production), sprouting was applied to durum wheat, quinoa and sorghum to enhance their use in bread making in view of their agronomic and/or nutritional features.

The intensity of sprouting was different among the selected grains: the highest α-amylase activity was shown by durum wheat, instead the highest accumulation of proteases was observed for quinoa and sorghum. Such results suggest the importance of monitoring the sprouting process and the impossibility to transfer the optimal conditions from one grain to another. By controlling the process, it was possible to limit the hydrolysis of the main biopolymers (starch and proteins) so that the functional properties of the related flours (i.e., wholegrain or refined) were improved. Thus, sprouting improved volume and specific volume, and crumb softness of bread, even when wholegrain flours were used, suggesting new potential application of sprouting as a pre-treatment of fiber-enriched flours. Finally, sprouting was successfully in solving the main issues related to the incorporation of quinoa and sorghum in bread-making: bitterness and astringency in quinoa, and low protein digestibility in sorghum.

Overall, sprouted grains can be incorporated in wheat-based formulations as new ingredients thanks to their ability to improve bread volume and crumb softness, as well as nutritional and sensory properties.

THE NUTRITIONAL/FUNCTIONAL POTENTIAL OF THE SOURDOUGH FERMENTATION

Carlo Giuseppe Rizzello,[1*] Marco Gobbetti,[2]

[1]Department of Environmental Biology, Sapienza University of Rome, Italy;
[2] Faculty of Science and Technology, Free University of Bozen, Italy.
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The ancient biotechnology of sourdough fermentation has several effects on sensory, rheology, and shelf life properties of baked goods. Moreover, the recent literature has highlighted the effects of sourdough fermentation on many functional/nutritional features of baked goods. While some aspects such as the potential to lower glycemic index, increase mineral bioavailability and increase of protein digestibilty have been largely proved *in vitro* and *in vivo* [1-3], others potentialities are emerging, deserving further investigations.

Among the novel evidences on the use of sourdough fermentation there are the healthy microbiota metabolism at the colon level [4], the synthesis/release of functional compounds (like bioactive peptides, GABA and EPS, or related to the metabolism of phenolic compounds), and the degradation of antinutritional compounds (such as condensed tannins, saponins, raffinose-family oligosaccharydes, vicine and convicine) [5]. These latter are abundant in non-conventional flours (legumes and pseudo-cereals) and milling by-products (bran and germ), thus rendering sourdough fermentation, both spontaneous or guided through the use of selected starters, a suitable tool for the exploitation of their nutritional potential [5].

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QUINOA WET MILLING: PRODUCTS AND APPLICATIONS

Claudia M. Haros

Instituto de Agroquímica y Tecnología de Alimentos (IATA), Consejo Superior de Investigaciones Científicas (CSIC), Av. Agustín Escardino 7, Parque Científico, Paterna, 46980 Valencia, Spain; *cmharos@iata.csic.es

The objective in dry milling is to obtain the maximum quantity of flour, by separating the anatomical parts of the grain, such as the endosperm, germ, and pericarp, whereas the purpose of wet milling is to separate the chemical components of the grain, such as starch, protein, fibre, and oil. Wet milling starts with a maceration/steeping process in which physical and chemical changes occur in the basic constituents. The objective is complete dissociation of endosperm cell contents with the release of starch granules from the protein network. The cereal that is mainly used for wet milling is maize. Although the main product of wet milling is starch, other subproducts of interest for technological/nutritional purposes are the fibre-rich and protein-rich fractions, mainly if the raw material used is a pseudocereal such as quinoa (*Chenopodium quinoa*). Quinoa is source of high biologically value proteins and oil with high unsaturated faty acids. Still intensive research is necessary regarding the possibilities of applying the wet milling process to pseudocereals. Today, they seem to be a fine alternative to increase the range of plants used globally because of their nutritional/functional value and interesting technological properties.

Acknowledgments
This work was supported by grants la ValSe-Food-CYTED (**I**bero**a**merican **Val**uable **Se**eds - 119RT0567) and Food4ImNut (PID2019-107650RB-C21) from the Ministry of Sciences and Innovation (MICINN-Spain).

SELECTING CLIMATE ROBUST PROTEIN CROPS: BLUE LUPIN

Laura Roman

Center for Innovative Food (CiFOOD), Department of Food Science, Aarhus University, AgroFood Park 48, Aarhus N 8200, Denmark. *lroman@food.au.dk

There is an urgent need to deliver novel sustainable, climate friendly food solutions to accommodate to a healthy, less resource-intensive plant-based diet. A robust supply of nutritious and sustainable protein is becoming an increasingly critical need, both for human and animal consumption. Finding alternative sources of plant-proteins is then of outmost importance. This presentation will focus on the potential of legumes with focus on Lupin. Legumes are a high value crop, because of their high protein content, and their potential for re-balancing ecosystems. Lupin is one such legume that can be cultivated under different environmental conditions and seems a promising protein rich source with high nutritional value. However, the presence of antinutritional components, such as alkaloids is a drawback in their use as human food. This talk will highlight the identification and development of varieties of blue lupin (*Lupinus angustifolius*) that can be suitable for their cultivation in different lands, based on their robustness towards upcoming harsh climate conditions and processing performance into different plant-based food products and ingredients. By exploiting different pre-breeding blue lupin materials and commercial lines we expect to identify more suitable and robust genotypes with improved protein quality for both food and feed and, at the same time, reduced amount of toxic secondary metabolites, that may negatively impact their use for food and processing quality. This research also aims to understand climate robustness in blue lupin seeds by evaluating the phenotypic traits of different genotypes/cultivars for climate tolerance using typically stress related physiological parameters and characterize both changes in protein composition and functionality as well as nutrient quality. The combined responses in morphology, physiology and protein amount and composition and presence of other metabolites will provide traits for genomic studies and will orientate the future breeding process for optimal protein quality.

Acknowledgments
I would like to thank Milena Corredig, Carl-Otto Ottosen, Emmanuel Tsochatzis, Lovisa Johansson Sjödin, Kubra Tarin, Eje Mattis Röndahl and Katherine F. Grasberger, who are also co-authors of this work. I would also like to thank the Novo Nordisk Fonden for my postdoctoral fellowship (grant number NNF20OC0064423) at Aarhus University, and Nordic seed for providing the raw material.

GOOD CARBS, BAD CARBS: GAPS AND OPPORTUNITIES FOR EDIBLE PLANT CELLS

Mario M. Martinez

Center for Innovative Food (CiFOOD), Department of Food Science, Aarhus University, AgroFood Park 48, Aarhus N 8200, Denmark. *mm@food.au.dk

Dietary carbohydrates are a diverse group of molecules typically present in edible plant tissues, such as cereals and grains, that range from simple sugars to highly complex polysaccharides, such as starch and dietary fiber. Carbohydrates are the principal energy source in most societies throughout the world and, hence, their importance in human nutrition cannot be underestimated. Carbohydrates are often viewed as a health-neutral energy filler, used to make up the energy content of the diet in place of dietary fat. Nevertheless, a simplistic focus on calorie counting may achieve some success but does not account for the complex interplay of carbohydrate-rich foods and dietary patterns, on long-term weight control and metabolic health. The impact carbohydrates can have on human health is typically exemplified by the relationship between the contribution of sugar sweetened beverages to excessive dietary energy intake resulting in weight gain and obesity. Therefore, the long-recognized centrality and importance of nutrition for good health naturally leads to the practical question of what carbohydrates to eat to stay healthy. This presentation will emphasize the roles of single nutrients, such as starch, but will also integrate knowledge across nutrients (e.g., cell walls, flavonoids) and foods (e.g., food supramolecular structuring) to understand how dietary carbohydrates typically present in edible plant cells impact health and disease. This talk will also expand on potential metrics for carbohydrate nutritional quality, the importance of harmonized digestion models, and the recognition that carbohydrate quality is not defined by the chemical make-up of the carbohydrate alone, but it comprises of broad groups of molecules and structures. In this presentation, I will also endeavor to provide some systematic insights into the different physical and biological behaviors of cell wall polysaccharides and their protective effect action against non-communicable diseases, with a focus on carbohydrate (diabetes) metabolism, food intake limitation (satiety), and/or large intestinal microbiota (colon cancer). To conclude, the one-size-fits-all dietary approach will be contrasted with the profound differences among individuals in disease risk and biological responses to diet (e.g., glycemic index), highlighting the importance of precision nutrition to deliver more tailored and cost-effective interventions and food products.

Acknowledgments

I would like to thank the Natural Sciences and Engineering Research Council of Canada (NSERC), the Walmart-Foundation, the Good Food Institute (GFI), Aarhus University Research Foundation (AUFF), and Independent Research Fund Denmark (DFF) for funding all the glycosicence research performed by my team at University of Guelph and Aarhus University.

CEREALS: INNOVATION OPPORTUNITIES FOR FOOD SECTOR IN A CIRCULAR ECONOMY CONTEXT

Manuela Pintado

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Cereal grains have been a primary human food source since thousands of years ago, being one of the most vital sources of calories for a large sector of the world population. The estimate for world cereal consumption has been increasing throughout the years and for that reason also the opportunities to reuse cereal by-products to obtain new food products. Breakfast cereal products are largely consumed in occidental countries, where typically 50% of the population eats them and this percentage increases for children/adolescents. In recent years, the lifestyle and eating habits of the worldwide population have changed, encouraged by finding healthier and more nutritious food habits, namely consumers have been searching for products with high fiber content. The consumption of cereals products has been expanding, due to the practicality too. In parallel, food industries generate a high amount of by-products, and although these by-products present a rich nutritional composition, most of these by-products are often undervalued and used as animal feed. In this context, the direct of development of functional granules using by-products from the food industry is an opportunity to contribute to the food products diversification and to consumer health and well-being and to valorize the by-products, promoting the circular economy. Thus, the objective of this presentation is to highlight the potential of cereal by-products alone or combined with other by products to develop new food products with functional properties.

Co-Cereal Value project has as major objective to increase the added value of by-products that result from the processing of cereals (into bran and germ) and through the formulation of new granules/flakes suitable for human consumption which can be enriched by natural products of low value (okara e acorn), but having a high concentration of proteins, polyunsaturated fatty acids, fibers and minerals and antioxidants. Besides, the biological activities impacted by the gastrointestinal digestion (GID) of the new functional cereal-based granules, will be presented. Besides, the initial steps to develop innovative multifunctional sustainable breakfast cereal products, using fruit and vegetable by-products as fibre ingredients to increase fibre content of cereals will be also explored.

Technical presentation

Technical presentation

MEASURING INGREDIENT PERFORMANCE, CHARACTERIZING PROCESSING EFFECTS, AND DODGING BULLETS IN THE PLANT PROTEIN WILD WEST

Stefan Lundgren

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Processing conditions have a profound impact on plant protein functionality. Changes in heat treatments, exerted shear, and chemicals used in extraction and purification have a lot to say about how proteins hydrate and respond to temperature. In a space where there isn't an industry-wide set of common practices, it's especially important to characterize the functionality in addition to composition of plant protein ingredient systems. The PerkinElmer Rapid Visco Analyser is the tool to do just that in an easy and precise way.

INNOVATION IN BAKERY AND *PÂTISSERIE* INDUSTRY – THE CASE OF TECPAN

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With more than 30 years in the market, Innovation is part of TECPAN's DNA, which since the beginning of its activity has played a key role in business development and customer loyalty. Innovation consists in the development of new products (disruptive), of new production process technologies and scientific knowledge. The fact that we do business with other markets than the national one forces the company to be constantly developing, becoming a permanent challenge, which when shared with the constant evolutions in food technology – make stagnation not an option. This organizational behavior that characterizes us creates closer connections with our markets (customers), it is a differentiating competitive advantage and internally it enhances the creativity and the increase of skills/knowledge of our employees. We have a technological research center with pilot equipment for the pastry and bakery industry where we replicate the manufacturing conditions of our customers, in addition to the laboratory where we carry out physical-chemical analyzes of new ingredients, raw materials in use and finished product. In addition to research at the technological level, we have partnerships with scientific entities in order to promote the creation of scientific knowledge linked and applied to the industry.

COLLABORATE TO MOVE FORWARD

Juan Carbajo Aguirre

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The TRANSCOLAB project, which is coming to an end today, is aligned with our work philosophy: to collaborate to move forward. We understand collaborative work as the only way to grow small companies like ours.

Collaboration at all levels, starting from the field through close contact with farmers, listening to their needs and concerns and trying to solve their difficulties through the support of research institutes for the improvement of crop profitability.

Continuing with the production through the development of new flours thanks to the application of the knowledge provided by researchers from universities and technology centers.

And finishing with our clients, offering them advice and training for the improvement of processes. In this area we work closely with professionals in the bakery sector.

In short, to work together to achieve quality, sustainable products that allow the development of our region and improve the transfer of knowledge at all levels. Thanks to this, synergies are established that allow us to move in the right direction.

Oral Session

Oral session

Section 1: Past as key to the future (ancient grains, wholemeal products, and sourdoughs)

Section 2: New Ingredients in grain-based products (Pseudocereals, pulses, and new flour sources)

Plenary session 4: Sustainability and Circular economy

Past as key to the future

ACORN FLOUR: AN INGREDIENT FROM THE PAST READY FOR THE FUTURE

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Food scarcity predictions by 2050, are driving the world to a new underexploited resources valorization perspective. Acorn is the fruit of *Quercus* gender tree (oak), which in the Mediterranean Region, particularly holm oak (*Quercus ilex* and *Quercus rotundifolia*), is one of the most important trees of the unique agroforestry system, named "*Montado* | *Dehesa*" [1]. However, it has been a wasted resource, since a substantial amount of its production has not been used or harvested. Acorn flour is described by Strabo as an important crop during Roman period, in the Mediterranean countries, especially in years with lower agricultural production. Moreover, archaeological remains have revealed the use of acorn flour even before Roman Era [2]. In addition, these trees are under strict law protection, and their implementation area cannot be used for any other purpose. Thus, acorn can be harvested and seen like many other crops. Regarding acorn uses, apparently, its flour is one of the most interesting and suitable ways to its introduction as a conventional crop for the human diet [1]. Acorn flour is naturally gluten free, and in addition, exhibits a very interesting nutritional and functional profile: is rich in unsaturated fatty acids and fibre, vitamin E, chlorophylls, carotenoids, other bioactive compounds, and possesses antioxidant activity, which can contribute to improve the nutritional properties of both, gluten containing and gluten free bread [1]. Since acorn is a wild resource, is very dependent on abiotic factors, particularly in what concerns its functional and nutritional characteristics [3]. Consequently, the aim of this work was to analyse and compare acorn flour from two consecutive years (2018 and 2019), in order to understand its variability, with the objective of better characterizing acorn flour as a common ingredient for human diet. Nutritional composition, fatty acids profile and minerals, bioactive compounds, and antioxidant activity were analysed. The results revealed significant differences between the years, for the majority of the assessed parameters, showing the influence of abiotic factors as rain and temperature, in acorn flour characteristics.

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TECHNOLOGICAL AND NUTRITIONAL CHARACTERIZATION OF WHEAT FROM ANCIENT CROPS

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Today, there is a growing interest on the part of consumers in the consumption of foods made with ancestral grains, the main components of the diet of our ancestors. The rediscovery and revaluation of many of them, with agronomic potential in the face of climate change, high nutritional value with clear benefits for health and technological potential, has drawn the attention of farmers, technologists, nutritionists and scientists from all over the world. The ancestral grains come from millenary cultivars, and have now burst onto the international market as part of a nutritious and healthy diet. Some of these crops refer to ancestral wheats such as Emmer, Spelt and Khorasan.

The objective of this study was to determine the nutritional characteristics of ancient wheat. Ancient crops such as Emmer, Khorasan and/or Spelt will be the raw materials of the current investigation. Commercial wheat and organic wheat seeds will be the control samples. Characterisation of wheat seeds/whole flours in terms of moisture, ash, total dietary fibre, proteins, and lipids, colour, phytates and phytase activity, minerals were determined. The protein content ranged from 6.2±0.2 g/100 g (Khorasan) and 14.8±1.2 g/100 g (Spelt), and the ashes between 1.59±0.11 g/100 g (Control) and 2.04±0.20 g/100 g (Spelt and Emmer). The total dietary fibre values ranged between 4.58±0.72 g/100 g and 5.58±0.26 (%) corresponding to Emmer and organic wheat, respectively. Beside the nutritional profile of the seeds, phytate is considered to be the major factor causing negative effects on mineral uptake in humans and monogastric animals. Organic (8.9±1.0 U/g) and Spelt wheat (8.71±0.29 U/g) shown the highest amount of phytase, Khorasan (6.3±1.0 U/g) shown similar to the control (6.8±1.3 U/g) and Emmer (4.8±1.8 U/g) the lowest activity (U: mg P/min at 50ºC and pH: 5.5). Phytic acid is found mostly in the aleurone layer which is removed during milling remaining in the bran fraction. The phytic acid content following the trend Spelt>Organic>Control~Khorasan>Emmer. In general, these analyses do not support the suggestion that ancient wheats are generally more nutritious and/or healthy than modern wheats. The intake of whole grains (modern or ancients) remains the consumption recommendation to prevent non-transmissible illness. Further detailed studies are required, with multiple genotypes of ancient and modern wheat species.

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BROADENING FOOD SECURITY THROUGH GRAIN-BASED SOLUTIONS: AFRICAN MILLETS AND THEIR CABO VERDEAN WILD RELATIVES

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Millets (small Poaceae grain crops) are a diverse group of cereal crops well-adapted to adverse agroecological conditions (limited rainfall) and mainly cultivated in marginal agricultural areas. Throughout arid tropical regions of Africa and Asia millets and sorghum play an important role to rural communities, where agriculture is practised primarily by small-scale farmers, reinforcing their household diet [1]. Regarding the importance of these agricultural grains and their ancestral use in Cabo Verde, this study unveils and value the use of local species, identifying their Crop Wild Relatives (CWR - species growing in natural habitats, genetically related to crops) occurring under extreme conditions. As nature-based solutions, CWR can improve crops against heat and pest-resistant, helping farmers maintain productivity alongside a framework of rising temperatures, increasing water scarcity, and emerging pests and diseases. In Cabo Verde there are 26 Poaceae CWR species related to 14 crops (Figure 1), namely barley, barnyard millet, finger millet, fonio, foxtail millet, indian and japonese barnyard millet, kodo millet, oat, pearl millet, proso millet, sorghum, sugarcane and teff millet (more information in [2]). Currently, sugarcane and corn are the most cultivated grasses in Cabo Verde [3], however, until the XVIII century, African millets and rice, were among the most important crops and formed the basis of diet of the Cabo Verdean populations. The cultivation of wild forms of African millet (ex.: fonio, black fonio and guinea millet) could offer a more sustainable food source than their main related crops because they are more efficient in using water and nitrogen [2]. As so, the identification and enhancement of local plant genetic resources, namely those related to African millet crops, is of great importance to combat hunger and ensure food and nutritional security in Cabo Verde, as in other arid tropical regions of Africa and Asia that are struggling with similar problems.

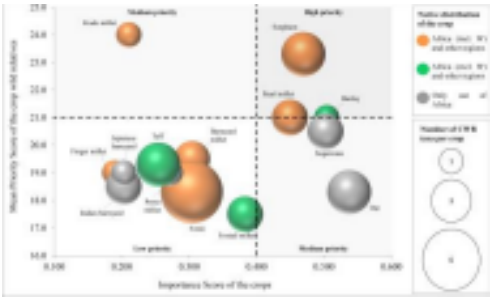

Figure 1: Comparison of the importance of the 14 Poaceae crops studied and their CWR in Cabo Verde. The Importance Score concerns the food supply and agricultural production metrics of the crops, and the mean Priority Score represents the nine criteria used as a proxy to prioritize the CWR (for details see [2]).

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"RICE AUTHENTICITY &TRACEABILITY, ELEMENTS OF SUSTAINABILITY AND QUALITY DIFFERENTIATION"

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The key element for sustainability of rice sector is the integration of economic, social and environmental issues by all actors along the value chain. That systemic approach should consider the promotion of consumption of local adapted varieties and their awareness implies the use of advanced quality control systems with blockchain technology and predictive quality models, as well the valorization of by-products. The adoption of authenticity and traceability tools is particularly important given that in Europe there are Protected Designations of Origin and contaminant limits, especially for rice labeled as organic. The information linked to the consumer should be consistent with regulation and with quality specifications and source labels, however, there are currently several weaknesses in the control and certification system [1]. The inclusion of rice or rice ingredients in foods is increasing, as the market analysis reflects. This analysis shows that food recipes should be developed using combined processes to improve whole rice characteristics, together with blends of other ingredients, to improve the sensorial characteristics and nutritional profile of the resulting foods.

This session will highlight the improvements that have been achieved using quality models and DNA based tools to certify the rice varietal authenticity [2] and a blockchain technology implementation system for rice traceability, highlighting alternatives for improving rice-based food products, and providing specific examples of incorporation of many tools through the TRACE-RICE project in order to contribute to a sustainable rice sector transformation in the Mediterranean region.

Figure 1: TRACE-RICE project is a consortium of 10 partners from Portugal, Spain and Egypt www.trace-rice.eu

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COMPARATIVE ANALYSIS OF THE CHEMICAL COMPOSITION OF DIFFERENT PORTUGUESE BREAD

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Bakery products are one of the most widely consumed foods in the world. Among them, bread is daily consumed by all social classes due to its macro (carbohydrates, protein, and fat) and micronutrients (minerals and vitamins). However, the refined wheat used in traditional baking diminishes its nutritional quality by reducing its dietary fibre, vitamins, minerals, and phytochemicals[1]. In addition, studies have been showing some health-related problems associated with obesity and diabetes. Compared with others made with different cereals or whole grains, traditional bread tends to be less satiating and increase the postprandial glycaemic index[2]. Thus, the great challenge of the cereal industry today is to innovate and reinvent a large part of its products, mainly by changing the traditional composition of food products, since it seems to be an effective method to improve the diet. Alternatives such as whole grains, other cereals or the incorporation of protein-rich flours such as legumes may help improve the nutritional quality of bread and have a favourable impact on consumers' health[3]. Thus, in this study, a comparative analysis, and chemical parameters among two traditional wheat bread (smoked sausage and cheese, SSCB; and wine, WB) and five non-conventional bread supplemented with different cereals (rye, RB; legumes and cereals, LCB; biological seed, BSeB; biological spelt, BSpB; and chickpea and sprouted seeds, CSSB) was performed. The bread centesimal composition was evaluated by AOAC official procedures; free sugars using HPLC-RI, and fatty acids by GC-FID. Regarding the chemical characterisation of traditional bread, SSCB showed a high protein concentration (9.95±0.02 g $100g^{-1}$ FW). However, it was also the bread with the highest amount of fat and a high percentage of saturated fatty acids (6.1±0.1 g $100g^{-1}$ FW and 67.1±0.4 %, respectively). WB revealed the highest concentration of free sugars (37.6±1.8 g $100g^{-1}$ FW). In general, the non-conventional bread presented lower energy and higher polyunsaturated fatty acids than the traditional. Additionally, RB, BSpB, and CSSB presented the lowest fat concentration, with CSSB showing the highest concentration of dietary fibre (7.2±0.4 g $100g^{-1}$ FW). This study demonstrates that incorporating alternative flours produces bread of higher nutritional quality. In general, non-conventional bread is lower in calories, fat and have a higher percentage of polyunsaturated fatty acids and dietary fibre.

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THE IMPACT OF TRIBOLIUM CASTANEUM INFESTATIONS ON QUALITY OF WHEAT FLOUR FOR BREAD-MAKING

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Tribolium castaneum (Herbst) (Coleoptera: Tenebrionidae) is a key-pest of stored processed grains, causing many losses on cereal flours. Considering that this insect species impacts reducing the available food quantity, but in fact the insect is not harmful to human health. Therefore, our main objective was to study the impact on wheat flour, previously infested by this key-pest, on the quality and technological performance of bread-making. To promote insect tolerance in flour, to reduce significantly insecticidal treatments, tolerated but toxic to humans, and food waste.

Trials were carried out using three different levels of infestation on wheat flour T65 (a) one insect per every two grams of flour, (b) one insect per gram of flour and (c) two insects per gram of flour. The flours remained infested over two weeks in a controlled chamber, after that the insects were removed. Color of the flours, content of total starch and protein, mineral composition, moisture, and acidity were studied. The viscoelastic properties of the doughs produced, and properties of their starch were evaluated as well. Specific bread volume, firmness and staling rate during storage as well as color of the crust and crumb, were determined. Total and resistant starch, in vitro starch digestibility and glycemic index of the bread samples were also estimated.

The results showed variations in some of the characteristics studied at the different levels of infestation. At the level of wheat flour measured properties, significant differences were obtained solely on color changes and high acidity values, compared to control wheat flour (no infestation). In terms of dough rheology properties, as the infestation levels increased a significant reduction in dough deformation energy after 1h of fermentation, were obtained. However, the resulting bread samples were significantly softer without a markedly impact on specific bread volume and staling rate. The higher glycemic index of the “infested” bread samples compared to control bread, might be a critical parameter that can impact the nutritional quality of the bread.

YEAST PROTEIN EXTRACT AS AN ALTERNATIVE PROTEIN IN THE FORMULATION OF MAYONNAISE

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Consumers are increasingly concerned of healthy and natural foods. To respond to the sharp increase in the world population the agri-food sector must implement cleaner and sustainable approaches and ingredients. The food industry faces some important challenges regarding allergies and food intolerance when using animal-derived protein (gelatin, casein, and egg white or ovalbumin) which emerge the use of alternative proteins[1].

In this study, the goal is the replacement of egg protein in a mayonnaise model by an alternative protein, a Yeast Protein Extract (YPE) obtained from the common baker yeast *S. cerevisiae*. YPE is a good source of proteins which come from an ancient and very described processed named fermentation. YPE have several advantages such as natural origin, don't bring flavor, highly digestible and are easy to implement in clean label products. Other strategies in the agri-food sector were the use of residues as a source of bioactive compounds. Indeed, their natural ability to bind to proteins can bring new insights in the use of Phenolic Compounds (PCs) as emulsifier agents[2]. PCs are known for their antioxidant, anti-inflammatory, anticancer and antiaging properties[3]. PCs also have been described as one of the main responsible compounds for the main organoleptic characteristics of plant-derived foods such as astringency sensation and bitter taste[4]. Thus, the molecular mechanisms of the interaction between egg or YPE protein models and PCs (gallic acid-GA, tannic acid-TA, and grape seed extract-GSE) were unraveled by fluorescence quenching. The molecular binding models were studied at pH 7.4 (physiological pH) and at pH 3.5 (mayonnaise pH) and at different temperatures (4 °C and room temperature) simulating the storage conditions. Overall, different mechanisms of molecular interaction were found for the different PCs. Molecular affinity constants were calculated by using the Stern-Volmer equation. A generally trend to higher constant affinity was observed in YPE model when compared to egg proteins. YPE immerge as a promising alternative protein to incorporate in the most diverse foods. The PCs were found to be the main factor affecting the affinities, which also depended on the temperature and the pH. The results obtained within this study clearly showed the potential of PC to be used as natural emulsifiers, which can conquer the food industry in response to the consumer demand for clean labelling and potentially health-beneficial foods.

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New ingredients in grain-based products

NON-CONVENTIONAL SEEDS FOR THE DEVELOPMENT OF NEW BAKERY PRODUCTS: *A NEW TREND OR MYTH*?

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Of the numerous ways that the food industry has revolutionized itself in the last century, it is possible to point out the use of unconventional food plants (UFP) as one of them. These plants, in addition to their abundance, organoleptic, nutritional, and bioactive characteristics, do not compete directly with other plant matrices used for human consumption [1,2]. All of these facts led us to the following question: the use of non-conventional seeds for the development of new bakery products can be a new trend or is just a myth? To answer this question, the flour of three PANC seeds, *Guizotia abyssinica* (Lf, niger) Cass., *Panicum miliaceum* L. (millet) and *Phalaris canariensis* L. (birdssed) were chosen for the development of new bread products. Physical parameters (granulometry and water absorption index - WAI) were studied, followed by the nutritional value (AOAC methods), free sugars (HPLC-RI), fatty acids (GC-FID), organic acids (UPLC-DAD), tocopherols (HPLC -fluorescence) and phenolic compounds (HPLC-DAD/ESI/MS^n). The antioxidant, hepatotoxic, and antimicrobial potential of the hydroethanolic extracts was also determined. The breads were prepared with partial replacement of the wheat flour (20% of the UFP's flour), having been studied several physical-chemical characteristics of the products, supported by the centroid simplex statistical method to understand the real effect of the application of the UFP flours. The use of the three flours should be complemented with other flours for bakery application, since all presented high granulometry and a high WAI. The seed that stood out the most was niger seed, with high total fat, PUFA, sugars, tocopherols, and phenolic compounds contents; as also low IC_{50} and MIC values (hydroethanolic extracts) for inhibition of lipid peroxidation and antimicrobial activity, respectively. Niger and millet presented outstanding results as antifungal, with MIC values lower than the positive controls used (E211 and E224). None of the samples presented hepatotoxicity. Finally, the most similar breads in terms of texture, specific volume, and color to the control bread (100% wheat) were the ones prepared with partial replacement with millet and birdseed. Considering their nutritional, chemical, and bioactive profile, the use of these seeds is highly advisable in the context of a fortified diet, with beneficial health effects for the consumer. In addition, all proved to have a great potential to be a new trend in the bakery industry.

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FIG (*FICUS CARICA* L.) BIORESIDUES AS SOURCES OF BIOACTIVE COMPOUNDS AND NATURAL PIGMENTS FOR THE FOOD INDUSTRY

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The 17 goals of sustainable development address several topics, such as: (2) Zero hunger and sustainable agriculture; (9) Industry, Innovation, and Infrastructure; (12) Responsible consumption and production; that are essential for the promotion of the circular economy, product development and conscious production [1]. Fig is a food matrix, cultivated in Portugal and valued by the Portuguese people for consumption in natura, being also used in wines, liqueurs, and jams. As this fruit is very appreciated and consumed, it´s cultivation leads to the production of tons of leaves, usually discarded [2].

Therefore, in the present work, the leaves of five fig varieties (Figure 1), namely Dauphine (Da), Longue d'Aout (La), Pasteliere (Pa), Marseille (Ma) and Bourjassote Noire (Bn), were nutritionally and chemically characterized to detect possible bioactive molecules. The antioxidant and antimicrobial, activities were also analyzed, to provide the food industry with natural additives in alternative to the artificial ones; and at the same time, promote the circular economy.

Regarding the nutritional profile of the five leaves, La sample exhibited the highest amount in proteins (18.0±0.6 g/100g dw), while Pa revealed the highest content in fats (2.2±0.1 g/100g dw). The highest moisture content was presented by Da leaves (17.3±0.1 g/100g fw), and for the ashes, La sample was the one that presented the highest value (14.18±0.06 g/100g fw).

Concerning the organic acids, these molecules were most abundant in Ma leaves, where it was possible to identify oxalic, malic and citric acids with a total of 139.6±0.4 mg/g dw. For the soluble sugars profiling, in all samples it was possible to identify five sugars, namely, fructose, glucose, sucrose, trehalose, and raffinose in different concentrations; however, Da leaves revealed the higher amount (17±1 g/100g dw). Tocopherols where also analyzed, and in all samples, three of the four isoforms where detected, being Pa sample standing for the predominance of these compounds (4.14±0.05 mg/100 g dw).

For the bioactive analysis, different assays were performed, and Pa sample showed the strongest antioxidant potential for the TBARS assay, with an EC_{50} value of 105±5 mg/mL. For the antimicrobial activity assay, Da leaf extract was the one displaying the best results, by presenting Minimum Inhibitory Concentrations (MIC) ranging from 1.25 to 10 mg/mL against the tested bacterial strains. On the other hand, for the antifungal activity, the samples present very similar profiles, with the exception of the Pa sample, that present the lowest MIC of 5 mg/mL for *Aspergillus fumigatus*.

In general, these leaf extracts can be used in the food industry namely in pastry and bakery products as promising sources of bioactive compounds, and at the same time, this reuse of biowaste promotes circular economy, and reduces the impact of bio-waste resulting from the fig industry, thus meeting some of the goals of sustainable development.

Dauphine | Longue d'Aout | Pasteliere | Marseille | Bourjassote Noire

Figure 1: Fig leaves from the five analyzed species.

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RISK/BENEFITS OF NEW INGREDIENTS ADDED TO NOVEL CEREAL-BASED FORMULATIONS

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The cereal-based food formulations has evolved in the last decades with the inclusion of alternative cereals, pseudocereals and other ingredients in traditional recipes, which allows current consumers' needs to be met. The incorporation of ingredients such as seeds, legume flours or different type of sugars in the innovative formulation of biscuits may be particularly desirable from a nutritional and healthy point of view. However, the dough composition, low moisture and thermal treatment applied during baking can promote the formation of chemical process contaminants, such as acrylamide, which is classified as "probably carcinogenic for humans" [1]. The effect of addition of chia seeds, carob flour and coconut sugar on the nutritional and bioactive properties and the formation of acrylamide in wheat flour-based biscuits was investigated. Different biscuits were formulated replacing wheat flour by chia seeds (percentages in the final weight: 5, 10 and 15%) and carob flour (percentages in the final weight: 1, 5 and 10%) and white sugar by coconut sugar. Biscuit were prepared under controlled conditions and baked for 23 minutes at 180 ºC. Nutritional composition (AOAC methods), in vitro bioactivity (antioxidant capacity (TBARs), antibacterial and antifungal activity) and acrylamide content (HPLC-ESI-MS/MS) were determined in both ingredients and biscuits. Results were statistically analyzed using SPSS version 26 (SPSS, Chicago, IL, USA) assuming a level of significance of $p < 0.05$. Higher percentages of chia seeds, carob flour and coconut sugar in the formula exhibited similar antibacterial and antifungal activity to the control biscuit (100% wheat flour, 100% white sugar) but increased the antioxidant capacity, protein, fiber and, in the case of chia seeds, the polyunsaturated fatty acids content, then resulting in a nutritionally enhanced product. However, levels of acrylamide were also increased, from 113 to 236 µg/kg, when chia seeds were added in a range of 5-15% of the total weight and reaching values up to 351 µg/kg when carob flour was incorporated in a 10% or even to 1030 µg/kg when biscuit containing 10% carob flour were also formulated with coconut sugar. In these cases, acrylamide concentrations exceeded the benchmark levels (350 µg/kg) established for biscuits in the European Regulation 2158/2017 [2]. This study suggests that the reformulation of traditional recipes with innovative ingredients should be carefully considered, not only looking for nutritionally improved recipes but also taking into account possible changes in the toxicological aspects. To this end, it should be recommended to include a risk/benefit evaluation of the control of process contaminants when designing novel biscuit formulas.

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MICROALGAE AS A VALUABLE INGREDIENT FOR BREAD ENRICHMENT: INFLUENCE ON THE DOUGH RHEOLOGY AND BREAD MAKING PERFORMANCE

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Over the last years, our research group has been extensively working to develop innovative healthy foods prepared from microalgae biomass, rich in proteins, polyunsaturated fatty acids, fibre, minerals, vitamins, pigments, and other bioactive compounds with antioxidant effect and other beneficial properties. More than ever, the enrichment of food products with microalgae is a market trend, due to the sustainability of their production and remarkable positive impact on health. A strategy to avoid the hassled of changing food habits was used adding the microalgae to staple and traditional foods, like bread [1-5], largely consumed on daily basis on different European diets and worldwide.

Besides nutritional purposes, introducing microalgae ingredients in dough systems, impart significant changes in its rheology properties. This effect depends on the physicochemical characteristics of the microalgal biomass and the incorporation level. To evaluate the impact of microalgae addition on the rheology of wheat and gluten-free flour doughs, both empirical and fundamental methods have been used. In bakery, the empirical rheology methods are especially prominent to study the influence of flour constituents, and other ingredients, on dough behaviour, and are commonly used by the industry. Dough mixing tests were performed using Farinograph or Micro-doughLab equipment, to determine the water absorptions of different formulations and evaluate empirical rheology parameters related to mixing tolerances. Biaxial extension was applied by the Alveograph to simulate fermentation during the wheat baking process. Doughs were also characterized in a Texturometer using penetration and extensibility tests. Fundamental small amplitude oscillatory shear (SAOS) measurements and creep tests were evaluated as well, in a controlled-stress Rheometer. The obtained results from these different types of tests are discussed and compared to estimate dough performance during processing and future bread properties. The technological aptitude of the breads was accessed based on loaf volume, texture and colour.

This work is part of the Algae2Future project that intends to explore microalgae potential to be low-carbon footprint healthy ingredients for future foods. It aims to increase nutritional quality of bread by addition of microalgae biomass, while maintaining the mechanical behaviour and a high sensorial quality. The obtained results from the rheology types of tests will be discussed and compared to estimate dough performance during processing and future bread properties. The approach used for studying gluten-free doughs need to be adapted since most of the equipment were designed cconsidering the wheat bread as a reference and, in some cases, the reference values established for wheat cannot be applied when gluten-free formulations are developed and characterized.

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PSYLLIUM: A NATURAL BAKERY IMPROVER .

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Psyllium is a natural product with high water absorption capacity and properties similar to xanthan gum [1]. It has been shown to be effective in reducing cholesterol, the risk of cardiovascular disease and constipation [2, 3]. Because of its water absorption and thickening effect, it can also be a natural food improver. Despite the clear nutritional benefits of whole grain products, consumption is lower than recommended, mainly due to low consumer acceptance. This paper proposes the use of psyllium to improve the quality of breads elaborated with white wheat flour and wholemeal flour. To test the effect of psyllium, breads were made with 1, 2, 5 and 10% of psyllium (replacing flour) and compared with the control white wheat flour and wholemeal flour respectively. Mixolab was used to analyse dough behaviour. The breads produced were analysed for specific volume, width/height ratio (out-of-mould), weight loss, colour and texture. Microstructure were analysed in white breads (imageJ and microscopy) and macronutrient composition, and bread acceptability were also analysed in wholemeal breads. Psyllium incorporation increased absorption by 76% in white flour and 67% in wholemeal flour when 10% psyllium is incorporated. Increased tolerance in kneading but shorter kneading time was observed in both white and wholemeal flours. It also reduced dough consistency after starch gelatinisation. Specific volume and weight loss were not affected, despite the higher hydration level of the doughs. The psyllium breads retained their rounded shape better than the control when they come out of the mould. The addition of psyllium reduced bread hardness and increased its cohesiveness and resilience, thus lowering staling in white and wholemeal breads. Regarding bread colour, no significant differences in crust colour were detected in either white breads or wholemeal breads. In terms of crumb colour, no significant differences were found for wholemeal breads but in white breads the incorporation of psyllium reduced the values of a* and b* moderately. Microscopy images of white breads showed that, as the concentration of psyllium increased, the crusts and crumbs become more and more protruding and rough compared to the control. The addition of psyllium also reduced the calorie content of the wholemeal breads, achieving a reduction of 20.4% in the case of breads with 10% psyllium, due to increased moisture and fibre content. Moreover, the addition of up to 5% psyllium, clearly improved the acceptability of wholemeal breads. The use of psyllium can improve the organoleptic and nutritional quality of wholemeal breads, improving their acceptability by consumers. Psyllium can function as a natural improver in baking.

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MINERAL AND PROXIMATE COMPOSITION OF COMMERCIAL PLANT-BASED FLOURS.

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Non-traditional flours products attract a big interest of researchers and the food industry [1]. This growing interest is linked to consumer concerns about environmental sustainability and food safety, which has led to a. numerous investigations focused on finding new protein sources. While facing climate change and natural resource scarcity, ensuring sufficient, nutritious, safe and affordable food to a fast-growing world population with changing dietary habits becomes increasingly challenging. Protein supply is, in this context, one of the most critical issues. The integration of alternative protein sources from vegetal origin such as pulses and cereals into new and/or existing processes or products needs to be explored, in order to develop and ensure more sustainable and resilient supply chains. On the one hand, these kinds of products are suitable to meet the need for gluten-free formulations [2] for the population suffering from coeliac disease [3] and also to prevent other disorders such as irritable bowel syndrome (IBS) and Diabetes [4]. On the other hand, these flours can be used to improve textural properties of foods and/or improve their nutritional composition. This type of flours provides high levels of good quality protein and dietary fiber [5]. In this research, the mineral composition (Na, Mg, P, Ca, Mn, Fe, Cu, Zn), heavy metals content (Ni, Cr, Se, Cd, Pb) and proximate composition (Ash, moisture, proteins, carbohydrates, energy, fiber, fat and starch) of ten commercial vegetable flours were analyzed. Among the flours studied were chickpea, rice, pea, soya and hemp. For all the element analyzed, statistically significant differences were observed between the ten commercial flours for each parameter. Soybean and hemp flours had the highest content of proteins, ash, fat, fiber, and energy. Moisture content varied significantly by the type of flour. Total ash content was significantly higher for hemp flours compared to rice flour. Fat content varied significantly, with soybean flour having the highest fat content followed by hemp flour, while rice flour had the lowest content. All flours analyzed showed high amounts of carbohydrates (> 31.8%), with starch being the most important carbohydrate. The total energy in pea and soybean flours was significantly higher. Regarding mineral and metal contents, all flours had significantly higher content of sodium, magnesium, phosphate, potassium, and calcium followed by a low content of manganese, iron, copper and zinc. Chickpea flour had the highest content of sodium, while hemp flour had the highest content of magnesium and phosphate. Potassium content showed no differences between the different flours. As for the calcium, the lowest concentrations were found in rice flour.

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CEREALS AND PSEUDOCEREALS CONTAMINATED WITH TROPANE ALKALOIDS: ANALYTICAL TOOLS TO ASSURE FOOD SAFETY

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Nowadays, the use of alternative cereals and pseudocereals such as buckwheat, chia, soya and others has increased. These foods have several health benefits, comprising properties as antidiabetic, hypotension, hypocholesterolemic and hypoglycemic effects [1]. Moreover they also contain beneficial compounds as protein, phenolic compounds, starch and dietary fiber [2]. However, the use of this new food sources implies the possible contamination with both human and natural contaminants. Tropane alkaloids (TAs) contamination can be placed in this second scenario. TAs are a large group of more than 200 compounds mainly produced by Solanaceae family plants and characterized to contain the tropane ring. These compounds have strong anticholinergic effects over the central nervous system (CNS) and the autonomic nervous system (ANS) [3]. The European Food Safety Authority (EFSA) has published 2 documents concerning TAs contamination in samples as buckwheat, millet, corn or cereals-based baby foods [3,4]. In addition, the European Union (EU) has set legal limits for atropine and scopolamine in cereal-based baby food (1 µg/kg) [5]. The contamination occurs when cereal grains are harvested together with Solanaceae seeds. The monitoring of TAs in cereals and pseudocereals requires reliable extraction and analytical methods.

In this presentation, different optimized analytical methods are presented. These are QuEChERS and solid liquid extraction (SLE) as extraction methods and ultrahigh performance liquid chromatography coupled to high resolution mass spectrometry (UHPLC-Orbitrap-HRMS) as analytical technique. Fourteen TAs were studied in 28 samples of different cereals (4 samples of each matrix of buckwheat, wheat, soy, amaranth, chia, soy and millet), 6 samples of buckwheat pasta, 15 samples of pap for babies under 1 year, 12 samples of baby biscuits and 4 samples of snacks and grissines. 2 cereals samples contained TAs with concentration 13-23 µg/kg, while 1 baby food sample overcome the EU limits (11.5 µg/kg of atropine).It highlights the requirement of continuous monitoring of these compounds by reliable analytical methods.

Finally, the influence of cooking was evaluated under bread baking and pasta boiling conditions in samples contaminated with Solanaceae seeds (*Datura Stramonium* and *Brugmansia Arborea*), unravelling the degradation routes for the 14 TAs under each condition.

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OPTIMISATION OF HYDROCOLLOIDS DOSES IN GLUTEN-FREE BREAD MADE OF FLAXSEED AND RED LENTILS FLOUR BLEND

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While there are many flours and additives known to have thickening, gelling and functional properties for breadmaking, the development of good quality gluten-free bread is still a technological challenge. The objective of this study was to optimise the doses of hydrocolloids – xanthan gum (XG) and hydroxypropyl methyl cellulose (HPMC) – in the elaboration of gluten-free bread formulated with a blend of chick pea and red lentils flour. Gluten-free breads were elaborated using a mix base of potato starch (40%), rice flour (30%), red lentils flour (15%) and flaxseed flour (15%). Using a fractional factorial design, 18 batches of bread were produced with water varying between 90% to 120%, XG between 0.14% to 2.36%, and HPMC between 2.0% to 4.8%. Technological properties were measured on batter (i.e., firmness, consistency) and bread (i.e., specific volume, yield, crumb hardness, chewiness, and crumb grain porosity image analysis features). A response surface analysis model was performed to each of the properties measured. Batter firmness and consistency decreased with higher water levels ($p<0.001$), and increased with HPMC to more extent than with XG ($p<0.001$), although there was a synergetic effect ($p<0.001$).

Increments in XG produced bread of harder crumb ($p=0.050$), unless increased water levels are added to counteract the effect and produce softer crumbs ($p<0.001$). Water presented a positive interaction effect with both HPMC ($p<0.001$) and XG ($p<0.001$) in increasing the specific volume of loaves, whereas higher doses of XG alone produced breads of lower volume ($p=0.020$). Furthermore, higher doses of hydrocolloids decreased ($p<0.001$) the crumb springiness of this composite bread. As shown in **Figure 1**, the cell size uniformity was affected by the three factors. Higher levels of water ($p<0.001$) and in interaction with HPMC ($p=0.008$) produced bread of lower cell size uniformity, this is, very large alveoli. Overall, gluten-free bread produced with a 30% blend of flaxseeds and red lentils flour attained good technological properties when formulated with 110-120% water, 3.0 – 3.5% HPMC and 0.5 – 1.0% XG.

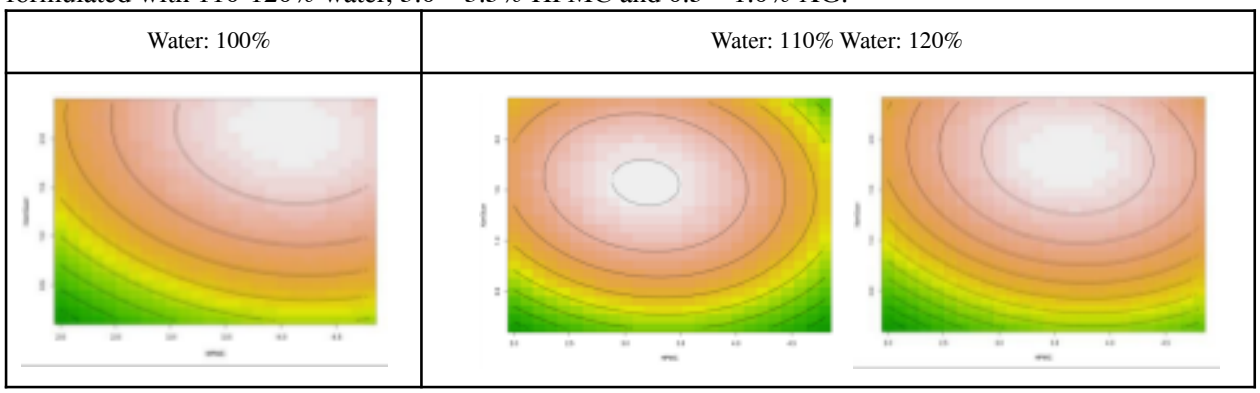

Figure 1: Response surface contour plots showing the effects of HPMC (x-axis), XG (y-axis) and water on bread cell size uniformity

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A BREAKTHROUGH ON BREAD FORMULATION: NATURAL MINERAL WATER AS A NOVEL FUNCTIONAL INGREDIENT

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The food industry has a significant impact on global economy. The development of new products and food ingredients that improve the nutritional, functional, and organoleptic properties play a critical role in the discovery of higher-quality products. Bread is one of the most common foods found in most people's daily diets. Water plays a crucial role in its preparation, since it hydrates the flour, amide, and proteins. In this way, natural mineral waters (thermal and carbonated) are rich in trace elements, presenting great potential in the development of new enriched products[1,2]. The main purpose of this study was to create bread, biju, and chapata formulations that used natural mineral water instead of regular water to better understand the impact of different liquids on the physicochemical properties and centesimal composition of bread (thermal and carbonated). After cooking, parameters such as carbohydrates, ash, fat, protein, salt content, pH, water activity, minerals and fatty acids were determined. With regards to the centesimal composition, the carbonated and thermal biju breads showed significant increase in the energy value when compared to normal bread. Although the chapata thermal bread had the highest protein and salt content, the energy value remained unchanged. Noteworthy, analyzing the fatty acid profile for the thermal biju bread there was a significant decrease in the PUFA content. Considering the chapata bread (carbonated and thermal) highest contents of mainly SFA and MUFA were found. When comparing normal bread with carbonated and thermal chapata breads in pH parameter, these breads showed the highest values, while the water activity increased in the carbonated and thermal biju bread. Finally, a highest total mineral content, was observed in the carbonated and thermal biju bread. Overall, the results suggest that thermal and carbonated waters could be useful ingredients in the development of novel functional products.

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HYDROETHANOLIC EXTRACT OF *OCIMUM BASILICUM* 'CINNAMON' AS A NATURAL PRESERVATIVE FOR THE FOOD INDUSTRY

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Ocimum basilicum 'Cinnamon' is an aromatic and medicinal herb belonging to the *Lamiaceae* family [1]. Cinnamon basil, as it is popularly known, has aroused the interest of the scientific community for presenting significant concentrations of phenolic compounds [2]. Due to the increasing concern that consumers have towards artificial additives, an intensification in the demand for safer and natural preservatives has been observed [3]. In this sense, the present work aimed to identify the phenolic profile of *O. basilicum* 'Cinnamon' hydroethanolic extract (80:20, *v/v*) (EOBC) and to study its bioactive properties. The phenolic composition of the extract was evaluated by a chromatographic method: HPLC-DAD-ESI/MS. Seven distinct compounds were identified, including three phenolic acids (hydroxycinnamic acids) and four flavonoids that corresponded to quercetin derivatives. Regarding the bioactive properties, the antioxidant activity was tested by three *in vitro* assays: oxidative hemolysis inhibition (OxHLIA), reducing power, and free radical scavenging capacity (DPPH); the cytotoxicity was assessed in human tumor cells (MCF-7, breast carcinoma; NCI-H460, lung cancer; and AGS, gastric carcinoma) and in non-tumor cells (PLP2 and Vero) by the sulforhodamine B method; the antimicrobial activity was evaluated against a panel of twelve food pathogens by the microdilution method, where the maximum bactericidal (MBC) and fungicidal (MFC) concentration values were determined. The results showed a great antioxidant activity, with EC_{50} values of 0.054 ± 0.002 mg/mL (DPPH), 0.079 ± 0.001 mg/mL (reducing power), and 21.4±0.6 µg/mL (OxHLIA). A remarkable activity against AGS carcinoma (GI_{50} = 48 ± 3 µg /mL) was also observed. The absence of toxicity of the extract was confirmed up to the maximum concentration studied (>400 µg/mL). In biological terms, EOBC extract showed antimicrobial performance in the ranges of 2-4 mg/mL (CMB) and 1-2 mg/mL (CMF) against all tested strains.

In conclusion, it can be observed that *O. basilicum* 'Cinnamon' represents a valuable natural antioxidant and can also be considered a functional ingredient to be introduced into products of the bakery and pastry sector.

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THE POTENTIAL OF AROMATIC EXTRACTS TO ENHANCE THE SENSORY PERCEPTION OF BREAD

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Aromas are widely recognized for influencing human stimulation, mood and, consequently, choices and decisions [1]. This work aims to study the extracts of *Rosmarinus of icinalis* L. leaves and *Prunus dulcis* (Mill.) D. A. Webb fruits as food ingredients.

The extracts were obtained by SFE-CO_2technology. Three sample groups were prepared: i) bread containing rosemary extract (40 µL/Kg of bread) ii) bread containing almond extract (10 µL/Kg of bread), and iii) bread without any functionalizing element (control sample). The samples were cooked in industrial ovens and the perception of the cooked products was evaluated by acceptability tests. The nutritional profile (protein, ash, fat, carbohydrate and energy content) was determined using official methodologies for the analysis of food products (AOAC). The chemical profile was evaluated, determining free sugars by HPLC-RI, fatty acids by GC-FID, and the most abundant terpene molecules (*D*-limonene and eucalyptol) by HS SPME-GC-MS.

The results showed a very similar nutritional profile in all tested samples. The moisture presented values of 40%, the protein content varied between 6.4 and 6.8 g/100g fresh weight (fw), the amount of ash was about 1 g/100g fw, and the lipid content was on average 0.15 g/100g fw. Considering the fiber concentration, the values ranging between 3 and 4%, being higher in the control sample. In chemical composition, fructose, glucose and maltose were detected in sugar profile, and in fatty acids composition the polyunsaturated fatty acids were the most abundant in all cases. Regarding the terpene composition of bread crust and crumb samples, the aroma molecules of *P. dulcis* fruit were manly detected in the crumb samples, with this behavior persisting over the time. Moreover, *R. of icinalis* molecules were firstly detected (*t0*) in the bread crust, but after 4 hours (*t4*), they were identified in crumbs. The inclusion of extracts improved consumer assessment of the visual appearance, texture and overall acceptability of the breads.

In conclusion, this work emphasizes the importance of studying natural aromas as food ingredients to improve the sensory perception of bread, maintaining their nutritional profile. It also represents as a steppingstone for a new generation of foods under the olfactive marketing concept, validated in an industrial context.

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DAIRY GLUTEN-FREE BREAD: TECHNOLOGICAL, NUTRITIONALAND FUNCTIONAL ENHANCEMENT BY CURD CHEESE SUPPLEMENTATION

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During the last few years, considerable advances in research have been taken to overcome the technological challenge of gluten-free goods manufacturing. Nevertheless, nutritional value and health-promoting benefits must not be forgotten and should be kept as a top priority to improve the celiac consumer´s daily diet. Dairy products are natural and functional products and interesting protein-rich sources, which can perhaps be considered as a promising bakery ingredient to improve both, gluten-free bread (GFB) manufacturing and nutritional value.

In the present work, different levels of Cc addition (5% up to 20% w/w) were used to supplement the GFB formulas, and the impact on dough rheology properties was well correlated to the bread technological and nutritional parameters obtained.

Linear correlations (R^2> 0.95) between steady shear (viscosity) and oscillatory (elastic and viscous moduli) values of the dough rheology with bread quality parameters (volume and firmness), were obtained, suggesting that the bread quality improvements are proportional to the levels of Cc added. Likewise, a strong linear correlation (R^2> 0.91) between pasting properties parameter, starch fractions digestibility, and bread glycemic index, support the hypothesis that the Cc is a potential bakery-ingredient to generate a functional bread.

In short, the obtained results confirmed that the Cc addition led to a significant improvement in GFB quality, increasing the bread volume and crumb softness while reducing staling rate during the storage time. Nutritionally, the generated bread is liable to offer a good nutritional and functional contribution, in terms of proteins and minerals, and lower glycemic response, which can constitute an advantage to improve the daily diet of celiac people.

Figure 1: Comparation of the resulted breads obtained for control bread (CB) and those breads obtained by different additions of curd cheese (CcB): CcB5% up to CcB20.

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Novel technologies, processes, and products

ELECTRIC FIELDS - A PROMISING TECHNOLOGY TOWARDS SUSTAINABLE PROCESSING OF GRAIN-BASED FOODS

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During the last decade, a growing body of knowledge has been established about the use of Electric Fields (EF) technology as a sustainable processing tool in food biotechnology. EF treatment is based on the principle that biological matrices can work as conductors of electricity when submitted to a voltage difference. Depending on the way how EF treatment is designed, a myriad of physical-chemical events can be promoted and *in-situ* controlled, allowing the change of functional aspects of solvent media, structure of biomolecules and biomass, and tunning biological activity of microorganisms and enzymes. These events include for example reversible/irreversible permeabilization of cellular membranes (known as electroporation) and generation of direct and volumetric heat with high levels of efficiency (> 98 %) through ohmic heating (OH). This synergy between thermal and electrical effects is a game-changer in the conventional (bio)processing pathways allowing to enhance thermal and extraction processes towards recovery of molecules or fractions of interest in plant or fruit based materials, such as potatoes, grape pomace among others [1,2]. Recently, the use of OH effect allowed to recover extracts with a diversity of phenolic compounds (e.g., 4-hydroxybenzoic and ferulic acids) with antioxidant activity from beer spent grains [3]. Further, OH can be used to tune the functional properties of proteins and reduce their potential allergenicity [4], which may be determinant to boost the application of grain-based proteins as an alternative source to animal proteins. EF is considered an environmental-friendly technology, offering potential to reduce energy inputs and water consumption once it can generates heat within a given material thus avoiding limitations of conventional heat transfer mechanisms [5]. EF envisages a sustainable route for an efficient production of food-based ingredients and recovery of value added-products, but its potential of application in grain-based foods still in its infancy.

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EXTRUDED FORMULATIONS BASED ON RICE AND CHICKPEA: DIETARY FIBER AND OLIGOSACCHARIDES

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Extrusion is a technological process widely used by the food industry for the development of a large range of food products. The use of cereals and pulses such as ingredients, allows to obtain extruded value-added products, with functional properties, interesting nutritional value, and suitable organoleptic characteristics [1-3]. In this sense, is interesting to deep in the study of the extrusion effect on important bioactive compounds such as dietary fiber and oligosaccharides, which are associated with beneficial health effects. [3-5]. Therefore, the aim of this study was to evaluate the extrusion effect on dietary fiber and α-galactosides content in different formulations based on rice-chickpea flours, enriched with Fibersol® and passion fruit. The content of total (TDF), soluble (SDF) and insoluble (IDF) dietary fiber was analyzed according to AOAC enzymatic–gravimetric methods 993.19 and 991.42.17 [6]. HPLC was used to determine the α galactosides content [4].

In analyzed samples, extrusion treatment caused a significant increase ($p < 0.05$) in SDF. This increase also resulted in higher TDF content in extruded samples. However, the extrusion effect on IDF content did not follow a consistent pattern. These results were in accordance with those previously obtained by other authors [1,2,5]. In the formulations under study, raffinose was the main α-galactoside followed by stachyose. In general, the content of these compounds was higher in extruded samples, compared to their respective raw counterparts. This effect could be explained because of extrusion make modifications in cell walls, which may increase the extractability of α-galactosides from the extrudate matrix [4].

The obtained results showed that extrusion is an interesting technological treatment that affect positively the content of important bioactive compounds, such as dietary fiber and α-galactosides-type oligossacharides, in formulations based on rice and chickpea.

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BREAD FREEZING AS A NEW ALTERNATIVE TO CONSUMPTION

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The growing consumer interest in health and food safety, as well as the increased consumption of fresh food, make frozen bread an increasingly popular alternative. This type of bread has several advantages, such as, large-scale manufacturing, economize manpower and equipment, and lowering production costs. Furthermore, one of the ways to extend shelf-life of ready-to-eat bread is to use deep freezing systems [1–3]. In the present study, the effect of frozen storage time on the bread quality made from frozen dough, were studied, through the nutritional and chemical composition evaluation. Six equal multicereal breads were frozen, submitted to different storage times under deep freezing (190, 225, 251, 310, 344 and 694 days), and compared to the fresh multicereal bread. The nutritional profile was evaluated through the protein, ash, fat, and carbohydrate content, using official analysis methodologies (AOAC) and the energetic value was also estimated. The chemical composition regarding sugars and fatty were determined by chromatographic techniques, using a HPLC- RI and a GC-FID, respectively.

In general, the results revealed that moister content is similar in all frozen breads, with values around 40%, while the fresh bread showed a content of 43.4%. The ash content presented values ranging between 1.51 ± 0.02 and 1.02 ± 0.02 g/100 g fresh weight (fw); and the mean value of the protein content in the samples was approximately 7 g/100 g fw. On the other hand, fiber showed values of 4% of total dietary fiber (TDF) fw for breads with longer frozen time, while the bread frozen for less time (190 days) and fresh bread showed values around 6% TDF fw. The fat content was also variable between fresh and frozen breads, however, the presence of polyunsaturated fatty acids (PUFA) in all samples was predominant, namely linoleic acid (C18:2n6c). Regarding the sugars profile, fructose, glucose, and maltose were detected in all bread samples, showing a total sugar value between 1.78 and 2.97 g/100g fw; and as expected, the most abundant sugar was maltose, a common sugar found in cereal. Regarding the carbohydrate evaluation, the obtained results ranged between 40.4 and 43 g/100g fw for frozen breads and 38.3 g/100 g fw for fresh bread; and the energetic value presented values greater than 220 kcal/100g in all samples.

The results obtained show that freezing may be a promising alternative for bread conservation, contributing to the reduction of the high percentage of disposal that happens in all industrialized countries.

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STUDY OF THE TURBO-TECHNOLOGY POTENTIAL IN THE PRODUCTION OF GLUTEN-FREE INGREDIENTS AND POTATO-BASED PASTA

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New market opportunities for pasta producers, especially in the sector of fresh products, are nowadays opening thanks to the consumers' demand for healthier and innovative foods and the increase in dietary restrictions. In grain-based foods, contemporary trends include the quality improvement of pasta for people suffering from celiac disease or other allergic reactions to gluten. However, the absence of gluten represents a challenge for good quality products, mainly in terms of structure [1, 2, 3, 4]. In this context, new technologies able to improve the techno-functionalities of gluten-free (GF) flours and/or to better texturize GF pasta products are very important for food industries. The turbo-technology patented by VOMM® Impianti e Processi S.p.A. (Rozzano, Italy) is a treatment combining heat and shear that can be used for modifying technological properties of different types of flours and for potato-based pasta production. This technology, thanks to a specially designed turbine and a centrifuge, guarantees a rapid and uniform treatment of the product by creating strong turbulence in a thin layer of material in contact with a heated surface [5]. For flour treatment, a turbo-cooker and a turbo-dryer are installed in a cascade-configuration, whereas for pasta only the turbo-cooker is needed.

This work aims at presenting the results of systematic studies focused on the evaluation of the turbo technology performances in modifying the technological properties of rice flour and in the production of GF potato-based pasta (i.e., gnocchi). The case study of rice flour considered turbo-cooking temperature (120-200 °C), added water (30-40%), and turbo-drying temperature (160-200 °C) as experimental factors. As for GF gnocchi, besides the turbo-cooking temperature (85 and 93 °C), also formulation changes were considered (i.e., corn flour, rice flour, and dried potato ratios; amount of water) [3]. The most important factor in modifying rice flour techno-functionality was the added water, significantly ($p < 0.001$) affecting all the treated flour characteristics (i.e., moisture, damaged starch, pasting properties, and cold viscosities). A pre-wetting of flour (40% water), followed by turbo-treatment at 200 °C resulted in high damaged starch values (49.5 ± 1.5 g/100 g db) and high levels of cold viscosities (from 6213 to 21436 cP), thus providing rice flour with improved technological properties, suitable for GF food production. As for GF gnocchi production, quality descriptors (i.e., gnocchi cooking behaviour and texture) very similar to those of conventional gnocchi containing wheat flour were obtained by applying the turbo-technology, especially at the highest temperature. However, the amount of water added in the formulation and the ratio between corn and rice flour proved to be the critical parameters as well [3].

Based on the results of these studies, the turbo-technology can be considered a valuable tool for different applications intended to develop new ingredients and/or products with tailored properties.

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APPLICATION OF SHORT-TIME HIGH HYDROSTATIC PRESSURE TREATMENTS TO WHOLE BUCKWHEAT GRAINS TO MODULATE THE FUNCTIONAL PROPERTIES OF THE RESULTING FLOURS.

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The consumer interest in high-quality additive-free food has led the industry to explore novel food processing techniques. Among them, high hydrostatic pressure treatment (HHP), has attracted the attention of food technologists as it can modify the functional properties of proteins and promote starch gelatinization [1]. HHP is also of interest as an environmentally friendly technology with minimal effects on the organoleptic and nutritional properties of foods.

Studies on cereal products generally focus on HHP treatments in batters or starch/protein isolate dispersions. However, scarce information is available in the literature on the effects on whole grains. In this study, buckwheat grains, a gluten-free and nutritious plant material, are used to evaluate the effect of HHP treatments. As the changes promoted by HHP are pressure and time-dependent, this study explored the effects of short-time HHP treatments to modulate the techno-functional properties of the resulting flours. Therefore, the treatment times were 0 (the pressure was released once the pressure level was reached) and 5 min, with 300 and 600 MPa of pressure levels.

Pressure significantly influenced the water absorption capacity (WAC) of resulting flours. Regardless of the treatment time, samples treated at 300 MPa showed lower WAC values compared to an untreated control sample. Conversely, those treated at 600 showed significantly higher values. Pressure and time significantly affected the emulsion activity (EA) of the samples. A significant decrease in EA was observed with the sample treated at 600 MPa for 5 min. Moreover, a significant loss of foaming capacity was observed for samples treated at 600 MPa irrespective of the treatment time or for those treated at 300 MPa for 5 min. Pressure and time also significantly influenced the pasting profiles of the flours. Samples treated with the lowest treatment time had higher peak and final viscosities. Increasing treatment time and pressure level resulted in lower breakdown viscosities. In turn, the gel consistency of samples showed a decrease with increasing treatment time and pressure level.

Results presented in this work proved short-time HHP treatments are promising tools for obtaining flours with tailor-made functional properties and could facilitate the industrial application of this technology.

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PHYSICAL MODIFICATION OF RICE FLOUR VIA ULTRASONICATION INFLUENCE OF TREATMENT TIME AND TEMPERATURE

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Over the last decade, the gluten-free market has grown considerable due to better diagnostic methods identifying an increasing number of people suffering from coeliac disease and other gluten-related disorders, and people removing gluten from their diets for considering it a "healthy improve" [1]. Native gluten-free flours have a limited range of industrial applicability given that their natural characteristics limit their functionality. To overcome this challenge modifications are applied to alter their physicochemical properties, where physical modifications are better perceived for being an environment friendly technology that does not require the use of chemicals [2]. Ultrasounds (US) have been used in recent years in the food industry to physically modify starches and flours. These treatments are applied in a liquid-solid system to generate a homogeneous impact in the treated source by the action of acoustic cavitation [3]. There are many variables involved in US treatments, such as frequency, power, pulse, temperature and time of treatment, as well as botanical origin of the treated matter and its concentration in the liquid dispersion. All these variables are involved in the extent of modification achieved by treatments, making it necessary to evaluate the influence that they have in determining the final properties of the treated matter.

The main objective of this study was to modify rice flour using US treatments at different time and temperature, leaving the rest of the variables constant. The treatments were carried out using a Hielscher UP400St ultrasound equipment (Hielscher Ultrasonics, Germany) equipped with a 22mm titanium sonotrode (S24d22D) at a frequency of 24 kHz and a pulse of 80% (on-off), applied on rice flour dispersions of 10% w/w. The effect of US treatments was evaluated in morphological changes, crystallinity by X-ray diffraction, thermal and pasting properties of the flours and rheological properties of the gels made with them. US treatments led to a significant reduction of particle size, showing a greater reduction with longer US exposure when varying time, while lower temperatures showed a more marked reduction. X-ray diffraction and thermal properties indicated that treatments led to an improved crystalline structure arrangement within the starch granules, particularly remarkable when applying increasing temperature, causing a narrowing of the gelatinization temperature range. Pasting profiles were reduced and the pasting temperatures were significantly increased in all studied treatments. Ultrasound treated flours led to gels higher strength, obtaining lower values of tan(δ) with increasing sonication time, and at all studied temperatures.

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IMPROVING THE NUTRITIONAL VALUE OF COLD-PRESSED OILSEED CAKES THROUGH EXTRUSION COOKING

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Oilseed plants are the largest source of edible oils with a world oilseed production of 628.03 million metric tons in 2020/2021. The edible oil industry generates a significant amount of protein-rich oilseed cakes and they represent a good alternative plant protein source to cover the increasing demand of protein foods. Soybean, rapeseed/canola, and sunflower, the most produced oilseeds, contain meaningful amounts of antinutritional polyphenols that limit their potential to be used for human and animal consumption. The objective of this study was to remove polyphenols without compromising the nutritional and technological quality of the protein fraction, using pilot-scale twin-screw extrusion. Extrusion significantly increased the ratio of soluble to insoluble dietary fiber from 0.45 to 0.58 in canola and from 0.19 to 0.31 in sunflower, whereas the opposite was found in soybean (0.52 to 0.36). Canola (67.7 mg GAE/g) and sunflower (58.9 mg GAE/g) exhibited large quantities of polyphenols, which mostly consisted of sinapic and chlorogenic acid derivatives, respectively. Extrusion increased the proportion of free polyphenols and did not significantly reduce the amount of sinapic acid derivatives in canola; however, it decreased the content of free polyphenols in sunflower by 68 %. Generally, the extrusion conditions shown in this study resulted in limited protein denaturation and aggregation and a moderate decrease in β-sheet structures (up to 59%), which led to similar liquid holding capacity and enhanced protein solubility. Gastric protein hydrolysis of extruded soybean cake was increased, but it negligibly affected that of canola and sunflower possibly due to the formation of indigestible quinone-protein adducts. Overall, extrusion is a promising technology to reduce meaningfully polyphenols in certain oilseed cakes while retaining or improving their protein quality (**Figure 1**).

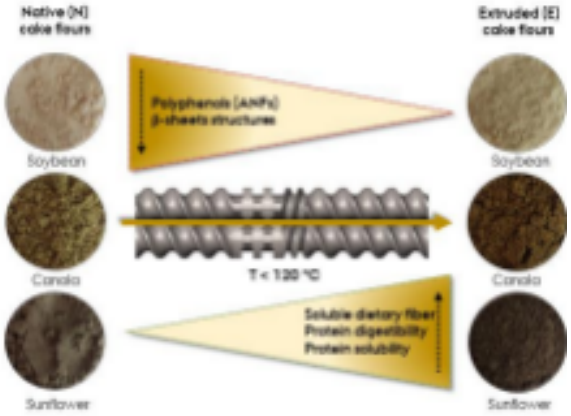

Figure 1: Summary of the results obtained in the present study.

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Enrichment of fresh egg pasta with antioxidant extracts obtained from wild Italian *Plantago coronopus* L. and *Chicorium intybus* L. and quality characterisation of the fresh end product

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Consumers are increasingly aware of the strong relationship between diet and health status and, for this reason, they have changed food preferences and have increasingly oriented towards functional foods. Indeed, functional foods represent new "enhanced" foods with healing-pharmaceutical characteristics. These plants leaves are used salad ingredients in France and Italy and are well known for being rich in phenolic compounds with antioxidant properties (Saybel, Rendyuk, Dargaeva, et al., 2020). The great interest in phenolics as food ingredients is that they are used as anti-diabetic, antioxidant, antibacterial, anti inflammatory, diuretic, digestive, and protector of other different diseases (Pereira, Custódio, Rodrigues, et al., 2017). Therefore, this work aimed to apply a functional ingredient obtained from wild edible plants in pasta food product. Bioactive compounds and nutraceutical qualities (radical scavenging activity, inhibition of lipid peroxidation and antihaemolytic activity) were evaluated. A pasta-making procedure was performed using different *P. coronopus* and *C. intybus* extract concentrations and different drying times to research the pasta-making procedure's optimisation. The phenolic compounds were identified and quantified by LC DAD-ESI/MS^n, with results expressed in mg/g extract. According to the obtained results, twenty-six phenolic compounds were identified. Cichoric acid (36 ± 2 mg/g) was the most abundant in *C. intybus*, followed by 5-*O*-caffeoylquinic acid (14.1 ± 0.1 mg/g), while in *P. coronopus,* verbascoside (151 ± 6 mg/g) was the most abundant compound. Flavonoid rearranged with different glycosidic molecules were found in the enriched pasta, i.e., apigenin-*O*-glucuronide, kaempferol-*O*-malonyl-hexoside, and kaempferol-*O* glucuronide. A strong interaction between the plant extract concentration and the drying time was demonstrated. These results indicated that plant extracts could be used as a functional food ingrediente due to the significant antioxidant capacity and phenolic profile preserved after the incorporation process in typical pasta. Relevant factors have already been established, given that implementation of an experimental design provides more expansive knowledge.

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NEW INGREDIENTS IN THE PREPARATION OF COOKIES TO MITIGATE ACRYLAMIDE CONTENT

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Acrylamide (AA), as a food contaminant, is commonly found in heat-processed foods (>120ºC), such as potato chips, French fries, and cookies. The formation of AA in heat-processed foods has been attributed to the Maillard reaction that involves the formation of Schiff bases between asparagine (Asn) and reducing sugars, followed by introducing or without introducing an oxazolidin-5-one intermediate [1]. The toxicological effects of AA on humans are neurotoxicity, genotoxicity, carcinogenicity, and reproductive toxicity, leading to its classification as a Group 2A carcinogen by the International Agency for Research on Cancer [2]. Mitigate and control of AA formation in foods [3] and establish reference levels for the reduction of the presence of AA in coffee, potatoes, and bakery products [4] is needed for food industry reach the lowest possible level below the reference one. Concerning the category "cookies and wafers", the AA benchmark value is 350 µg/kg. Cookies are included in the foods that must be monitored to identify the AA risk and adopt new reduction measures against this contaminant [5]. The aim of this work is the search for ingredients that can reduce AA formation on cookies besides sugar, leaving agents and type of oils employed, which have already been studied. Therefore, several modifications of cookies receipt evaluate the impact on AA formation from enrichment of wheat flour with pectin, arabinogalactan, or K-carrageenan and the mix with rice flour or chia seeds. The AA quantification was done by GC-MS after derivatization with xanthydrol [6]. The limits of detection, quantification, and precision (RSD) were 4 µg/kg, 25 µg/kg, and <8%, respectively.

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Applicability of near infrared spectroscopy on wheat flour supplemented with lentil flour

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Consumer's demand for healthier and more sustainable products has led to an exponential growth in the consumption of plant-based foods in recent years. In this context, flours are playing an important role as they are easy to incorporate in different preparations, providing interesting technological and nutritional properties. The combination of wheat flour with other flours such as chickpea, amaranth, quinoa, lentils, mushroom powder and others has been extensively studied in recent years. Among them, lentil flour is particularly important for its high content of protein, bioactive compounds and phytochemicals, as well as mineral elements and fibre [2], with a low amount of fat [3]. In relation to its protein, lentil amino acids complement wheat very well by covering its deficiencies in wheat lysine and arginine [4]. Products containing mixtures of cereals with other ingredients are among the foods in which the highest number of adulterations are detected. This calls for control techniques to detect fraud and truthfulness in the labelling of these products. Near-infrared (NIR) spectroscopy has wide applicability for chemical composition determination and adulteration detection in flour blends with other ingredients [5].

The work presented here is based on the application of NIRS technology on supplemented wheat flour. A total of 110 flour samples were analysed, 20 samples corresponded to lentil flours of different varieties and 90 samples to wheat flour supplemented with 25, 50 and 75% lentil flour. The aim of the work is to establish a methodology to quantify the percentage of lentil flours in a mixture. For this purpose, the NIR spectra of the samples were recorded using a Foss NIR System equipment in a spectral range of 1100-2000 by direct application of optical fibre on the flour. The spectra were processed using the specific WinISI software and different mathematical and smoothing treatments were applied to the spectral signal. The prediction of the percentage as a function of the blend content using the modified partial least squares regression method (MPLS) and the classification of the samples by the combination of NIRS and RMS-X residual discrimination of the samples according to the lentil flour variety were tested. The results obtained show that no statistically significant differences were found between the actual percentage contained in the sample and the percentage predicted. On the other hand, a percentage of 100% of the correctly classified samples was obtained when RMS-X residual discrimination was tested. In accordance with these results, NIRS technology has been shown to be an effective tool for the study of supplemented wheat flours, being possible to predict percentages of different lentil flours in these mixtures. The results obtained in this work should be extended in order to assess the effectiveness of the methodology developed when working with smaller concentrations of lentil flour.

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Sustainability and circular economy

FLOURS MADE FROM FRUIT BY-PRODUCTS AS SUSTAINABLE INNOVATIVE INGREDIENTS: ARE THEIR MINERALS BIOACCESSIBLE?

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There is a growing interest in flours made from fruit by-products, as sustainable alternatives to be used as functional ingredients for bread, cookies, snacks, cakes, cereals, bars, and muffins [1,2]. Therefore, it is particularly important to know their nutritional composition and the nutrients released in the gastrointestinal tract. This study evaluated (i) the proximate composition, total phenolic and mineral contents, (ii) the estimated daily intake (EDI) of minerals with daily consumption of 30g, (iii) the bioaccessibility of essential minerals, and (iv) the influence of chemical composition on minerals bioaccessibility of 20 commercial fruit flours from different manufacturers. Samples included 5 green banana flours, 5 passion fruit flours, 3 apple flours, 2 orange flours, 2 grape flours, one blackberry flour, one açaí flour, and one plum flour. All the samples were purchased in local markets in Guarapuava city, in Brazil. Official AOAC methods were used for proximate composition analyses. The standardized INFOGEST method was applied for in vitro simulating gastrointestinal digestion [3]. The determination of Ca, Mg, Na, and K were performed by flame atomic absorption spectrometry, whereas the other minerals (Fe, Mn, Zn, Cu and P) were determined by inductively coupled plasma mass spectrometry (ICP-MS). Bioaccessibility rates were calculated using the equation: *Bioaccessibility (%) = (mineral content in bioaccessible fraction / total mineral content)* x 100.

The fruit flours evaluated in this work presented high variability on nutrients composition: dietary fiber (7.5 to 69.7 g/100g), carbohydrates (4.1 to 74.9 g/100g), protein (2.9 to 12.9 g/100g), ash (1.0 to 7.0 g/100g), lipids (1.0 to 8.1 g/100g), and total phenolic content (2.9 to 41.0 mg GAE/g). All flours were a good source of minerals. An average per capita daily consumption of 30 g of fruit flour provides a relevant contribution to the daily mineral requirements. However, some of these elements showed low bioaccessible fractions, depending on the type of fruit flour and its proximate composition, which have a significant. Calcium and Fe were the elements with the lowest average bioaccessibility (18.0 and 28.9%, respectively). Even so, these flours proved to be important sources of fiber and minerals, especially, Mn and Cu, whose concentrations in some flours contribute more than 100 % of the reference daily intake.

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CEREAL MILLING BY-PRODUCTS AS SOURCES OF NUTRIENTS AND ANTIOXIDANT PHENOLIC COMPOUNDS

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Cereals are staple food crops and major sources of nutrition worldwide, but their processing generates a large amount of by-products. In addition to environmental and economic aspects, cereal milling by-products represent a significant loss of natural resources and nutrients when discarded as useless waste [1,2]. Thus, in order to promote the upcycling of these by-products as valuable raw materials, this study was carried out to provide a compositional and bioactive characterisation of wheat, maise and rye by-products currently produced in large quantities by the cereal grain milling industry. The cereal by-products were studied for their proximate composition following official methods of food analysis, and organic acids, soluble sugars, fatty acids and tocopherols were analysed by different chromatographic techniques [3]. After preparation of hydroethanolic extracts, the detected phenolic compounds were characterised by HPLC-DAD-ESI/MS^{n}and the antioxidant activity was evaluated through *in vitro* assays for the ability to inhibit lipid peroxidation by monitoring the formation of thiobarbituric acid reactive substances (TBARS), and to inhibit oxidative hemolysis caused by free radicals generated in the *in vitro* system [3]. Regarding the compositional results, expressed in dry weight (dw), carbohydrates (56.35–78.12 g/100 g) were the major proximate constituents of the studied cereal by-products, followed by proteins (11.2–30.0 g/100 g). The higher energy value (432.3 kcal/100 g) was presented by wheat germ, which also presented the highest citric acid content (0.86 g/100 g). Sucrose was the most abundant soluble sugar in all cereal by-products, reaching 10.4 g/100 g in wheat germ, 3.84 g/100 g in maise bran-germ mixture, and approximately 2.9 g/100 g in wheat and rye bran samples. Unsaturated fatty acids predominated in all samples, given the high contents of linoleic (53.9– 57.1%) and oleic (13.4–29.0%) acids. Wheat germ had the highest levels of tocopherols (22.8 mg/100 g) and phenolic compounds (5.7 mg/g extract, with a high content of apigenin-*C*-pentoside-*C*-hexoside). In turn, while the wheat bran extract was particularly effective in inhibiting the formation of TBARS, the rye bran extract was the only one capable of protecting sheep erythrocytes from oxidative haemolysis. Overall, these results are valid arguments to support the use of cereal by-products as underexploited alternative sources of nutrients and bioactive phenolic compounds with potential health benefits for consumers.

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RESPONSE SURFACE METHODOLOGY APPLIED TO ESSENTIAL OIL EXTRACTION OF EUCALYPTUS LEAVES

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Plant volatiles are secondary metabolites with a wide range of applications in several industries, namely the textile, food, pharma, and perfumery. These molecules are usually from three major groups, the terpenoid, phenylpropanoid/benzenoid and fatty acid derivatives group. This work focused on applying the response surface methodology technique towards optimizing the yield in essential oils of *Eucalyptus globulus* Labill, extracted by hydro distillation. For this, three factors were varied, namely the time of extraction (variation between 180 to 270 min), particle size (varying between 1 and 3 mm), and solid/liquid ration (varying between 10 and 50 g/L). The response recorded was the amount (g) of recovered essential oil. Using the optimization function, the optimal points were set at 260 minutes of extraction time, particle size of 1.2 mm and 50 g/L ratio. The model was significant, and the lack of fit was not, allowing for an R^2 of 0.9911 and an adjusted R^2 of 0.9777. Figure 1 shows the 3D charts of the response-surface.

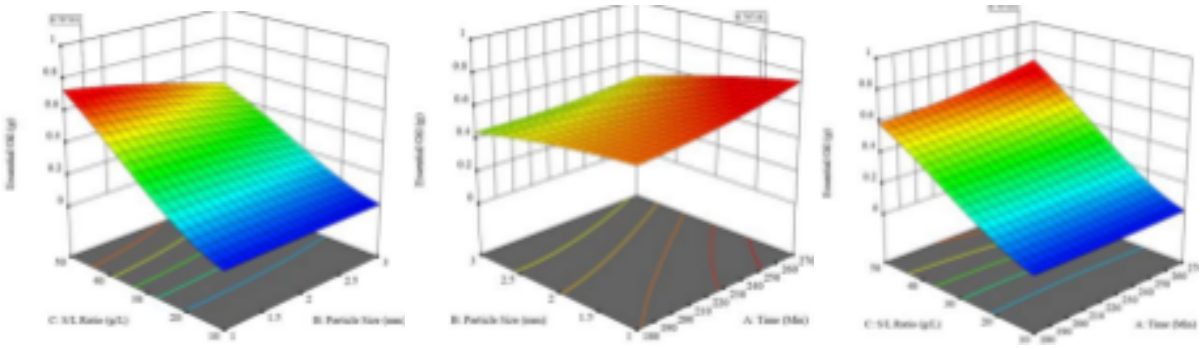

Figure 1- Response surface charts showing the optimal point, in which the amount of essential oil is maximized.

The model predicted that, at the optimal point, the yield in essential oils is 0.707 g, an amount above the one found in any of the 17 extraction conditions performed. Overall, the most important of the three factors was the solid to liquid ratio, showing that this factor accounts for most variations in the amount of pure essential oil, followed by particle size and finally, the least important factor, extraction time. This study allows an optimization of the extraction of essential oils from eucalyptus by showing that larger amounts of extract render more oil, as well as smaller particle sizes, while the extraction time has a low influence, thus allowing for shorter extraction times, which corresponds to lower energetic waste. The results herein are important for the food industry, specifically for new food additives, but also as flavorings for grain based foods.

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DEVELOPMENT OF A FERMENTED PLANT-BASED BEVERAGE FROM DISCARDED BREAD FLOUR

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Bread and bakery products are among the most discarded food products in the world. This work aims to investigate the revalorization of bread waste developing a new fermented beverage. Discarded bread was dried and ground in a hammer mill and bread flour was mixed with water at 20 %(p/v). Two commercial starters (CHR Hansen, Hørsholm, Denmark) were chosen to carry out the fermentation of the bread flour. One of them contained *L. rhamnosus* and the other one contained *L. bulgaricus, S. thermophilus and Bifidobacterium.* The addition of α-amylase and glucoamylase enzymes (Novozyme JSC, Bagsværd, Denmark) were also studied. The effect of salt removal from the blend was analysed. Two bread-water mixtures were prepared and the enzymes were added to just one of them. Considering the salt removal, two more mixtures were desalted and the enzymes were added to one of them. Desalting was carried out by centrifugation and these mixtures were rehydrated at 20% (p/v). All the mixtures were pasteurized at 72ºC for 5 min and were cooled until 37ºC. Then, all the samples were inoculated at 10^7 ufc and incubated at 38 ± 2ºC for 24h. Acid-lactic bacteria counts, pH and acidity were determined at different incubation times: 0, 3, 6, 9 and 24 h and at different storage times: 15 and 21 days. *Bifidobacterium* counts and water retention capacity (WHC) were measured at 0 and 24 h for 15 and 21 days. Eight trials were carried out to combine all the variables. Results show that the first starter, *L. rhamnosus,* grew better in the beverage with enzymes and salt reaching a maximum growth rate (μmax) of 0,263 Log ufc·g^{-1} h^{-1}. The rate dropped 15% without salt and with enzymes and the rate decreased by more than 25% to 0,193 Log ufc g^{-1}·h^{-1} without adding enzymes and with salt. In comparison, the speed rate was reduced by 16% without enzymes and salt. The difference between the highest rate (enzymes and salt) and the lowest (no enzymes and no salt) was 38%. Regarding the second starter, only the presence or absence of salt affected *Bifidobacterium* growth at 24h. *Streptococcus* did not experience growth and remained stable with and without salt and enzymes throughout fermentation. However, *L. bulgaricus* grew more without enzymes and especially with salt and more studies are needed to see this trend. In general terms, desalting reduced the growth of the starters and the presence of enzyme was a growth factor for *L. rhamnosus* and *Bifidobacterium* but not for *L. bulgaricus.* In all cases, pH decreased and acidity increased more in the enzyme beverage using both cultures with or without salt. The removal of salt did not affect the pH reduction at 24h whether or not enzymes were added and, the beverage with starter 1 had a lower pH. More acidity was reached in the drinks with salt. Starter 1 caused a higher acidity in the enzymes samples whereas the starter 2 caused this in the no enzymes ones. WHC oscillated between 33-45% with enzymes and between 59-77% without enzymes considering the salt variable. No significant differences were found between the beverages considering salt and starters factors. This drink can be an interesting product for consumers because it avoids food waste and is of plant origin. A sensory and a bromatological compound analysis will be carried out to complete this first step.

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STUDY OF THE PHENOLIC PROFILE AND BIOACTIVE POTENTIAL OF CARDOON BRACTS AS A PROMISING FUNCTIONAL INGREDIENT

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The world population has been growing and, consequently, so have the nutritional and food needs. The balance between adequate supply and the planet's resources is a subject with increasing attention in the world. The development of new strategies to combat this problem and ensure the population's nutritional needs are urgent and extremely necessary. The most complete characterization of crop species and their potential is extremely important for the adequate use of resources and the valorization of bio-waste generated annually through the development of new functional products [1]. *Cynara cardunculus* L. is a species widely cultivated in the Mediterranean region, and its production has an economic impact on this region. It is widely consumed in the Mediterranean cuisine as a result of its high nutritional value and the medicinal properties it has been demonstrating [1,2]. Cardoon bracts (variable *altilis*) were collected at the principal growth stage (PGS) 5. The phenolic composition was evaluated by HPLC-DAD-ESI/MS. Two *in vitro* assays were used to evaluate the antioxidant potential: TBARS (thiobarbituric acid reactive substances formation inhibition) and OxHLIA (oxidative hemolysis inhibition). The antiproliferative capacity was evaluated by the colorimetric method of sulforhodamine B, using several tumor cells lines and in a primary culture of non-tumor cells (PLP2). The anti-inflammatory activity was evaluated using a murine macrophage cell line (RAW 264.7). Eleven phenolic compounds were tentatively identified, with the compounds 5-*O*-caffeoylquinic and 3,5-*O*-dicaffeoylquinic acids present in higher abundance (6.362 and 21.83 mg/g extract, respectively). The cardoon bracts demonstrated cytotoxic (GI_{50} of 30 – 79 µg/mL) and anti-inflammatory (IC_{50} of 72 µg/mL) potential. The capacity to inhibit the formation of TBARS (IC_{50} = 26.8 µg/mL) and the oxidative hemolysis (IC_{50} of 82 and 159 µg/mL at Δt=60 min and 120 min, respectively) were also demonstrated. The results obtained allow us to confirm the high bioactive potential associated with cardoon bracts, as well as the great variety in phenolic compounds. These results also showed the promising potential of this species for its exploitation in the fortification of food products, such as bakery products and others. Therefore, the newly acquired knowledge allows the application of less used and less studied species as functional ingredients, and at the same time, obtain food products with richer nutritional value and higher interest for the food industry. Nevertheless, further studies are needed to better understand the compounds responsible for the observed activities, to reveal the mechanisms involved in these activities, as well as to evaluate the incorporation of this material in new functional food products.

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Poster Communication

Poster Communication

Past as key to the future (ancient grains, wholemeal products, and sourdoughs)

New Ingredients in grain-based products (Pseudocereals, pulses, and new flour sources)

Past as key to the future (Poster)

ANCIENT SEEDS IN MODERN DIETS: CHIAAND FLAXSEEDS' HIGH-PROTEIN FLOURS

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The growth of human population and climate changes' impact on agriculture reinforce the need for sustainable food production. One solution for this problem could be rediscovering ancient foods. Recently, ancient seeds became a trend in diets due to their bioactive compounds, functional properties, and resilience to high-stress conditions [1]. After seeds' cold pressing, the remaining by-products (flours), are sustainable ingredients with potential for new food formulations to be developed by the food industry [2]. This work aimed to evaluate the nutritional value of chia seeds (*Salvia hispanica*), chia's defatted flour, flaxseeds (*Linum usitatissimum*), and flaxseeds' defatted flour by determining the total protein content by Kjeldahl method [3] and total amino acids by HPLC-FLD [4].

Regarding the total protein content, chia seeds and flaxseeds did not present significant differences (16-18%, $p < 0.05$), what also happened for the respective flours (27-28%, $p < 0.05$). Concerning total amino acids, flaxseeds' flour presented the highest value (314 mg/g), followed by chia's flour (269 mg/g), while both seeds presented the lowest amounts (194-203 mg/g). The major amino acids identified were the same in all the samples - glutamic acid, followed by arginine and aspartic acid - but flaxseed's flour presented the highest amounts (65, 37 and 31 mg/g, respectively). A similar profile was previously obtained for sesame seeds and defatted flour [1]. All samples were dietary sources of all essential amino acids. Particularly, branched-chain amino acids - leucine, isoleucine, and valine - were identified in all samples with amounts varying between 12-19 mg/g for leucine, 7-13 mg/g for isoleucine, and 9-15 mg/g for valine. When comparing these results with other trending grains in diets - amaranth and quinoa [5], both presented lower total protein contents (21% and 16%, respectively) than chia and flaxseeds' flours (27-28%), but quinoa presented a similar content to flaxseeds (16%). Amaranth and quinoa presented lower contents of total amino acids (140 and 114 mg/g, respectively) [5] in relation to the samples analysed in this study. Unlike the present results, glutamine, tryptophan, and lysine were not identified in amaranth and quinoa. Furthermore, similarly to sesame, amaranth and quinoa, chia and flaxseed's protein is a plant-based and gluten-free alternative suitable for vegetarian food patterns. Lastly, the incorporation of seeds and specially their flours can nutritionally enrich various foodstuffs, providing high-protein levels. These flours are an alternative to wheat flour, being suitable for celiac patients and people who avoid gluten for other reasons, for the development of new food products.

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DEVELOPMENT AND CHARACTERISATION OF A SOURDOUGH STARTER MADE FROM THE PORTUGUESE VARIETY OF WHEAT "PRETO-AMARELO" – THE IMPACT OF SOURDOUGH BREADMAKING ON THE PROPERTIES AND TECHNOLOGICALAPTITUDE OF BREAD

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In recent years, the increase in the consumers' demand for healthier and delicious wheat bread has led to the widespread incorporation of sourdough in breadmaking. This consumers' trend, together with an increased interest on new environmentally-friendly and sustainable raw materials, has created a renewed curiosity on the use of sourdough made with ancient cereal varieties. Although naturally fermented bread has been studied recently all over the world [1,2], the Portuguese wheat varieties, their microbiome and their influence on the rheology properties of doughs and in the technological aptitude of breads, are still greatly unknown. Therefore, it is important to deepen the knowledge about these cereals, which are part of Portugal's identity [3]. In this study a sourdough starter was prepared using the traditional Portuguese variety of wheat "Preto amarelo".

In order to compare doughs and breads fermented with the "Preto-amarelo", wheat sourdough starter and baker's yeast, fermented doughs with the same flour, two different hydration levels (56.25% and 66.67%) and sourdough starter or baker's yeast were prepared. The doughs were analysed as far as it concerns to pH, acidity, texture and viscoelastic behaviour. The technological quality of the breads was evaluated based on their acidity, texture, volume, colour, humidity and water activity. As expected, the doughs fermented with sourdough starter presented lower pH, with values around 3.8, very close to the final pH value of the matured sourdough starter. Moreover, it was observed by doing mixing tests in a microdough-Lab that the lower flour hydration value (56.25%) led to a lower dough development time, but also to lower stability. After fermentation, these doughs were also more structured (higher elastic modulus, G', obtained from the mechanical spectrum by a controlled stress rheometer) and achieved higher firmness values in a Texture Profile Analysis. There were no noteworthy differences between the rheology and texture of the doughs prepared with the sourdough starter and the baker's yeast. In what concerns the comparison between the breads prepared with the sourdough starter and the baker's yeast, the breads prepared with the "Preto-amarelo" wheat sourdough starter presented higher values of firmness and lower volume than the breads fermented using the baker's yeast. In addition to this, they also presented higher aging velocity values. The results presented in this study allow us to infer that traditional breadmaking techniques using sourdough have a strong impact on rheologic properties of doughs and in the technological aptitude of breads.

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NUTRITIONALAND CHEMICAL EVALUATION OF DIFFERENT ARMUÑA LENTILS CULTIVARS (LEN CULINARIS SPP) FROM PGI "RUBIA DE LA ARMUÑA", GROWN IN DIFFERENT SOILS

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Lentils (Lens culinaris Medik) are part of an ancient culture, characterized for being a fast-cooking pulse consumed worldwide due to its richness in proteins, dietary fibers, complex carbohydrates, and essential micronutrients [1,2]. Lentil's production and chemical composition are largely influenced by their resistance to biotic and abiotic stresses, conditioned not only by their variety but also by the climatic conditions and composition of the soils in which they grow [3]. Additionally, among some edaphic influences, the accessibility of the right nutrients for plants is of supreme importance, with a variety of micronutrients present in the soil being identified as crucial in both growths, chemical, and nutritional composition, and production of lentils [4]. To the north of the Salamanca province (Spain), there is the comarca of La Armuña, which belongs to a Protected Geographical Indication (PGI), characterized by the occurrence of climates with low precipitation, long and cold winters, and hot and dry summers. Therefore, the present study aims to provide an evaluation of the nutritional and chemical profiles of different samples of Armuña lentils "Rubia de La Armuña" grown in two different types of soils (luvisol and combisol), thus contributing to the characterization of this variety and the potential influence of edaphic factors in its composition. Samples were studied for their nutritional value following AOAC procedures and, free sugars and organic acids were analyzed by chromatographic techniques [3]. The results show similar amounts of the evaluated parameters, with carbohydrates and proteins being the outstanding macronutrients (68.1±0.3 and 25.17±0.03 g/100 g of fresh weight, respectively). Sugars such as fructose, glucose, and raffinose, and organic acids such as oxalic and malic acid were also detected in similar amounts between samples. In sum, the results show that different samples of the same variety of PGI lentils cultivated in these specific types of soils do not present significant differences in the analyzed nutritional and chemical parameters.

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RESEARCH OF THE BIO-PHYSICO-CHEMICAL KINETICS OF SOURDOUGHS MADE WITH SEVERAL GLUTEN-FREE CEREAL FLOURS.

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The sourdough contains an acidifying microbiota, consisting of lactic acid bacteria (LAB) and of wild yeasts [1]. The presence of sourdough has an impact on both the technological and nutritional properties of the bread, also improving its sensory quality [2]. The development of sourdough is influenced by many factors such as the type of flour, the temperature and the water content [3]. The aim of this research was to determine the influence of the use of different gluten-free cereals on the fermentation kinetics and development of microbial populations in sourdoughs.

For the development of the three batches of sourdoughs, firstly, a liquid starter culture was obtained consisting of three strains of LAB: *Lactobacillus casei, Pediococcus pentosaceus* y *Leuconostoc mesenteroides subp. dextranicum*. Then, three dough starter (DS) were produced, according to different formulations: DS100R, rice flour only, DS75R-25M with a mixture of rice flour (75%) and maize flour (25%), and DS25R-75M with a mixture of rice flour (25%) and maize flour (75%). Finally, the sourdoughs were made with 100 g of the corresponding DF, 100 g of mineral water and 200 g of rice flour (S-R) or a mixture of maize and rice flour in the same proportions as the dough feet base used (S-RM and S-MR). Samples were taken from the three sourdoughs, freshly made and after 24 h of fermentation, to determine pH and titratable acidity, and counts were made of the following microbial groups: LAB in general, *Leuconostoc* and lactobacilli in particular, and yeasts.

In general, *Lactobacillus* counts increased slowly until 24 h, reaching values of 10^7– 10^8ufc/g, with the exception of the S-MR whose counts were higher (10^8– 10^9ufc/g). The yeast population increased in the order of one logarithmic unit during the fermentation time, both in S-R and S-RM, reaching values of 10^7 ufc/g. The pH values of the sourdoughs were around 5,0 at the beginning of fermentation, reaching values of 3,8 – 3,9 after 24 hours. The initial titratable acidity values of the sourdoughs ranged from 0,20 y 0,41% lactic acid, although all three sourdoughs reached values around 0,80 – 0,90% after 24 h of fermentation. The sourdough made exclusively from rice flour showed the lowest titratable acidity values.

The sourdough made exclusively from rice flour showed the lowest titratable acidity values. The doughs were subsequently preserved by freezing in order to be used, after being revitalised, as natural cultures in the production of gluten-free bread.

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THE *FUNDO* OR *FONIO* - A WEST AFRICAN CEREAL IN A PROCESS OF GENETIC EROSION

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Fonio in several West African countries, and *fundo* in Guinea-Bissau is the local name of a cereal obtained from species of the genus *Digitaria* (e.g, *Digitaria exilis*, *D. iburua*) produced and consumed in several countries in this region. The main producer is Republic of Guinea, in Fouta-Djalon, with about 60% of world production, because it is the staple food of the population in some regions. Now exported to Europe and the United States, the *fundo* is more and more consumed beyond its production area. Scientists' interest in this so-called "minor" crop is very recent. It was only in the 2000s that a multidisciplinary team of African and European researchers took the initiative for the first time, to study the *fundo* crop in West Africa more extensively. Two species are used in Guinea-Bissau: *Digitaria exilis* (cultivated *fundo*), which was domesticated in this part of Africa and is grown in several countries; and *D. longiflora* (wild *fundo*), harvested from wild populations. The origin of *fundo* dates back more than 5000 years, and it is possibly one of the oldest cereals in Africa.

It is a very short cycle cereal that can be harvested during the rainy season, in August or September, when there is little other food available. Both *fundo* types are sold in local markets in the country in limited quantities. The domesticated species is cultivated on small plots in the interior of the country and the grain is also imported from the Republic of Guinea. On the other hand, the wild *fundo* grows spontaneously in degraded soils and abandoned agricultural fields. Both species are well adapted to semi-arid areas, which makes this crop especially important.

The grain is very small, the yield of the crop is low, and harvesting and processing the grain is more labor-intensive than for other cereals, as is the cooking process, where it is necessary to remove the sand grains mixed with the cereal during preparation.

The consumption of cultivated *fundo*, which in the past would have been a common food, is now done in small quantities and this cereal is considered a prestige food. Considered as rich in nutrients, this cereal is prepared in a similar way to couscous, and is locally considered to have medicinal properties, particularly for diabetics and in the regulation of the digestive system.

Thus, in Guinea-Bissau *fundo* has become the most expensive cereal for sale in the markets. The dietary properties and functional characteristics of the *fundo* have been studied in other West African countries, but in Guinea-Bissau there are, as yet, no studies on the two species consumed.

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New ingredients in grain-based products (Poster)

AGRICULTURAL CEREAL BY-PRODUCTS AS A SOURCE OF PREBIOTICS FOR THE DEVELOPMENT OF FUNCTIONAL FOODS

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Prebiotics are specialized plant fibers that stimulate the growth of beneficial gut bacteria. They are naturally present in foods that contain complex carbohydrates, such as fiber, starch, non-digestible starch polysaccharides, oligosaccharides, and xylooligosaccharides. Nowadays, it is well known that prebiotics exert beneficial effects on health, such as inhibition of pathogenic bacteria, regulation of lipid and glucose metabolism, prevention of some chronic diseases, favor loss weight, and have antioxidant activity, which contribute human health and wellbeing [1]. Thus, a higher consumption of prebiotics is regarded as positive, and they have been widely used in the formulation of food and nutraceuticals [2]. They are mainly obtained from cereal grains, such as rice, wheat, corn, or barley. For most grains, the industrial processing of cereal grains usually leads to the generation of considerable amounts of by-products, that are still rich in different compounds, like proteins, carbohydrates, minerals and antioxidants and also dietary fiber and resistant starch fractions, which are important prebiotics [1]. In this sense, the use of cereal by-products has been described as a sustainable and renewable source of prebiotics, as well as contributing to the management of residues that are traditionally destined for the formation of compost or the burning, adopting the circular economy principles. The purpose of this review is to evaluate the potential of agro-industrial residues from cereals as an alternative to obtain prebiotics and that can be used in the food industry in the production of functional foods.

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CAROTENOIDS AND PHENOLS CONTENT CHANGES IN GLUTEN-FREE BREADS ENRICHED WITH ROSE HIP POWDERS

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Functional foods are one of the current food trends. These have specific beneficial effects on the health of the consumer due to the ingredients they incorporate or eliminate [1]. Functional foods include gluten-free products. They support the daily life of coeliacs, but a strict adherence to a gluten-free diet leads to deficiencies in micronutrients and macronutrients such as fiber [2]. Rose hips (*Rosaceae canina*) is a fruit with high concentration of vitamin C, phenols and flavonoids. It also contains tannins, vitamins [3], and minerals [4]. These functional ingredients are usually treated to incorporate them as powder form and protected with a biopolymer [5]. The aim of this study is to evaluate the effect of adding rosehip powder to 3D printed gluten-free breads on carotenoids (TC) and total phenols (TP) content. For this purpose, three doughs were used: control (C), with rose hip powder (RH), and with rose hip powder encapsulated with maltodextrin (RHM). The doughs were 3D printed in a rectangular design (3 cm wide, 7 cm long and 1-2-3 cm height) and baked. Bioactive content was evaluated before and after baking (**Table 1**). The incorporation of rose hip increases the phenol content by five times and carotenoids by forty-nine times in the doughs. After baking, rose hip samples had the highest amount of bioactives, but rose hip with maltodextrin samples showed lower percentages of loss of bioactives.

Table 1: Bioactive content of the doughs and a sample of 3 cm height after baking. a) Total carotenoids (TC); b) Total phenols (TP). (D: dough; B: baked; C: Control; RH: Rose hip; RHM: Rose hip with maltodextrine).

Sample	TP	TC
DC	$27.0(0.9)^{a}$	$0.32(0.02)^{a}$
DRH	$145(4)^{d}$	$15.33(0.09)^{e}$
DRHM	$77.39(0.04)^{bc}$	$7.23(0.08)^{c}$
BC	$27.0(0.04)^{bc}$	$0.383(0.012)^{a}$
BRH	$81(3)^{c}$	$7.72(0.02)^{d}$
BRHM	$73(4)^{b}$	$4.81(0.08)^{b}$

The letters (a - e) in columns indicate homogeneous groups according to ANOVA ($p < 0.05$).

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CHARACTERIZATION OF GRAINS FROM THREE INDUSTRIAL HEMP CULTIVARS APPROVED FOR PRODUCTION IN SPAIN

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Cannabis sativa L, known as Hemp, shows health and economic benefits with commercial potential such as in seed production, fiber, oil, and pharmaceutical uses [1]. The chemical composition of this product, especially its high lipid and protein content, makes it a raw material of great interest for application in different foods in order to enrich their nutritional value [2].

The aim of this study was to evaluate the nutritional properties of hulled hemp grains extracted from *Ferimon, USO 31* and *Henola* cultivars approved for production in Spain. All cultivars were grown in the same climatic and geographic conditions, and were agronomically evaluated by determining their yield and 1000-seed weight. Proximate composition (moisture, crude protein, crude fat, total ash) was determined according to the standard procedures of the Association of Official Analytical Chemists (AOCS, 2003). Lipids were extracted from grains with the Soxhlet method and stored at 8°C. The thermal properties of hemp grains were investigated using a DSC3 calorimeter (Mettler Toledo, Spain). The elemental analysis of macro and trace elements was done using inductively coupled plasma optical emission spectrometry (ICP-OES). The results revealed that hemp grain yield and properties varied greatly between cultivars, depending mainly on the genetics of each cultivar and its adaptation to agro-climatic and cultivation system conditions. The USO 31 cultivar had the lowest yield and the highest thousand seed weight. The obtained results showed that defatted hemp grains (regardless of hemp cultivar) can be suitable for human consumption as a superior source of protein, proportional to widely recognized soy proteins. DSC measurements confirmed the presence of globulin type 11S and 7S which denaturation temperatures are above 92ºC. Hempseed oil concentration was 49.7%, 48.8% y 49,2 for *Ferimon, Uso 31* and *Henola* respectively, while crude protein concentration ranged from 33.7 to 34.6 %. Hempseed oil was mainly composed of unsaturated fatty acids, with linoleic acid (~526 g/kg) and a-linolenic acid (190 g/kg) being the dominant. K and Mg were the most abundant minerals in hemp grain, while Fe and Cu were the predominant trace elements. The hemp cultivars grown in Spain produce grains with enormous potential as a food ingredient beneficial to human health.

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CURRENT PERSPECTIVES OF PASTA SUPPLEMENTED WITH PHENOLIC COMPOUNDS

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Wheat pasta is a very popular food, being one of the basic foods of numerous diets along the world and composing the base of the food pyramid. Pasta is a great source of carbohydrates with also small amounts of dietary fiber and proteins. In addition, pasta has also other advantages, such as low glycemic index compared with bread, and can slow digestion, favoring satiety [1]. Nowadays, consumers are more aware of the nutritional value and benefits of certain foods and bioactive compounds. Therefore, since the last few years, there is a growing consumer trend towards the consumption of foods with good nutritional values, but which also provide health benefits. This is reflected in the significant growth that the market of functional foods has been experienced [2]. In this context, novel formulations of pasta products containing new ingredients to enhance their composition and biological properties have been proposed. Among alternatives, the addition of phenolic compounds in pasta formulation is an interesting strategy to promote the health benefits of these food products. These compounds are secondary metabolites of plants, which are well known to exert many biological properties (*e.g.* antioxidant, anti-inflammatory, antitumor, or anti diabetic, among others) and some studies have reported that phenolic compounds are involved in the prevention of some chronic diseases in humans [2, 3]. Therefore, higher consumption of phenolic compounds is regarded as positive to human health. When phenolic compounds are tended to be incorporated into foods, the effect of food matrix on phenolics bioavailability and molecular interactions should be carefully considered. Such evaluation is fundamental to assess the effectiveness of the functional pasta [2]. In this context, this study aimed to evaluate the strategies employed and their limitations to fortify pasta with phenolic compounds, bearing in mind bioavailability studies that will determine the usefulness of these strategies.

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EFFECT OF ENRICHMENT WITH QUINOAAND AMARANTH ON PROPERTIES OF EXTRUDED CORN SNACKS

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Extrusion is a more and more popular technique for snack production using interesting raw ingredients, to produce snacks improving their nutritional value [1]. Quinoa and amaranth seeds stand out for their protein, mineral and fatty acid content. The aim of this work was to evaluate the effect of enrichment with two concentration (10 and 20 %) of quinoa and amaranth on properties of extruded corn snacks. To achieve this goal, extrudate physicochemical characteristics, such as water content, water absorption index, water solubility index, swelling index, expansion index, bulk density, porosity and texture were determined. Extrudates (**Figure 1**) were produced with a single-screw extruder. It operated at a 3:1 compression ratio, loaded with prepared corn samples at a constant dosing speed of 18 rpm. The screw was rotated constantly at 150 rpm, and temperatures of barrel sections 1-4 were set to 25, 70, 170, and 175 ◦C, respectively; the nozzle diameter was 3 mm [2]. The addition of quinoa and amaranth in the mixtures to be extruded reduced significantly ($p < 0.05$) the water content and the expansion index of the extruded products and increased their bulk density and swelling index. The addition of quinoa increased significantly ($p < 0.05$) the water loss during extrusion, as well as the water solubility index and the porosity of the extrudates. However, the addition of amaranth in the mixtures for extrusion caused a significant ($p < 0.05$) increase in the water absorption index of the snacks and a decrease in their water solubility and porosity index. Extrudates with quinoa are crispier than the control while extrudates with amaranth are harder. The addition of both seeds in flour will improve the snack nutritionally and functionally due to its composition, however, according to its physicochemical properties, the use of quinoa is recommended. The two concentrations studied (10 and 20%) are adequate since they produce crispier, porous and drier snacks than those extruded from corn alone.

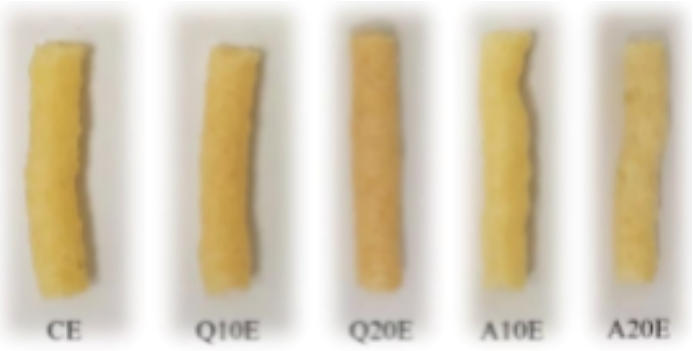

Figure 1: Appearance of extrudates (E); C: Control, Q10: 10% of Quinoa, Q20: 20% of Quinoa, A10: 10% of amaranth, A20: 20% of amaranth

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EVALUATION OF THE POTENTIAL OF MEDICINAL PLANT EXTRACTS FOR THE DEVELOPMENT OF NEW BAKERY PRODUCTS

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Medicinal plants have been traditionally used throughout time as therapeutic treatments. These plants possess different compounds with antioxidant, anti-inflammatory and antimicrobial properties of industrial interest. In particular, the plants *Achillea millefolium* L., *Arnica montana* L., *Calendula of icinalis* L., *Chamaemelum nobile* L. All. and *Taraxacum of icinale* F.H. Wigg. belonging to the Asteraceae family, have shown relevant applications including food preparation, dyes, cosmetics, and traditional remedies, although their consumption is currently decreasing [1]. However, the extracts of this type of plants are mostly applied by the food industry as preservatives, due to their antioxidant and antimicrobial properties that prevent food spoilage and microbial growth, preserving the organoleptic characteristics of various products, such as meat, dairy products, or bakery products [2]. The aim of this study was to develop new ingredients derived from these plants, which may be of interest to the food industry, more specifically in bakery. For this, a study of their main bioactivities of interest such as antioxidant and antimicrobial capacity was carried out. The results obtained for antioxidant activity, through the thiobarbituric acid reactive substances (TBARS) assay, indicated that the extracts of *A. millefolium* showed exceptional activity, with an EC_{50} value of 0.013 mg/mL whereas the extracts of *A. montana*, *C. nobile* and *C. of icinalis* showed similar EC_{50} values (0.2, 0.2 and 0.25 mg/mL, respectively). On the other hand, *A. montana* extract showed the highest antibacterial and antifungal effects, with minimum bactericidal and fungicidal concentrations ranging from 0.25-0.5 mg/mL and 0.5-1 mg/mL, respectively. Overall, this study provides scientific evidence for the evaluation of the potential of medicinal plant extracts for the development of new bakery products.

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FERMENTATION IN SOLID SUBSTRATE OF *MONASCUS PURPUREUS* ON *CHENOPODIUM QUINOA*

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Chenopodium quinoa is a gluten-free Andean grain, recognized as the grain of the 21st century for its high nutritional value [1]. *M. purpures* is a fungus that produces natural pigments in addition to cholesterol-regulating monacolin K. In this study, we aimed to obtain a pigmented quinoa flour by fermentation of *M. purpureus*. Quinoa was moistened with different concentrations of NaCl (0.05, 0.1, 0.1, 0.2, 0.4%) and 1% fish hydrolysate, autoclaved, inoculated and incubated at 30°C for 14 days. For pigment extraction, methanol was used as solvent and measured for spectrophotometry at 400, 470 and 500 nm for yellow, orange and red bands, respectively [2]. Quinoa grains showed changes in pigmentation during fermentation by *M. purpureus* (Figure 1). In all treatments, there was a higher concentration of yellow pigments followed by orange and red (Figure 2); however, there were no significant differences ($p>0.05$) at 0.05 and 0.2% NaCl, and there was a low production at 0.4% NaCl. Furthermore, a higher pigment production was obtained at days 10, 12, 14; although, in general, no significant differences were shown in the four NaCl concentrations. The data obtained showed that quinoa can be used as a substrate in the production of pigments, which can be obtained from day 10 at a concentrationsof 0.05% NaCl at a low cost. Work is ongoing to study the use of this fermented product in the food industry.

Figure 1: Fermentation of quinoa grains at different NaCl concentrations for 14 days.

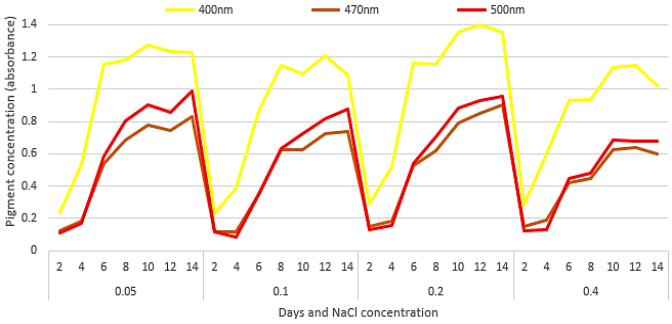

Figure 2: Absorbance of different concentrations of %NaCl for 14 days

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Health effects of whole grain cereals and the process of improving their production

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Whole grains refer to grains or foods that contain all the bran, germ, and endosperm of the entire grain seeds with the original proportions [1]. Whole grain cereals have a protective role in human health, due to their composition including dietary fiber, vitamins and other bioactive compounds with antioxidant properties[2]. To preserve these nutritionally relevant compounds in the final product, whole grain flour should be used during the formulation of novel food products since it is a healthier alternative than refined grain [3]. It is now widely accepted that whole grain products positively impact chronic diseases, such as reducing the incidence of type 2 diabetes, cardiovascular diseases, certain cancers, obesity and intestinal diseases [4]. Despite growing interest in the health-promoting effects of whole grain products, very few wholemeal products are on the market so far, because of their unpleasant sensory properties [5]. However, sensory properties can be improved by using different processing strategies. Food processing such as milling, baking, malting and extruding are important both for the sensory and nutritional quality of grains. As bioactive compounds and dietary fiber are concentrated in the outer layers, any defect in these processes will reduce or eliminate these compounds [6]. Sourdough baking processes has shown to promote a good texture and pleasing flavor of wholemeal products, improving their consumer acceptability [4,5]. Sourdough baking has also shown to deliver cereal products with low starch digestibility and hence low glycemic responses while improving the texture of gluten-free bread for celiac patients [7]. However, stability of bioactive compounds present in sourdough, as well as bioavailability of minerals and starch digestibility may be affected during processing [5]. Thus, more research is needed to ensure a food product with promising bioactivities. In this context, the objective of this study is to provide insight into advances in sourdough processing affecting the nutritional and sensory quality of the final product, as well as analyze the effects of such processing on the stability and bioavailability of health-promoting compounds.

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HOW THE ADDITION OF ALGINATES WITH DIFFERENT MOLECULAR WEIGHTS AFFECTS THE STRUCTURE OF CORN STARCH GELS

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Sodium alginate (SA) is a polyuronic saccharide that is isolated from different brown seaweeds. SA is a copolymer composed of β-D-mannuronic acid and α-L-guluronic acid. Alginates have extensive industrial uses, like as thickener in the paper industry, dye in textile industry, and binder in food industry. In addition, studies show that the use of alginates with starch can cause a delay in the retrogradation of starch [1]. The objective of our work is to study how the average viscosimetric molecular weight (Mv) of alginates affects to the final structure of the formed gels.

The gels were prepared at constant corn starch:water ratio (1:4), with different added alginate content (0, 1 and 2% w/w, starch basis). For the study, 3 alginates of high, medium, and low Mv (428 ± 7, 257 ± 1 and 133 ± 1 kg/mol, respectively) from the same seaweeds (*Ascophyllum nodosum*) were used. To study the structure of corn starch and alginate-corn starch gels, samples were freeze-dried and observed using scanning electron microscopy (SEM, S-4800, Hitachi). Gels were covered with gold by vacuum evaporator (JEE 400; JEOL) for 5 min. The images were captured using 10 kV of acceleration voltage and 180x magnification. In addition, a rheological characterization was carried out with a controlled stress rheometer (MCR 301; Anton Paar Physica) with a specific cell for starch (ST24-2D/2V/2V-30). After gelatinization of the gel for 20 min at 95ºC, it was cooled to 37°C at 3°C/min. Subsequently, a strain sweep was performed from 0.1 to 10% at 37ºC and 1 Hz frequency to obtain the linear viscoelastic region (LVR) of the gels and finally, a frequency sweep was made from 0.1 to 10 Hz at 1% strain and 37ºC.

Corn starch gel presented uniform and circular structure, but the addition of alginates modified clearly the microstructure creating elongated and unequal cavities, described as “honeycomb” network structure, that configured spatial anisotropic networks. Besides, hydrocolloid concentration could be associated to a phase separation process and this effect could be related to the formation of a network structure with fewer bonds among the starch and more entanglements between the hydrocolloid’s chains [2] altering gel properties. Probably, a threshold alginate content (< 1% w/w) exists and, hereby, the structure was maintained invariant with increasing alginate content above 1 %. The structural changes promoted by alginates of different molecular weight were not significant. These results were confirmed by rheology as the addition of alginate decreased the elastic modulus and increased the damping factor. This fact may be related to alginate and starch interactions, since the presence of alginate disrupted the gel formation giving as result a weaker gel [3].

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Identification of γ-oryzanol profiles in rice varieties

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Rice is one of the most consumed cereals, therefore, in order to improve its quality and functionality breeding programs leading to the selection and development of rice varieties are a priority. γ-Oryzanol (GO) is an important bioactive compound present in rice grain due to its antioxidant activity, hypocholesteremic effects [1], and their effects in the blood pressure reduction [2]. GO represents from 20 to 30% of the unsaponifiable matter of the bran [3] and consists of a mixture of ferulate esters, which are formed by the esterification of the hydroxyl group of sterols (campesterol, stigmasterol, β-sitosterol) or triterpene alcohols (cycloartanol, cycloartenol, 24-methylenecycloartanol, cyclobranol) with a carboxylic group of ferulic acid [4]. The GO composition is characterized by several isomers that determine its final concentration and profile in the rice grain. There are some factors that may be associated with different oryzanol profiles, such as rice variety and phytochemical composition[3].

The aim of this work was to identify and quantify different GO compounds in rice varieties, in order to access different profiles. GO was extracted from the bran and brown rice from 5 different rice varieties (Table 1) and was quantified by HPLC-PDA and identified by MS.

A total of 4 GO compounds were identified by HPLC-MS as 24-methylenecycloartanyl ferulate (24MCAF), cycloartenyl ferulate (CAF), campesteryl ferulate (CampF) and ß-sitosteryl ferulate (SF). The rice variety that exhibited the highest GO content was the Giza 177 (51.81 mg/100g in brown rice and 472.95 mg/100g in bran) as shown in Table 1.

Table 1: GO content ± SD of the 5 rice varieties in the bran and brown rice.

Rice variety	Origin country	Bran GO±SD (mg/100g bran)	Whole flour GO±SD (mg/100g brown rice)
Giza 177	Egypt	472.95 ± 13.59	51.81 ± 0.83
Ariete	Italy	462.64 ± 0.91	49.14 ± 3.42
Caravela	Portugal	397.63 ± 23.41	45.81 ± 2.33
Arelate	France	355.09 ± 3.59	38.93 ± 0.97
Carnaroli	Italy	351.64 ± 11.05	41.01 ± 0.29

The GO profiles can be used for identification and characterization of rice varieties and provide knowledge related with their specific bioactive properties.

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IMPACT OF QUINOA FLOUR ON RHEOLOGICAL PROPERTIES OF DOUGHS AND QUALITY OF THE RESULTING GLUTEN-FREE BREAD

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The effect of quinoa (*Chenopodium quinoa* Willd.) flour incorporation level on the rheological properties of gluten-free dough and its effect on bread quality was evaluated. The interest in the development of quinoa-based gluten-free bread is based on the need to improve the nutritional and sensorial quality of gluten-free breads, as it is demanded by consumers [1]. Quinoa, being a pseudocereal with good nutritional value, could contribute to this objective by providing protein with a balanced amino acid profile, dietary fiber, polyphenols, minerals, phytosterols and vitamins [2]. For this study, a maize starch-based bread recipe was chosen and doughs and breads were prepared with different levels of maize starch substitution by quinoa flour: 25, 50 and 75%. Rheological measurements were performed by oscillatory tests to characterize the viscoelastic properties of the dough, which were correlated with bread volume and crumb texture. Quinoa addition at the lowest dose (25%) structured the bread crumb resulting in a homogeneous crumb grain. Higher incorporation levels led to underdeveloped breads with a harder crumb (firmness changed from 1.2 N for 25% to 9.0 N for 75%). Dough consistency, measured from complex modulus G*, increased markedly with quinoa addition ($r = 0.98$, $p = 0.000$). This parameter correlated negatively with bread specific volume ($r = -0.87$, $p = 0.005$) and positively with firmness ($r = 0.94$, $p = 0{,}001$). An excessive increase in dough consistency could have hindered its growth and expansion during fermentation and baking. A progressive delay in pasting temperature ($r = 0.98$, $p = 0.000$) and a lower viscosimetric profile ($r = 0{,}96$, $p = 0.000$ for Peak Viscosity and $r = 0.99$, $p = 0.000$ for Final Viscosity) were observed with increasing quinoa addition.

Based on these results, the addition of quinoa at a dose of 25% is feasible to produce a bread with good characteristics. For the use of higher doses, it would be necessary to modify the flour and/or the formulation, such as adjusting dough consistency or hydration to adapt to quinoa properties.

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INTERACTIONS BETWEEN CORN STARCH AND BIOACTIVE COMPOUNDS OF *ASCOPHYLLUM NODOSUM* SEAWEED: EFFECT OF STARCH GELATINIZATION

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Current gluten-free foods production is more focused on economic and technological aspects rather than nutritional quality showing high glycemic index. Polyphenols (PP) and carbohydrates from *Ascophyllum nodosum* seaweed are bioactive compounds with health beneficial properties. PP-starch systems have demonstrated to extend food shelf-life, protect PP against gastrointestinal tract conditions, being a low cost and GRAS systems [1,2]. Different blending methods (**Figure 1**) between dried and milled *A. nodosum* flour (AF) and corn starch (CS) were proposed, to determine the effect of CS structure (native and gelatinized), AF:CS ratio on the interactions between PP and starch. Assayed methods were, AF with native starch (NT), AF with gelatinized starch (GL) and AF with CS subjected to gelatinization (CGL) [3]. AF liquid-solid ratio was constant (100 g_W/g_{AF}) and AF:CS ratios varied from 1:0.5, 1:1, 1:2 to 1:25.

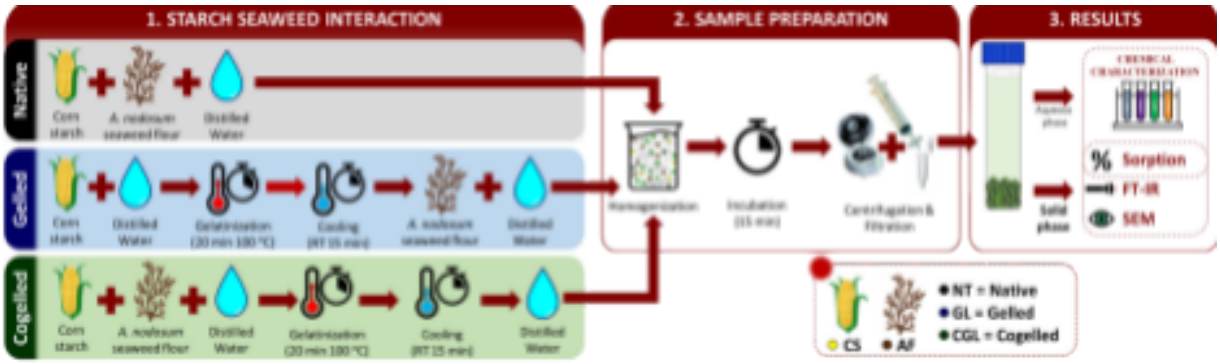

Figure 1: Methodology scheme.

After incubation times, liquid phases were chemically characterized by total polyphenolic content (TPC) to determine PP sorption yield, with values around 60% for NT and GL samples and higher than 80% for CGL samples. Solid phases characterization evidenced nature of interactions and the effect of AF bioactives on the cross-sectional morphologies of blends [3]. Results showed, PP sorption was higher when gelled CS was employed (GL and CGL). Differences observed between GL and CGL samples supported that mechanisms were different. NT and GL were based on direct interactions (weak physical bonds) while bioactives were trapped in CS gel structure during CGL procedure. It was demonstrated AF:CS matrixes have self-complexation mechanism suitable to obtain bioactive starchy-based materials [1,2,3] with rapid and low-cost methods. Experimental conditions such as time, temperature, AF:CS ratios and species origin must be deep-studied to achieve different bioactivity of starchy-based materials [2,3].

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NATURAL INGREDIENTS OBTAINED FROM *BRASSICA OLERACEA* L. WASTE

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There is a clear tendency to incorporate natural-based ingredients into food formulations, namely in products from the bakery industry. These type of ingredients have been highlighted as promising alternatives to commonly used artificial ingredients and have been well accepted by consumers due to the associations with beneficial health effects [1]. Natural ingredients, acting simultaneously as preservation and functionalization agents, due to their antioxidant and antimicrobial properties, are particularly valued when obtained from plant species, namely through the use of bio-waste [2]. The aim of this work was to obtain a new bioactive ingredient with functional properties, extracted from *B. oleracea* cultivars (cabbage) waste, to be incorporate in bakery products. For this, two extractions methods (heat assisted extraction, HAE and ultrasound assisted extraction, UAE) were tested. In each method, three independent variables, time (t), temperature or power (T; P) and solvent (S, % of ethanol) were combined in design of using response surface methodology (RSM). The content of total phenolic compounds, quantified through the Folin-Ciocalteu method, was the experimental response used in the optimization procedure. The polynomial models were successfully fitted to the experimental data and used to determine the optimal HAE and UAE conditions. The results obtained for the extraction by HAE showed that the maximum antioxidant activity was optimal by the S/L ratio (S/L = 49.1 g/L) and temperature (77 ºC), but for a short time (15.5 min) and with an ethanol percentage around 26.8 %. The temperature and time seem to be the least determining factors in this optimization, since the ratio and solvent percentage are the factors that most influence the extraction process. This way, it was possible to obtain an extract with total phenols averging of 19.82 mg/g. For UAE, the results showed that power appears to be one of the least important factors in the extraction of total phenols, with solvent percentage and S/L ratio being the most important factors. The optimal point was set at 458.4 W, and ratio S/L (38.36 g/L), but in the lower values of solvent percentage (42.2 %) and extraction time (19.9 min). At the optimal point, higher quantities of total phenols was predicted when compared to the ones achieved in the optimization runs, reaching 19.35 mg/g. In an overall, it was possible to observe that the UAE, using a small amount of solvent, presented a concentration of phenolic compounds similar to HAE, a conventional methodology. The extract rich in phenolic compounds will later have its antimicrobial and antioxidant capacity tested, in order to be incorporated into bakery products as a natural preservative. Thus being the main purpose of this work the replacement of artificial preservatives by natural agents.

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NEW ALTERNATIVES TO MILK FROM PULSES: CHICKPEAAND LUPIN BEVERAGES WITH IMPROVED DIGESTIBILITY AND POTENTIAL BIOACTIVITIES FOR HUMAN HEALTH

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There is a high demand for plant-based milk substitutes, often poor in protein content (< 1.5% w/v). Relevant choices are provided by protein-rich pulse seeds and adequate processing technologies. The major objective of this work was to evaluate the impact of processing on the nutritional characteristics of beverages with a high impact on health, namely on digestibility and specific bioactivities. Results suggest that pulse beverages are as good protein content (3.24% w/v for chickpea, and 4.05% w/v for lupin) as cow's milk. The levels of pulse characteristic anti-nutrients were considerably reduced by strategic processing. However, when present in small amounts, some of these anti-nutritional factors may exhibit beneficial health effects [1]. Manipulation processing conditions plays a crucial role in this fine balance, as a tool to take advantage of their health benefits. There was evidence of protein hydrolysis and good bioaccessibility of the produced peptides during the *in vitro* digestion [2] for both beverages (**Table 1**), and limited bioaccessibility of minerals mainly on chickpea beverage. In addition, besides being highly digestible and nutritional, lupin and chickpea beverages evidenced specific bioactivities of MMP-9 inhibition [3], as well as a reduction in colon cancer cell migration. Furthermore, the MMP-9 inhibitory activity was resistant to the digestion process, being significantly enhanced, thus suggesting a strong potential as a functional food, into effective preventive diets against inflammatory and cancer diseases, especially related to the digestive system.

Table 1. Protein content before and after *in vitro* digestion in chickpea and lupin beverages. Bioaccessibility percentages are shown for each pair of beverage-*digesta*. Values are represented as mean ± SD. Same letters in protein content per sample evidence no significant differences between parameters ($p > 0.05$).

	Beverage protein content (%)	Soluble protein after digestion (%)	Bioaccessibility (%)
Chickpea	$3.24^{a} \pm 0.16$	$3.30^{a} \pm 0.07$	100%
Lupin	$4.05^{b} \pm 0.25$	$3.88^{b} \pm 0.00$	96%

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PRODUCTION OF ENRICHED EXTRACTS FROM GRAPE SEEDS WITH ANTIDIABETIC POTENTIAL FOR WHEAT FLOUR FORTIFICATION

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About 1.3 billion tons per year of food are lost or wasted worldwide throughout the entire supply chain. Among the food industries responsible of this situation, wine making constitutes one of the most responsible actors [1]. In response to this paradigm, in the last decades, different experimental works have been carried out to characterize grape residues as a potential source of natural ingredients with beneficial properties [2]. Grape seeds have been classically valued for the nutritional properties of its derived oil, rich in unsaturated fatty acids and phenolic compounds. Particularly, there are three fundamental compounds that could be obtained from grape seeds: fiber, *trans*-resveratrol (tR), and proanthocyanidins (PACs). The three of them share a common associated feature as bioactive compounds, as it is the case of antidiabetic activity [3,4], which presents a beneficial direct impact in one of the most prevalent human diseases nowadays. As a chronic disease, type 2 diabetes (T2D) is assumed to be mainly influenced by the current lifestyle trends. In this regard, the use of grape seeds as a natural source of diabetes-alleviating agents, is proposed as a strategy based on the evidence about its antidiabetic effects developed in both *in vitro* and *in vivo* models [5,6]. Moreover, the adoption of sugar and fat-enriched diets is one of the leading causes of T2D. Among products, bakery represents one of the major nutritional sources of simple sugars with fast absorption and high fat contents, being responsible for the diabetes-inducing properties of modern diets [7]. In response to this problematic situation, exploring the use of natural additives for the fortification of flour, the most important ingredient in bakery, is a promising strategy to overcome the deleterious impact of bakery product consumption. Therefore, this work attempts to review the main strengths and limitations of the incorporation of bioactive constituents from grape seeds (fiber, tR and PACs) into flour, as a potential fortified ingredient for the elaboration of bakery products with antidiabetic properties.

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SEAWEED POLYSACCHARIDES AS FUNCTIONAL INGREDIENTS IN GLUTEN-FREE FOODS

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Bakery and pasta products constitute the main source of carbohydrates in Western countries. They are mainly composed of wheat flours and other gluten-containing cereals such as rye or oats. Regarding celiac individuals, there are several products available using gluten-free flours, mainly composed of maize and/or rice or potato. However, this lack of gluten results in foodstuff with poor mechanical properties and structure, as well as lower nutritional quality [1]. To solve this issue, one of the main strategies in processed gluten-free products consists in incorporating hydrocolloids to the flour in order to improve its water holding capacity and mechanical properties [1]. Seaweed polysaccharides, in particular alginate, agar, and carrageenan, are the most exploited hydrocolloids used for this purpose as gelling and thickening agents [1,2]. However, other seaweed polysaccharides such as ulvan, laminarin or fucoidan have been proposed as innovative alternatives with the advantage of providing additional biological activities (antioxidant and fiber-like digestibility) [2,3]. Furthermore, their application in gluten-free products is increasingly developing given that they can be applied at concentrations about 2-8% of the total flour composition, effectively increasing consistency and viscosity and improving the overall rheological properties of this flour foodstuff [2,3]. Their incorporation into flours has been shown to yield effective improvement of rheological and biological properties either as purified compounds or as part of whole seaweed biomass [2]. Therefore, their addition in pasta and bakery products can not only improve sensorial and mechanical properties of gluten-free pasta and bakery products, but also act as health-promoting functional ingredients [3]. Thus, these polysaccharides with marine origin may be regarded as molecules of great value for diverse functions in grain-based foods. In this context, this study aims to review challenges and recent developments involving the use of these marine hydrocolloids in pasta and bakery products.

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THYMUS MASTICHINA L. AS A NATURALALTERNATIVE FOR FOOD PRESERVATION: STUDY OF BIOACTIVITIES AND PHENOLIC PROFILE

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Market challenges are a strong promoter to innovation in the food preservatives segment, especially regarding consumer resistance to the use of artificial additives [1]. Plants belonging to the genus *Thymus* are traditionally used as spices in folk medicine and are characterized as promising sources of natural additives [2,3]. Thus, the present work aimed to identify and quantify the phenolic compounds and evaluate the bioactive properties of *Thymus mastichina* L., to validate its application as a natural preservative ingredient to be applied un the bakery and pastry industry. The chemical composition of *Thymus mastichina* L. aqueous extract was analyzed by chromatographic methods (HPLC-DAD-ESI/MS), followed by the identification of its individual compounds by comparison to literature data and commercial standards. To prove its bioactive properties, different *in vitro* tests were carried out to test its antioxidant properties (oxidative hemolysis inhibition (OxHLIA), reducing power, and free radical scavenging capacity (DPPH)), antimicrobial activity (evaluated using a panel of six bacteria and six filamentous fungi), anti-inflammatory action (in rat macrophage cells, RAW 264. 7), and cytotoxicity (in human tumor cell lines: MCF-7, breast carcinoma; NCI-H460, lung cancer; AGS, gastric carcinoma; and in non-tumor cells, PLP2 and Vero, by the sulforhodamine B method). Regarding the individual phenolic compounds, 12 distinct compounds were identified, derived from flavonoids and phenolic acids, in which kaempherol-*O*-hexuronoside stood out as the major compound. The antioxidant activity was the biological activity that stood out, with the extract presenting low EC_{50} values (0.048 ± 0.002 mg/mL, 0.035 ± 0.001 mg/mL, and 19.0 ± 0.6 µg/mL for DPPH, reducing power, and OxHLIA assays, respectively). In the cytotoxic assay, the extract showed higher efficiency for AGS cell line (59 ± 5 µg/mL), and for the antimicrobial activity, fungicidal (CMF) and bactericidal (CMB) potential was observed with a concentration range of 2 - 4 mg/mL. In general, based on the bioactive properties demonstrated by thyme extract, it can be considered as a natural ingredient with potential application in the food industry, attributing benefits to new food formulations, especially those developed in the bakery and pastry industry.

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TRADICIONAL CAKE "ECONÓMICO" WITH CHESTNUT FLOUR – NUTRITIONAL AND CHEMICAL PROPERTIES

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"Económicos" are highly appreciated traditional Portuguese pastry products made with a mixture of cheap ingredients, such as flour, sugar, margarine, olive oil, eggs, and brandy, and consequently it has a low nutritional value [1]. Several studies demonstrated the nutritional power of chestnuts (*Castanea sativa* Mill.), given its richness in carbohydrates, fibers, fatty acids, minerals, and vitamins. A considerable amount of chestnuts cannot be marketed due to their physiological characteristics, being an interesting raw material to explore for other food food bulking [2]. Thus, this work intended to improve the nutritional and physical characteristics of "Económicos" through the incorporation of chestnut flour. Two sample batches were prepared, one containing "Económicos" with 9% of chestnut flour and another one with traditional "Económicos". The centesimal composition, including proteins, crude fat, moisture, ash, fibers, carbohydrates, and energy were performed following the AOAC official methods [3]. The chemical composition, encompassing free sugars, organic acids and fatty acids was evaluated following procedures previously described by Barros et al. [4]. The most abundant nutrient in both batches were the carbohydrates (cake with 9% chestnut flour – 60 ± 2 g/100g fresh weight; traditional cake – 57 ± 2 g/100g fw), followed by crude fat. Although the incorporation of the 9% of chestnut flour did not reveal drastic changes in the nutritional profile of the cakes, a slight but statistically significant increase was verified in carbohydrates as also a decrease in the fats. In both batches, only one sugar, sucrose, and two organic acids, oxalic and fumaric, were identified and quantified, but the batch of "Económicos" with 9% chestnut flour was the one that contained the greatest amount of these compounds (sucrose- 35 ± 1 g/100 g fw; oxalic acid - 0.07±0.01 g/100 g fw; fumaric acid - 0.0021±0.0006 g/100 g fw). Regarding the fatty acids present in the two batches of cakes, fifteen compounds were detected; however only five of these compounds were in a percentage greater than 1%. Thus, the most abundant individual fatty acids were butyric acid (C4:0), followed by oleic and linoleic acids. Overall, the addition of the chestnut flour did not drastically change the appearance of nutritional and chemical profile of the cakes, but it reduced the content in fat, and most importantly, introduced healthier flour from no commercial chestnuts to this inexpensive cake.

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Novel technologies, processes, and products (Poster)

VALORIZATION OF APPLE BY-PRODUCTS INTO FLOUR: NUTRITIONAL AND CHEMICAL CHARACTERIZATION AND EVALUATION OF BIOACTIVE PROPERTIES

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The study of fruit and vegetable by-products has aroused great interest, not only in the agri-food industry, for sustainability and economic reasons, but also among the scientific community, which has been highlighting these underutilized and cheap materials as renewable sources of bioactive molecules, including phenolic compounds [1]. In this perspective, the present work aimed to characterize the nutritional and chemical composition of apple by-product flour, as well as to evaluate its bioactive properties in order to assess its potential application in the food industry. The centesimal composition (protein, ash, fat, and carbohydrate contents and energy value) was evaluated following official methodologies (AOAC) and the chemical profile (free sugars and fatty acids) was determined by different chromatographic techniques. The antioxidant activity was evaluated through two *in vitro* assays: the thiobarbituric acid reactive substances (TBARS) formation inhibition assay and the oxidative hemolysis inhibition assay (OxHLIA). The cytotoxic activity was tested in tumor and non-tumor cell lines by the sulforhodamine B method, and the anti inflammatory potential was evaluated *via* NO production inhibition by lipopolysaccharide-activated RAW 264.7 macrophages. Finally, the antimicrobial capacity against sixteen strains of Gram-negative and Gram positive bacteria and against two fungal strains was evaluated through a microdilution method. The characterized apple by-product contained 84.2 ± 0.1 g/100 g of water. In terms of dry weight, carbohydrates (14.22 ± 0.05 g/100 g) were the macronutrients presented in higher amounts, followed by ash (1.34 ± 0.05 g/100 g). The fat concentration was considerably low. Regarding the sugar profile, two monosaccharides (glucose and fructose) and one disaccharide (sucrose) were detected in the flour sample, and fructose was the main one. Considering the fatty acid profile, fourteen compounds were identified, with oleic (C18:1n9), linoleic (C18:2n6) and palmitic (C16:0) acids in the highest percentage (38.8 ± 0.1%, 27 ± 1% and 19 ± 1%, respectively). Regarding the bioactive potential, the apple by-product flour, despite showing cytotoxic potential for only one of the tested cell lines, revealed favorable antioxidant and antimicrobial activities. Based on the results obtained, it can be concluded that apple by-product flour has potential for application in the food industry, namely as an alternative ingredient for food products for celiac people. The valorization of this by-product also contributes to the circular economy and environmental issues.

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Chenopodium quinoa SUPPLEMENTED WITH NITROGENATED SOURCES AS A CULTIVATION MEDIUM AND ITS EFFECT ON THE PRODUCTION OF PIGMENTS FROM *Monascus purpureus*

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Monascus pigments are natural dyes widely used for colouring meat products, enhancing aroma and flavour of meat [1]. The present study was conducted to evaluate pigment production in quinoa (*Chenopodium quinoa*)-based culture media with both natural and synthetic nitrogen sources. Pigment concentration was determined spectrophotometrically at 400, 470 and 500 nm for yellow, orange and red respectively [2]. In general, as the mycelium developed in the culture media, more pigmentation occurred (Figure 1). The concentration of pigments produced in quinoa media with synthetic nitrogen sources: yeast extract (M4), monosodium glutamate (M5) and peptone (M6) showed no significant differences ($p>0.05$) even though mycelial growth tended to be in this order: M6>M4>M5. On the other hand, natural nitrogen sources showed no significant differences until day 12; whereas on day 14 a higher concentration of yellow, orange and red pigments was observed for fish hydrolysate (M3). From this work, it can be deduced that natural nitrogen sources can be selected to increase the pigment production of *M. purpureus*.

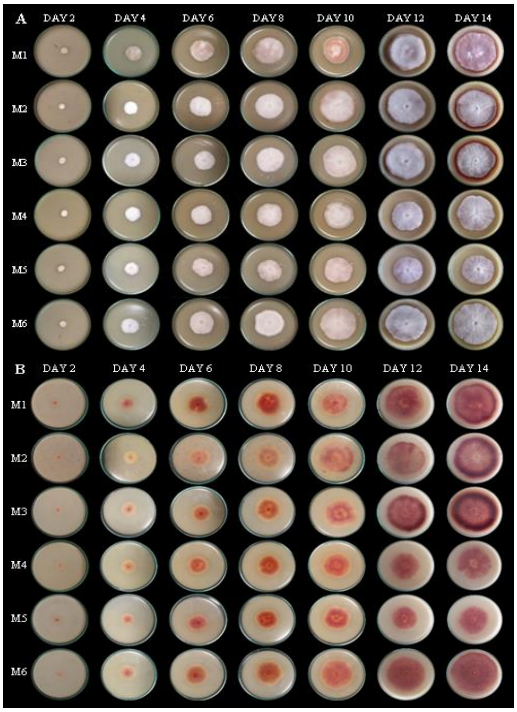

Figure 1: (A) and (B) *M. purpureus* evaluated in quinoa-based culture media with natural nitrogen sources: fish fermentate (M1), fish meal (M2) and fish hydrolysate (M3) and synthetic nitrogen sources: yeast extract (M4), monosodium glutamate (M5) and peptone (M6) during 14 days of fermentation in Petri dishes.

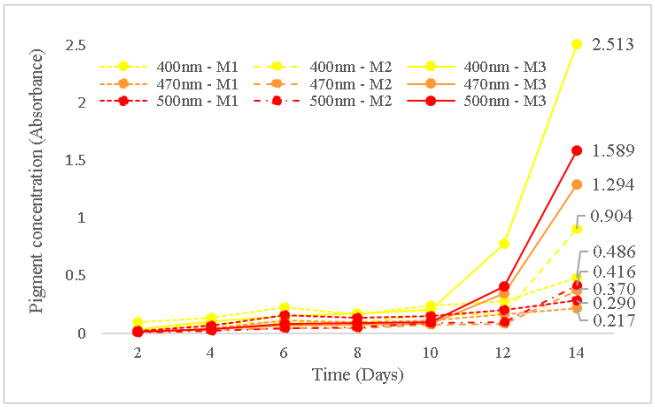

Figure 2: Concentration of pigments produced by *M. purpureus* on quinoa supplemented with natural nitrogen sources during 14 days of fermentation

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EFFECT OF THE MICROWAVE IRRADIATION TREATMENT ON THE PROTEIN FRACTIONS AND FUNCTIONAL PROPERTIES OF TEF FLOUR (DZ-CR – 438)

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The aim of this study was to investigate the effect of microwave irradiation (MW) on the protein fractions and functional properties of tef flour (variety DZ-CR – 438). For this purpose, the tef flour (with 20% of moisture content) was submitted to irradiation following the protocol described by Solaesa et al. [1]. The total irradiation times ranged from 1 to 6 min (in cycles of 10 s irradiation and 50 s of rest). The Osborne protein fractionation method was applied to extract albumins, globulins, prolamins and glutelins protein fractions [2]. Bradford [3] and SDS-PAGE [4] methods were used to quantify and characterize the protein fractions extracted from tef flours (native and treated). The total protein content in the native flour was 9.7%. The main protein fraction found in the native flour was glutelins (47.7 mg /g flour), followed by prolamins (17.0 mg /g flour), albumins (12.55 mg /g flour) and globulins (3.96 mg /g flour), which represented more than 80% of total protein content. The same profile was observed for the treated flours. The treatment performed at one min did not significantly alter the content of the protein fractions present in the native flour. However, a reduction in the content of albumins (66%), globulins (31%) and glutelins (16%) was observed in the flours treated for six min, denoting a decrease of these proteins solubility as a result of the MW treatment. These results were confirmed by electrophoresis analysis, which showed less intense bands for the albumins and globulins fractions obtained after six min of treatment. On the opposite, prolamins fraction increased in the 6 min MW-treated flour, which could be associated with the partial solubilization of albumins and globulins in the hydroalcoholic solvent. The electrophoresis analysis showed that the studied treatment did not change the protein profile, since the same bands were observed in the native and treated flours. Major bands of SDS-PAGE of albumins, globulins, prolamins and glutelins appeared between molecular weight markers of 10–72, 35–60, 15–100 and 15–25 kDa, respectively. The treatment times studied also affected the functional properties of the tef flour. After six min of irradiation, the flours showed an increase in the water-holding capacity (from 2.03 to 2.19 g/g) and in the oil-holding capacity (from 0.89 to 1.18 g/g) and a reduction in the emulsifying activity, emulsion stability, foaming capacity and foam stability. On the other hand, the short treatment led to a significant increase in the foaming capacity (+94%) of the flour, indicating an increase in the functional properties of the proteins. The results obtained in this study show that microwave irradiation time is a process parameter that affects the protein fractions content and the functional properties of the tef flour in a different way, and therefore, it should be selected according to the final application of the flour.

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Euterpe oleracea M. fruit as a source of natural pigments

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Color is an attribute that decisively influences consumer preference when purchasing a particular food. In this sense, interest in the use of natural dyes is growing every day, in addition to studies on sources that allow the use of these compounds in detriment to the use of artificial dyes, especially in the food industry, in bakery and pastry products, making them more natural, colorful, and attractive. In recent years, *Euterpe oleracea* M., has gained importance due to its health benefits, associated with its phytochemical composition and antioxidant capacity. This fruit is found in abundance in northern Brazil and has a high content in anthocyanins, besides being a highly nutritious fruit. The great interest in anthocyanins as food ingredients has advantages because they have a strong coloration and are water soluble, which simplifies their incorporation into aqueous food systems. Therefore, the aim of this work was to perform the determination of anthocyanin and non-anthocyanin compounds extracted in an 80% hydroethanolic solution (*v/v*) through the maceration technique. The anthocyanins were identified and quantified by LC-DAD-ESI/MS^n, with results expressed in mg/g extract. According to the obtained results, five compounds were obtained, being cyanidin-3-*O*-glucoside (4.7 ± 0.2 mg/g) the most abundant one, followed by cyanidin-3-*O*-rutinoside (4.54 ± 0.03 mg/g), compounds thar are described as strong antioxidant molecules. The less abundant compounds were the cyanidin-3,5-*O*-hexoside-pentoside (1.12 ± 0.01 mg/g), followed by peonidin-3-*O*-rutinoside (1.01 ± 0.02 mg/g) and pelargonidin-3-*O*-rutinoside (0.60 ± 0.01 mg/g), counting for a total content of 12.0 ± 0.2 mg/g of anthocyanins. For the non-anthocyanin compounds, four peaks were quantified, being taxifolin-*O*-deoxyhexosylhexoside obtained in higher amounts (4.34 ± 0.03 mg/g), followed by sinapoyl hexoside (2.27 ± 0.04 mg/g), quercetin-3-*O*-rutinoside (2.21 ± 0. 06 mg/g) and finally isorhamnetin-3-*O*-rutinoside (0.54 ± 0.02 mg/g), in a total of 9.4 ± 0.2 mg/g phenolic compounds (TPC) of which 7.1 ± 0.1 mg/g are total flavonoids (TF) and 2.27 ± 0.04 mg/g are phenolic acid (TFA). Overall, it is possible to conclude that this fruit can be a possible candidate to be used in the bakery industry as a natural colorant, adding value in replacing synthetic additives and increasing the attractiveness of the products given its richness in natural pigments that are responsible for its purple color.

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Evaluation of baking powder and baker's yeast addition to gluten-free doughs and geometry on 3D printing bread

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In recent years, three-dimensional (3D) printing technology has received a large interest in the food sector. 3D printing is a technology that uses a layer-by-layer material deposition mode to manufacture 3D objects [1]. The main advantage of 3D printing technology is to design and manufacture personalized foods, with different shapes and dimensions [2]. In this study, the aim was to evaluate the addition of baking powder and baker's yeast in gluten-free bread dough and the differences in the geometries (rectangle and oval) printed in 3D on physical-chemical properties. Rectangles and ovals 7 cm long, 3 cm wide, and 2 cm high were printed in triplicate (**Figure 1**). Moisture, color, texture, and image analysis were determined before and after baking the printed 3D figures. It was observed that the samples with baking powder had lower L* values, so they were darker than the rest in both the crust and the crumb. Moreover, they presented higher a* and b* values and therefore showed a more brownish-yellowish coloration. Samples with baking powder showed the highest hardness values. Samples with baker's yeast showed higher moisture values. The height and width of the figures increase and the length decreases after baking. Samples with baker's yeast after baking showed the greatest differences with respect to the established geometry, due to the fermentation process of the dough, producing greater aeration.

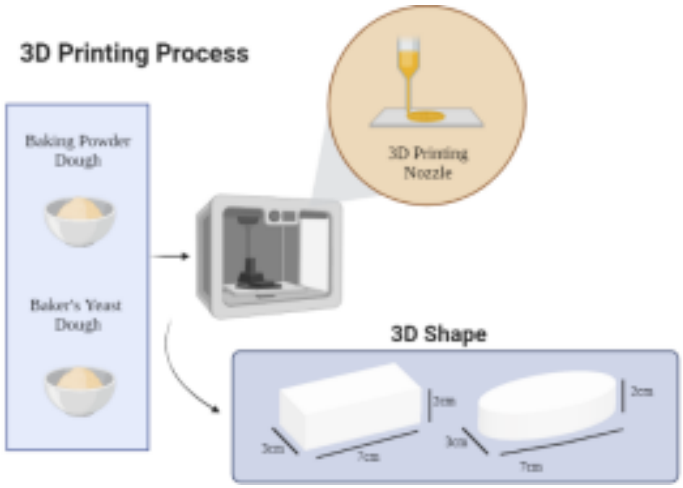

Figure 1: 3D Printing Process.

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EXTRUSION PROCESS EFFECT ON RESISTANT AND TOTAL STARCH IN GLUTEN-FREE FLOUR ENRICHED WITH GRAPE SEEDS (*Vitis vinifera* L.)

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Extrusion cooking allows the production of a wide range of gluten-free food products based in pulses [1]. It has been highlighted that products based on lentils as main ingredient can stimulate metabolic functions to prevent cardiovascular diseases, diabetes or colon cancer [2]. The incorporation of grape seed in lentil based food formulations result in an enrichment on dietary fiber and bioactive compounds [3]. These foods could generate also a prebiotic effect, due to the resistant starch content which fulfill important functions in colonic digestive physiology, exerting positive benefits for the health of consumers [4]. The main objective of the present study was to characterized the resistant starch (RS) and total starch (TS) content in different raw and extruded flours based on lentil-corn (30:70), with the incorporation of Cabernet Sauvignon grape seed (CS -Sd 0 – 20%) and Hylon V® (0 – 20%). The content of RS and TS was analyzed using Megazyme kits based on the AOAC 2002.02 [5] and 996.11- 76.13 [5] methods respectively. The results obtained showed that the raw control flour (formulated with 93.75% lentil-corn flour) contained 3.22% and 54.10% resistant and total starch, respectively. It was observed that the incorporation of 20% of Hylon V significantly increased ($p < 0.05$) the RS content (7.64 and 5.30% in raw flour). However, the extrusion process significantly ($p<0.05$) decreased the RS content in the analyzed samples, while the TS content was not significantly affected. Other authors obtained similar results of TS before and after extrusion of formulations based on legumes (beans) but with a total decrease in RS after the extrusion process [6]. The extrusion cooking is an important technological treatment that can maintain RS content in legume and cereal-based formulations to develop gluten-free snacks. Therefore, the analyzed extrudates formulated with lentil-corn flour, Hylon V and grape seed, could suggest functional and healthy foods.

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Sustainability and circular economy (Poster)

MICROWAVE RADIATION TREATMENT OF TEF GRAIN AND FLOUR . EFFECT ON ITS TECHNO-FUNCTIONAL PROPERTIES

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Tef (Eragrostis tef), an ancient grain extensively cultivated in countries like Eritrea and Ethiopia, provides a promising alternative for the developing of new food due to its high nutritional value [1]. In recent years, the use of gluten-free (GF) cereals such as tef has attracted a great deal of research interest for its potential health benefits. In addition, the currently available GF products in the market have less nutritional value [2] and often poorer physical and sensorial quality than their gluten-containing counterparts. For improving the functionality of flours different methods of physical modification have been employed including hydrothermal treatments. The use of microwave radiation (MW) to carry out these treatments provides a faster and environment friendly technology than conventional heating [3]. The objective of this study was to evaluate the effect of MW treatment of white tef grain (WTG) and flour (WTF) on their techno-functional and rheological properties. WTG and WTF were conditioned at 15% moisture content and microwaved for 480s in cycles of 10s radiation and 50s rest. The treatments were carried out in a hermetic teflon container, where the grains and flours were constantly stirred to ensure the homogeneity of the treatment. The grains, once treated, were milled and the resulting flour was studied along WTF. MW treatments of WTG and WTF significantly increased the particle size of the flour. Higher values of hydration properties and lower viscometric profiles, with delayed pasting temperature were observed in the treated flours with respect to the native flour. In general, the treatment had a higher impact on the final properties when was applied on flour than grain. MW treatments had a structuring and stabilizing effect of the tef gels, resulting in an increase in the viscoelastic moduli (G' and G") and in the stress that the gels withstood before breaking their structure.

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USE OF MICROWAVE-TREATED FLOURS AT DIFFERENT MOISTURE CONTENTS IN THE PRODUCTION OF GLUTEN-FREE BREADS

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In recent years, research on gluten-free production processes has increased due to the increasing number of patients with celiac disease, and the growing prevalence of non-celiac gluten sensitivity disease [1]. In the present study, the physical modification of rice flour by hydrothermal treatment at constant moisture assisted by microwave radiation was investigated, as well as its effect on the pasting properties of the flours, the rheological properties of the doughs, and the quality of the resulting breads. Microwave treatments were carried out at three flour moisture levels, 8% (MW-8%), 13% (MW-13%) and 30% (MW-30%), and the treated flours were used in bread-making at two levels (15% and 30%) of substitution of native flour. Regarding the pasting properties of the treated flours, it was found that the flour treated at the highest moisture content showed the highest pasting temperature, and the lowest peak and final viscosities (**Figure 1**). The most significant changes occurred in MW-30% flour [2]. The most significant rheological changes were observed in doughs made with rice flour treated with MW-30%. The elastic modulus doubled and quadrupled, for 15% and 30% substitutions, respectively, with respect to the control dough, made with 100% native flour.

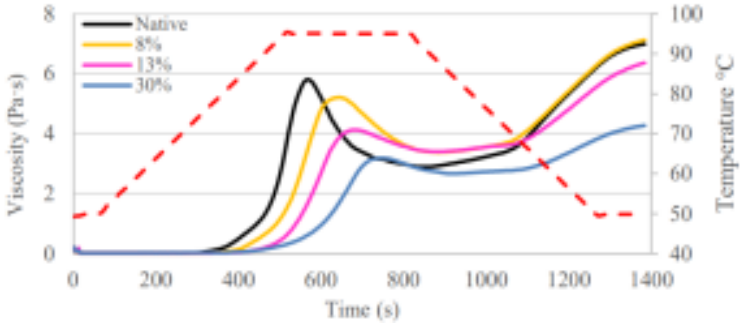

Figure 1. Pasting profiles of MW treated-rice flours. Discontinuous red line represents the temperature (right Y-axis).

Regarding the physical properties of the breads, it has been shown that, in all the breads, the use of MW treated flour, regardless of the humidity during treatment and the level of native flour substitution, resulted in breads with a higher specific volume and lower hardness. In addition, the increase in crumb hardness at 2 days, with respect to the control, is lower in breads made with the treated flour, indicating that the treatment increases the shelf life of gluten-free breads. It is concluded that there are no significant changes in the color of the crust or crumb of the breads made with treated flour, except in the bread made with the 30% of MW 30%, which presented a slightly more vivid color in the crust.

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ANTIDIABETIC POTENTIAL OF CEREAL BYPRODUCTS

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Type 2 diabetes mellitus is a complex metabolic disorder described by hyperglycemia and glucose intolerance. It is considered a new pandemic and its control involves numerous challenges[1]. Currently, the most common treatments consist of the use of oral hypoglycemic agents and insulin, treatments that have shown side effects(cardiovascular problems, liver and kidney disease, weight gain)[2]. Dietary therapy displays a promising alternative for the prevention and treatment of this type of diabetes[3]. In this regard, cereals (especially whole grain with high contents of fiber or amylose content) are increasingly being incorporated in dietetic formulations designed to contribute to the amelioration of such disorder due to their antidiabetic potential[4]. This bioactivity is mainly due to their high content of fiber[5], which has several diabetes-related effects that include enhancement of insulin sensitivity, modulation of the secretion of certain gut hormones, and effects on various metabolic and inflammatory markers[6]. Moreover, soluble fiber inhibits the absorption of macronutrients, reduces the postprandial glucose response, and beneficially influences certain blood lipids[6,7]. Prospective cohort studies have shown that insoluble fiber intake is associated with a reduced risk of diabetes, but the mechanisms involved are unknown[6]. Antidiabetic potential might also be ascribed to the presence of polyphenols[8], which could decrease insulin response, glycemia and insulin resistance, modulate carbohydrate and lipid metabolism, and regulate oxidative stress and inflammatory processes[9]. Large quantities of cereal by-products (*e.g.*, rice and rye by-products, or corn bran) are discarded worldwide and could be valorized since they are a rich source of fiber and polyphenols[8,10,11]. In this way, these by-products could be directly used in food fortification aiming to diabetic people or they could be subjected to extraction of the relevant compounds to be then used as nutraceuticals in functional foods. In conclusion, valorization of cereal by-products offers many applications by obtaining value-added products with health-benefits for diabetic people within the circular and sustainable bioeconomy perspective, which not only represents potential applications, but also represents a favorable measure for the environment, and results in the formation of value-added products within a circular and sustainable bioeconomy[12].

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BIOACTIVE "FLOURS" FROM BREWING BY-PRODUCTS: A SUSTAINABLE AND HEALTHY ALTERNATIVE FOR FOOD INDUSTRY

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Brewing industry generates annually millions of tons of by-products available at low or no cost, which represent an ecological and economical problem [1]. Nevertheless, the two major brewing by-products, brewer's spent grain (BSG - the insoluble part of the barley grain) and spent yeast (BSY) are rich in proteins and fibre, which can be fractionated to produce innovative and sustainable healthy "flours" for food industry. BSY and BSG protein fraction can be hydrolysed to produce diversified peptides presenting numerous functional activities (bioactive peptides) that enhance health, reduce the risk or ameliorate several pathological conditions [2]. Therefore, these proteins can offer additional health benefits beyond nutrition. On the other hand, BSY and BSG fibre fraction contains (1-3)-β-d-glucans, which are a major structural component of cell walls and present beneficial health properties when included in daily diet. (1-3)(1-4)-β d-Glucan occurs in cereals, while (1-3)(1-6)-β-d-glucan is mainly present in yeast [3], their use as food ingredient is approved by EFSA. The recovery of BSG and BSY peptides and fibre is a recent research area that has been constantly growing and the promising results collected so far indicate they could be translated the into future commercial food products [3]. The goal of this study is the production and characterization of protein rich fraction from BSY and BSG that present antioxidant and blood pressure reducing effects, targeting their use as food bioactive ingredients to prevent hypertension. BSG and BSY from Lager beer (Saccharomyces pastorianus) production was supplied by a local beer industry. Extraction of BSG and BSY proteins was performed following a sustainable and environmentally friendly protocol allied with economic and social benefits. BSY proteins (33.5%/dw) were extracted by a mechanical disruption process recovering 173.7mg proteins/mL. BSY protein fraction presents a well-balanced amino acid profile. Yeast contains several proteolytic enzymes and due to the mild conditions used for preparation of BSY protein extracts, proteolytic activity was maintained (0.94U/mL). BSG proteins (26.9%/dw) were subjected to alkaline extraction culminating in 17.3mg protein/mL. Hydrolysis of both protein sources performed by using BSY proteolytic enzymes is promising, and the hypotensive effect of these peptides is being studied in vitro using vascular cells and tissues to support its effective bioactivity. The process to adapt the protein hydrolysates' protocol to an efficient and cost-effective industrial scale production of innovative ingredient is under progress.

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CIRCULAR USE OF CRAFT BEERS BY-PRODUCTS: CHARACTERIZATION OF THE PHENOLIC PROFILE AND ANTIOXIDANT CAPACITY OF SPENT GRAINS AND HOPS

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Craft beers is a new concept introduced in the beer industry with great growth [1,2]. Although no definition legally determined, most authors define it as a product that is produced using traditional practices and using traditional raw materials, namely water, malt, hops, yeast or innovative raw materials, such as fruits or spices [3,4]. The production of craft beer includes the formation of huge amount of various by-products such as spent grains and spent hops. The high production of theses by-products spell a major environmental problem and can be reused for microalgae production, biofuel production, extraction of polyphenolic and antioxidants as a way of help achieve ecological sustainability [5,6]. In this sense, the main goal of this study was to determine the phenolic composition and antioxidant capacity of two different by-products of the craft beer industry, namely spent grains and spent hops. The evaluation for each by-product was carried out by the determination of the total polyphenolic, *ortho*-diphenols and flavonoids contents and the determination of antioxidant capacity using the ABTS and DPPH methodologies. The results indicated that there were significant differences in the content of phenolic compounds and antioxidant capacity of the analyzed by-products. The results of total phenolic content, *ortho*-diphenols, and flavonoids demonstrated the highest concentration of these parameters was found in spent hops, with 8.63 ± 0.38 mg GA/g, 20.40 ± 0.67 mg GA/g, and 2.07 ± 0.13 mg CAT/g, respectively. Concerning the $ABTS^{\bullet+}$ and $DPPH^{\bullet}$ methodologies, spent hops was also the by-product that presented the highest antioxidant capacity for both methods, namely 0.08 ± 0.00 mmol Trolox/L and 0.06 ± 0.00 mmol Trolox/L, respectively. Thus, the reuse of these by products represent sustainable and good alternative for bioactive compounds recovery and could be significantly useful in cosmetic, pharmaceutical and food industry.

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COFFEE BY-PRODUCTS: A POTENTIAL SOURCE OF ALTERNATIVE FLOURS WITH PREBIOTIC PROPERTIES

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Coffee is one of the most popular beverages in the world, but it also produces considerable amounts of by products such as pulp, parchment, silverskin, and defective beans. In general, all these parts are high in dietary fiber (xylans, arabinogalactans, galactomannans) and phenolic compounds (chlorogenic acids) [1]. These components have been associated with prebiotic properties, that is, they have low digestibility and stimulate the growth of beneficial bacteria in the colon [2,3].

Coffee by-products can be an interesting solution to improve the functional and nutritional properties of traditional bakery products [1]. In this work, the use of different coffee by-products as a source of prebiotic ingredients, as well as their potential application in bakery products was ascertained, having in view the economic valorisation and contribution to food security. According to the findings, coffee by-products are frequently used to produce oligosaccharides (structures containing 2 to 20 sugar units). These structures meet prebiotic requirements: low digestibility, sometimes lower than inulin [3]; promote the growth of beneficial bacteria as *Lactobacillus* and *Bifidobacterium* [4]; inhibit the growth of pathogenic bacteria as *Escherichia coli, Bacillus cereus* and *Salmonella* Paratyphi [5]; and increase the production of short-chain fatty acids with potential health benefits in a dose-dependent manner [6]. Spent coffee grounds and silverskin also demonstrated a positive impact on the gut microbiota, increasing bifidobacteria number while lowering clostridia and bacteroides [7]. In general, fecal bacteria have the ability to use coffee by-products as a carbon source. Considering the attributes of coffee by-products, they could be used as alternative flours in bakery products. In some studies, they were included in bread and cookies, with interesting nutritional, sensory, and rheological results [1,8]. Using coffee by-products as an alternative flour can be a viable approach for adding value to these materials, promoting the circular economy, and obtaining a functional food at the same time.

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IDENTIFICATIONS OF MOULDS ISOLATED FROM ARTISANALAND INDUSTRIAL BREADS

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Bread is one of the main foods in the Mediterranean diet. Its consumption per capita in Spain is 37.8 kg. Some environmental conditions in both retail and homes, such as high temperature or humidity, can lead to microbial growth in bread, such as moulds. These could be dangerous because of the formation of toxic metabolites, called mycotoxins, which could cause several health damages. Intrinsic parameters like water activity, pH, and moisture are the most critical factors in controlling the growth of bread microorganisms. The pH of bread is about 5.5 to 6.0, and aw in crust and crumb is below 0.85 and above 0.925, respectively. This study, counted, identified, and characterised several moulds and yeasts isolated from bread typical of the centre of northern Spain.

Four artisan and four industrially produced breads: white wheat loaf, whole wheat loaf, Candeal bread, and Tin bread loaf were collected by two artisanal and two industrial bakeries twice and on different days from September until February 2021 in Valladolid city.

Two characteristic colonies of moulds were collected from each plate. Then, samples were then processed by MALDI-TOF MS using three protein extraction methods, i.e. extraction with a water-formic acid solution, extraction with zirconia-silica beads, and extraction with an ethanol-water solution.

Non-significant differences ($p>0.05$) were found in mould counts between crust and crumb. Counts of moulds were between 0.85 to 1.85 Log ufc/g and 0.5 to 1.39 Log ufc/g for artisanal and industrial bread, respectively. The significant presence of moulds in artisanal bakeries could be related to the hygienic condition of equipment, the practices of bakery staff and the bakery environment.

MALDI-TOF MS identified a total of 15 out of 21 mould strains isolated from the above mentioned four types of bread. Using the protein extraction with a water-formic acid solution was possible to identify only one isolated strain. Following the extraction with zirconia beads were identified 9 of 21 mould strains. The extraction with ethanol-water identified 12 of out 21 of moulds isolated. The main moulds and yeasts identified in bread were *Penicillium chrysogenum, Pernicillum camembertii, Aspergillus niger* and *Candida solani.* Both *Pelicillum chrysogenum* and *Aspergillus niger* are considered as producer ochratoxin A (OTA). Moreover, the last mould species can also be considered as a potential producer fumonisin (FB2) because most of the strains isolated presented *fum1* genes. Although cereal products are not the main foodstuffs associated with mycotoxins, studying their presence in the bread seems to be necessary.

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COFFEE SILVERSKIN AS A SUSTAINABLE INGREDIENT TO PREVENT TYPE 2 DIABETES

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Coffee silverskin (CS), the major by-product of coffee roasting, has been appointed as a valuable ingredient for functional food formulation due to its nutritional and phytochemical profiles. CS is rich in protein and dietary fiber, reported to reduce the glycemic response [1], as well as in several bioactive compounds recognized to modulate sugar metabolism, such as chlorogenic acids (CGA) and caffeine [2]. This work aimed to study the potential of CS in the formulation of a bakery product able to prevent or manage type 2 diabetes. For that, their protein and dietary fiber contents were investigated, and extracts were studied regarding CGA profiles, caffeine contents, and effect on intestinal glucose and fructose uptake. CS was supplied by BICAFÉ, after roasting a commercial coffee blend (210 °C, 10 min). Total protein and soluble and insoluble fiber were performed according to AOAC procedures [3]. The extracts were prepared by a green technology, using an ultrasound probe and only water as a solvent. After, replicates were freeze dried (-80 °C, 0.015 mbar), and the obtained powder characterized RP-HPLC-DAD [4]. To evaluate the effects on glucose and fructose intestinal uptake, Caco-2 cells were incubated with CS extracts and after the uptake of each sugar was measured by incubating the cells with 10 nM ^{3}H-deoxy-D-glucose (^{3}H-DG) or 100 nM ^{14}C-fructose (^{14}C-FRU), respectively [5]. The effects of caffeine and 5-*O*-caffeoylquinic acid (the major compounds detected in the extract), alone and combined, on ^{3}H-DG and ^{14}C-FRU uptake were also studied for comparative purposes.

CS showed to be rich in protein (~12 g/100 g) and dietary fiber (~56 g/100 g), mainly insoluble fiber (~49 g/100 g). In CS extract, caffeine was the main compound (~27.7 mg/g), followed by 5-*O*-caffeoylquinic acid (5-CQA, ~2.0 mg/g), the major CGA. Regarding the effects on sugar uptake, CS extract was able to significantly reduce (p<0.05) both ^{3}H-DG (~17%) and ^{14}C-FRU uptake (~19%). Furthermore, caffeine and 5-CQA presented no effects when tested individually, but significant reductions of both sugar uptake were found when the compounds were combined (^{3}H-DG: ~16% and ^{14}C-FRU: ~13%). Overall, CS can be valued and used in food formulations that might present a low glycemic index, the ability to reduce intestinal sugar uptake, and potentially prevent or manage type 2 diabetes.

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NATURAL DEEP EUTECTIC SOLVENTS (NADES) AS A SUSTAINABLE ALTERNATIVE TO OBTAIN POLYPHENOL-RICHEXTRACTSFROMREDCOLOURED POTATOES

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Potato (*Solanum tuberosum* L.) is one of the most important foodstuffs, mainly consumed after processing, which generates tons of waste such as the potato peel. This waste could provide a useful and inexpensive source of high-value compounds for different industry uses [1], Specifically, red-coloured potatoes are rich in anthocyanins, which can be used as additives, colorants or preservatives, in food industry. Natural Deep Eutectic Solvents (NADES) mean an opportunity to carry out green and sustainable extraction of polyphenols, in addition to improve the bioactive properties of the extracts obtained.

The extractive capacities of different natural deep eutectic solvents (NADES), some of them formed by the combination of choline chloride (ChCl) and alcohols (propanediol and butanediol) or acids (lactic and malic), were tested (Figure 1). The most effective one, consisting of choline chloride and lactic acid was used for anthocyanin extraction in peels from four red potato varieties (Rudolph, Memphis, Manitou and Mozart) and the amount of pelargonidin (major compound) in the different varieties were compared (Figure 2). The antimicrobial activity of the extracts and the solvent were also evaluated.

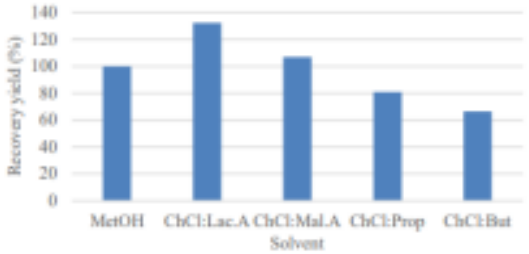

Figure 1: Comparison of anthocyanin recovery yields between NADES and conventional extraction.

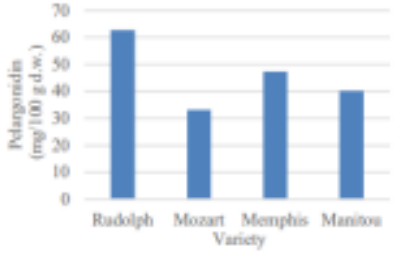

Figure 2: Comparison of pelargonidin content between different red-coloured potato varieties.

The results obtained show that recovery yields are higher in the green extraction, using choline chloride and lactic acid, than in methanolic extraction, being the Rudolph variety the richest. Therefore, NADES were shown to be promising alternative solvents for the isolation of phenolic compounds from by-products. Moreover, the NADES extracts showed good activity against bacterias such as *Enterococus faecalis*, *Escherichia coli*, *Klebsiella pneuoniae*, *Pseudomonas aeruginosa*, *Listeria monocytogenes*, among others. However, further research is needed to assess the properties and safety of the extracts, whether solvents need to be removed from the final extract, and to establish the best method for preserving them.

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SPONGE AND LAYER CAKE FLOURS AS A NOVEL INGREDIENT IN CAKE MAKING

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Food waste has a significantly environmental impact, which will be reduced reintroducing all waste suitable for human consumption on the food chain. Bakery products are the most wasted products after fruits and vegetables. There are already studies using discarded bread in cakes and cookies. Cakes are a popular bakery product that can be wasted in the manufacturing process. The aim of this study is to analyse how adding cake flour to sponge and layer cake formulations influences their final quality to reduce cake waste.

For this purpose, layer and sponge cakes elaborated with wheat flour (control layer and sponge cakes) minced and sieved (1000 µm mesh screen), after 4 days staling at room temperature. After that, layer cakes were prepared adding 10, 20 and 30% of layer cake flour to the total formulation, and sponge cakes adding 10 and 20% of sponge cake flour. The density and viscosity of cake batter, weight loss during baking, specific volume, hardness, springiness, cohesiveness and colour (crust and crumb) of the final cakes were evaluated.

In relation to batter properties, density increased with the addition of any percentage of cake flour in layer and sponge cakes in relation to the control cakes. Respect viscosity, there were no differences in the sponge cakes adding sponge cake flour. However, in layer cakes, the viscosity increased as a higher percentage of cake flour was added. Regarding weight loss during baking, in sponge cakes the addition of cake flour did not produce variations. Nevertheless, in the layer cakes it was reduced when 20 and 30% of layer cake flour was added. In terms of specific volume, in the sponge cakes, it was observed that the higher the percentage of sponge cake flour added the lower the volume. Although, only the sponge cake with 20% of cake flour is significantly lower than the control cake. In layer cakes, the addition of 20 and 30% of cake flour reduced significantly the specific volume. However, the specific volume reduction is much higher for sponge cakes than layer cakes. Concerning textural parameters, in the two types of cake, an increase in hardness was observed with the addition of 20% or more of cake flour. These results are inversely proportional to the specific volume. Springiness and cohesiveness only showed significant differences in layer cakes, decreasing with the addition of cake flour in any percentage compared to the control. In terms of colour, the addition of cake flour to both layer and sponge cakes did not change crust colour. In the crumb the yellowness and redness increased in both types of cake as a higher percentage of cake flour was added. Furthermore, in the sponge cakes, the crumb brightness decreased when 20% of cake flour was added.

The addition of cake flour to reduce food waste in the production of cakes is possible in sponge and layer cakes. However, it is not possible adding more than 10% without significantly modifying the textural properties and the specific volume of the cakes.

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SUSTAINABLE FLOUR PRODUCTION OF *OPUNTIA FICUS-INDICA* (L.) MILLER CLADODES: A MINERAL PROFILE APPROACH

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Currently, consumers are concerned about nutrition and food diversity, favoring healthier foods with proven beneficial effects on health [1]. On the other hand, consumers are increasingly demanding and concerned about sustainability and companies'sustainable practices. *Opuntia ficus-indica* (L.) Miller is a possible food alternative, being part of the dietary pattern of countries such as Mexico [2]. In Portugal, with the increase in prickly pear production, the discarded cladodes generated waste management issues, due to its invasive characteristics. However, this non-valued by-product has potential for valorization due to its nutritional/chemical composition. This work intends, therefore, to valorize cladodes for food consumption and/or applications in the food industry. One example is the production of flours for new food formulations such as bread. Hence, the mineral profile of cladodes of different varieties (2 years old) from plants cultivated in Portugal (Torres Novas) in the organic production mode were evaluated.Regarding methodologies, 4 macro elements (Na, K, Ca, Mg) were determined by flame atomic absorption spectrometry and 27 trace elements (^{7}Li,^{9}Be,^{11}B,^{27}Al,^{48}Ti,^{51}V,^{52}Cr,^{55}Mn,^{57}Fe,^{59}Co,^{60}Ni,^{65}Cu,^{66}Zn, ^{75}As,^{82}Se,^{85}Rb,^{88}Sr,^{90}Zr,^{98}Mo,^{111}Cd,^{118}Sn,^{121}Sb,^{125}Te,^{133}Cs,^{137}Ba,^{182}W,^{208}Pb and^{209}Bi) by inductively coupled plasma-mass spectrometry [3]. In total 31 mineral elements were analyzed.

Concerning the obtained results, all samples had substantial calcium contents (30-110 g/kg) and high levels of potassium (10-50 g/kg). Relevant levels of trace elements were also identified, such as manganese (15-330 µg/g), zinc (5-30 µg/g) and boron (10-20 µg/g). All results are expressed in dry weight. From the 27 trace elements analyzed, the following essential trace elements (Fe, Cu, Zn, Mn, Mo, Co, Cr, Se) were identified in the samples in varying amounts.

According to the obtained results and following circular economy principles, the cladodes have the potential for the development of nutritionally balanced flours, enriched in minerals, which contribute to valorizing this by-product and promoting food chain sustainability.

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THE COMPARATIVE EFFECT OF THE USE OF THREE PULSE FLOURS ON THE QUALITY OF A REDUCED MEAT COOKED SAUSAGE

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An excess in meat consumption can negatively affect health and environmental sustainability. One strategy to reduce meat consumption is to reduce the amount of meat in meat products by using quality plant protein sources, such as pulses [1,2]. Emulsion type sausages allows reformulation approaches and thus a reduction in the amount of meat. Reduced meat frankfurters (38% meat) were made in duplicate following four treatments: control sausage (CON), formulated with meat, 5.3% potato starch and 1.7 % soy protein, and bean (BEA), chickpea (CHI) and lentil (LEN) sausages, formulated with 7% flour from the correspondent three pulses (used without more pre-treatments than milling). All the experimental treatments contained as additional ingredients 35% water, 20% pork backfat, 18 g common salt/kg, 3 g phosphates/kg and spices. The amount of starch and protein among the sausages from the different treatments was similar. The sausages were analysed for water retention, emulsion stability, instrumental texture and color, and oxidative stability after 10 days of refrigerated aerobic storage. The use of pulse flour, with respect to CON, did not excessively modify yield, texture and colour characteristics, although a lower cooking performance and cohesiveness were detected (Table 1). Moreover, pulses promoted the oxidation of the sausages during refrigerated storage with this effect being more intense for BEA sausages. This finding might be explained by the presence in the pulses of lipoxygenase activity (Shi et al., 2020), with a relatively high thermo resistance, and thus resistant to the sausage pasteurization. The effect of pulse flour on decreasing lipid oxidation stability was higher in BEA sausages than in LEN, with CHI being in an intermediate position. Further research is needed on how to ameliorate this negative effect of pulse flours as meat replacers.

Table 1: Table caption

	Control	BEA	CHI	LEN	P-level
Cooking loss (%)	1.77±0.26b	4.18±0.57a	4.46±0.70a	4.56±0.16a	0.011
Cohesiveness	0.92±0.03	0.73±0.03	0.79±0.03	0.75±0.11	0.094
Oxidative stability (mg MDA/kg)[&]	0.59±0.04c	5.21±0.64a	3.63±0.06ab	2.57±0.58b	0.002

MDA: malondialdehyde
[&] Thiobarbituric reactive substances in the sausage after 10 days of refrigerated storage under aerobic conditions.
a,b Mean values with different superscript showed significant differences (Tukey test, P<0.05)

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TRACKING AFRICAN BEANS' DIVERSITY: A PHYSICOCHEMICAL STUDY OF *VIGNA UNGUICULATA* (L.) WALP. AND *PHASEOLUS VULGARIS* L.

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In sub-Saharan Africa, grain legumes (pulses) are essential food sources for the alleviation of malnutrition and can play an important role in sustainable agriculture, due to their ability to fix atmospheric nitrogen **[1]**. The introduced common bean (*Phaseolus vulgaris* L.) and the native cowpea (*Vigna unguiculata* (L.) Walp.), are among the most important pulses in the dry areas of tropical Africa **[2]**. This study has two main goals, specifically, we aim to 1) provide a comprehensive view of the available genetic resources of these genera, including data on germplasm collections and identification of diversity hotspots in Africa; and 2) investigate the patterns of physicochemical variation (i.e., seed phenotypic traits and mineral content) of the *Vigna unguiculata* and *Phaseolus vulgaris*, based on field surveys performed across two African countries (i.e., Angola – Western Africa and Mozambique – Eastern Africa). According to our results, 73 *Vigna* and 5 *Phaseolus* species occur in tropical regions of Africa, with 8 countries accounting for more than 20 native species. Conversely, germplasm collections are poorly represented when compared to worldwide collections. Regarding the chemical composition, *Vigna unguiculata* has higher contents of B, Mg, S, and Zn, while *Phaseolus vulgaris* had more content of Fe, Ca, and Cu. Moreover, the analysis of seed phenotypic traits showed that both studied species presented a varied array of colours and seed shapes. We conclude that both species are important resources to ensure food security in Angola and Mozambique, but native *Vigna* species are often disregarded, even though they have generally good alimentary properties **[3]**. To the best of our knowledge, this is the first comparative physicochemical study, focusing on wild and crop species, collected across different African countries. It is highlighted that interdisciplinary approaches and new data are needed for the sustainable use of African plant genetic resources, contributing to achieve some of the Sustainable Development Goals, such as the reduction of hunger and increasing human health.

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VALORIZATION OF PULSE BY-PRODUCTS FROM THE MEDITERRANEAN DIET

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The increase in standard of living and income, as well as the rising population in developing countries is leading to a drastic increase in the global demand for meat consumption and production. The excessive consumption of meat is well documented to be linked to cancer and several other chronic diseases, posing a great concern for human health. In the other hand, meat production contributes to significant environmental damage being the main reason for deforestation, land degradation, water pollution, desertification and, when compared to plant-based foods, production of meat results in significant higher greenhouse gas emissions. Thus, more sustainable food sources and diets are needed in order to meet future demands regarding global nutrition [1, 2]. Pulses, a low-fat source of proteins and carbohydrates, are known for both their nutritional and environmental benefits. Not only their ability to restore nitrogen content in the soil is an appealing green solution in crop productivity, but pulse grains are also of interest in plant protein based alternatives [3]. The protein content in pulses ranges 17-30% of dry weight, containing higher proportions of protein than other plant foods. Rich in carbohydrates, pulses also provide substantial amounts of minerals and vitamins which bioactivity might improve glycaemic control, protect against hypercholesterolemia, cancer and type 2 diabetes [4]. The present study aimed at characterizing the nutritional composition profile of two types of dry pulses typically consumed in the Mediterranean diet, cowpea (*Vigna unguiculata*) and butter bean (*Phaseolus lunatus*), while focusing on the study of protein extracts. The proximate composition, protein, lipid, carbohydrate, fibre, ash and moisture content was determined. Albumin, globulin, prolamin and glutelin - rich protein extracts (soluble in H20, NaCl, EtOH and NaOH, respectively) were obtained, following the Osborne sequential protein extraction method. Protein content was then determined using Kjeldahl method, with the albumin fraction showing the highest protein content. The future goal is to evaluate the bioactive and technological functionalities of the albumin extracts obtained, which may allow for its use in food formulation.

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