NUTRAGE
Consiglio Nazionale delle Ricerche

BOOK OF ABSTRACT

I WORKSHOP

NUTRAGE
"NUTRIZIONE, ALIMENTAZIONE & INVECCHIAMENTO ATTIVO"

Palermo, 16-17 Maggio 2024

Partners del progetto

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NUTRAGE "FOOD, NUTRITION & ACTIVE AGING"

Italy is one of the countries with the highest proportion of individuals over 65 (more than 22% of the total population). The consequences of the ageing process are multifaceted and involve health, socio-cultural, economic, financial and political factors. Crucially, a longer life expectancy is associated with an increased prevalence of chronic disorders, determining reduced functional capacity and lower quality of life. In fact, among older adults with multi-morbidity, the prevalence of physical and/or cognitive disability exceeds 65%.

The recently released Decade of Healthy Aging (2021-2030) WHO document forcefully calls attention to the importance of a multidisciplinary approach to preventing the most common age-associated diseases and promoting active and healthy ageing. These objectives have also been highlighted by the "Health, Nutrition, Quality of Life" priority topic as part of the National Strategy of Smart Specialization of the Italian National Research Council and the European Green Deal, which is the European Union's response to the climate crisis.

Appropriate, nutritious food choices and healthy diets are essential for maintaining good health, delaying tissue senescence, and preventing neurodegenerative and age-associated diseases. One of the most critical challenges in this context is identifying the dietary patterns that can prevent or delay the onset of these diseases and, simultaneously, develop personalized nutrition programs for target groups with specific chronic diseases. It is well known that the Mediterranean Diet, which is particularly rich in vegetable proteins, mono/polyunsaturated fatty acids, microelements and micronutrients, such as folate, fibers, carotenoids, polyphenols and phytosterols, is a powerful protective tool against the onset of many chronic degenerative diseases typical of older age.

The NUTRAGE project focuses on the study and development of:

i. innovative approaches and technologies related to agriculture (to rethink the supply chain organization and agricultural technologies, specifically regarding health and nutrition);
ii. food (bio)technology-based solutions (to develop products and food processing steps to maintain or increase the nutritional and health value of food);
iii. new nutritional requirements and new knowledges on genetic, genomic (including the microbiota) and physiological responses;
iv. molecular and cellular mechanisms of the ageing process, biomarkers of ageing, and strategies to delay ageing;
v. New omics approaches to the collective study of the role, relationships and actions of food components on microbiota and animal/human physiology, useful to develop predictive models for personalized nutrition;
vi. cultural patterns and practices related to food useful for developing "Nutrition Education" programmes that use of digital platforms to promote consumer awareness.

The 3-year NUTRAGE project, which relies on the multidisciplinary competencies and the network structure of the Italian National Research Council (CNR) and the involvement of several Departments and Institutes, is coordinated by Dr. Antonio Logrieco and Dr. Angelo Santino (DiSBA) and structured in the following work packages:

WP1. Predictive analysis of the metabolic pathways associated with the ageing process and the preventive role of specific dietary patterns;
WP2. Green, sustainable technologies for high agri-food value chains
WP3. Functional and innovative foods with high nutritional value
WP4. Identification and validation of biomarkers associated with the molecular and cellular mechanisms of ageing
WP5. Food and nutrition culture
WP 6. Food and gut microbiome/microbiota
WP 7. Validation of the healthiest dietary patterns and specific biomarkers associated with ageing
WP 8. New approaches to food education
WP 9. Healthy Aging: nutrition and lifestyle

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INVITED TALKS

Lifestyles and aging: the inseparable link between physical exercise and nutrition

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Healthy aging is the result of the interaction between a series of factors throughout life. Age and genetics are two unalterable parameters that contribute to aging, but lifestyle and environment are two key determinants of the aging process and both can be modified with interventions by the individual and society. To a large extent, individual lifestyle can create fertile ground for the development of disease, but we know that social, environmental and biological factors interact and jointly influence health. Among the main pillars of the prevention of chronic diseases, and therefore of the promotion of healthy aging, we find healthy habits of physical exercise and nutrition, which we will discuss briefly below. The Mediterranean Diet, understood as a set of healthy eating habits, regular physical activity and conviviality, is associated with a reduction in the risk of the most common chronic diseases (cardiovascular and metabolic, cancer, cognitive disorders), which today represent the main causes of death, of disability, poor quality of life and loss of productivity in the population of industrialized countries. The Council of Ministers of the European Union invites all member countries to "promote the health of citizens through a healthy diet, such as the Mediterranean Diet" (Council of the European Union. Conclusions on nutrition and physical activity, 2014). Longitudinal studies and randomized intervention studies with control groups have shown that adhering to the Mediterranean Diet can reduce the risk of cardiovascular disease, diabetes, metabolic syndrome by up to 40%, and the incidence of cancers associated with nutrition by up to 30%, and up to 50% physical and cognitive disability in the elderly population. In summary, the Mediterranean Diet has thousand-years of history and research irrefutably demonstrating its effectiveness not only in preventing major chronic diseases, but also in promoting longevity and well-being in the population, because it does not limit itself to promoting a healthy diet, but underlines the synergies between nutrition, physical activity and lifestyle in general. Finally, the Mediterranean Diet is also proposed as the most environmentally sustainable diet. The term "sustainable diet" was first coined to describe a diet that is healthier for the environment and the consumer. In fact, diet, health and environment are strongly interdependent, in a triumvirate known as the diet-health-environment trilemma. A sustainable diet has a low environmental impact, promotes biodiversity and optimizes natural resources thanks to its emphasis on plant foods, the consumption of local products and the preference for seasonal products, all factors that contribute to reducing the ecological footprint. Chronic exposure to air pollution, on the other hand, is one of the environmental factors whose cumulative effect can lead to pathological aging, with an increase in chronic diseases (cardiovascular, respiratory, metabolic, neurological), through direct effects on organism (chronic low-grade inflammation) and epigenetic effects, now widely studied. Various research has highlighted a direct correlation between environmental pollution and the speed of telomere shortening, an indicator of accelerated cellular aging. In conclusion, the probability of enjoying successful aging can be significantly increased by adopting healthy behaviors throughout life, but this is not just an individual responsibility, because the development of global-scale sustainable dietary patterns and lifestyle healthy habits, which reduce sedentary lifestyle and environmental pollution, requires synergistic actions based on the awareness of consumers, producers and governments that agriculture, nutrition, health and the environment are strongly interdependent.

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CroSeed: bioinformatics pipeline for the identification of miRNAs with nutraceutical activity in plants typical of the Mediterranean diet

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Introduction
It is well known that a diet rich in vegetables (such as the Mediterranean diet) has an impact on human health and prevents the onset of some chronic diseases by playing a protective role in cancer, obesity, and type 2 diabetes. Recently, plant microRNAs (miRNA), small nucleic acid molecules, have attracted the attention of scientists due to their cross-kingdom bioactivity and nutraceutical properties. miRNAs are ubiquitous RNA molecules with a length of 16-24 bases, miRNAs regulate metabolic activity by binding to specific messenger RNAs, typically protein-coding genes (but also to lncRNAs as in the case of the oncogenes MALAT1 and NEAT1[1]. Studies have shown that specific miRNAs from plant food can be detected in human sera and tissues, suggesting that they play a role in cross-species communication acting[2] on gene networks involved in chronic diseases.

Research carried out / methods used.
To exert biological functions, mature miRNAs bind to the complementary messenger RNA via a small sequence of 6-8 bases at the 5'end, the so-called seed region, leading to downregulation or inhibition of their expression. We have developed CroSeed, a bioinformatics pipeline that compares the 5'end regions of plant miRNAs with the human seed region and selects miRNAs with likely nutraceutical activity in humans. Using data accessible in various specialized databases, the pipeline assumes that plant miRNAs whose seed regions "mimic" human endogenous miRNAs (*plant functional analog miRNA or pfamiR*) can recognize the same binding sites on messenger RNAs and consequently compete with them. The pipeline uses a mySQL relational database as well as Perl, Bash and SQL scripts to analyze the seed region and find the pfamiR. In the next step CroSeed extracts the experimentally validated human and mouse gene targets, from specialized databases. The pipeline was applied to miRNA from *Brassica rapa*. We found that 56 pfamiR can exert cross-kingdom activity on human metabolism. Some miRNA from Brassica may regulate important human oncogene such as MYC, BCRA1, TP53 which we know are upregulated or mutated in some cancers.

Keywords: Bioinformatic pipeline, miRNA, Xenomirs, Cross-kingdom activity, cancer disease, Mediterranean diet

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Reference

1. Marzano F., Caratozzolo M.F., Consiglio A., Licciulli F., Liuni S., Sbisà E., D'Elia D., Tullo A., Catalano D. (2020). Plant miRNAs Reduce Cancer Cell Proliferation by Targeting MALAT1 and NEAT1: A Beneficial Cross-Kingdom Interaction. Front Genet. Sep 18;11:552490.
2. Link J., Thon C., Schanze D., Steponaitiene R., Kupcinskas J., Zenker M., et al. (2019). Food-derived Xeno-microRNAs: influence of diet and detectability in gastrointestinal tract-proof-of-principle study. Mol. Nutr. Food Res. 63:e1800076.

Development of a deep learning-based multi-omics framework for nutritional and pathological state classification

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Introduction:
Microbiome and metabolome contain information about host disease. Therefore, a multi-omics analysis of these data types can provide key constraints for disease classification. However, due to the complex and high-dimensional nature of multi-omics data, classical statistical methods struggle to capture the shared information between microbiome and metabolome. Deep learning represents a power framework to address this issue.
Metabolomics applications embrace different pathologies, between which there is obesity. Indeed, finding reliable biomarkers for complicated disorders like obesity and overweight has long been a priority in metabolic research. However, a new horizon has opened up with the introduction of Explainable XAI approaches. It has become a crucial framework in the rapidly developing world, bridging the gap between human interpretability and complex algorithms.

Methods and Results:
We design a deep learning model for the integrated analysis of microbiome and metabolome that leverages the complementary information between the two dataset types to perform a medical diagnosis of a given disease as a supervised classification task. We test our approach on different matched microbiome/metabolome datasets, related to diverse pathologies. We developed specific deep-learning techniques for patient stratification concerning a particular phenotype through multi-omics analysis of the microbiome, and metabolome-aligned datasets. Moreover, combining deep learning techniques with explainability techniques (XAI) on the input data we could identify metabolites that were 'relevant' for classification, and that were linked to the specific overweight/obese phenotype, which was used as case study. Subsequently, these metabolites were subjected to a study enrichment to determine the biological functions in the context of the specific nutritional state.

Keywords: metabolome, microbiome, XAI, Deep Learning

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Small RNA enclosed in plant nanovesicles: travelling messages with double role as dietary bioactive compounds and in host-virus interactions

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In recent years, plant extracellular vesicles (EVs) have been shown to play crucial role in mediating intercellular communication and cross-kingdom interaction by delivering their cargo. EV-encapsulated small RNA (sRNA) families (miRNAs, siRNAs and others) have been suggested as important dietary components, able to modulate, after ingestion, the expression of genes of the receiving animal and human cells cells. In this scenario, the characterization of RNA content in EVs is essential to understand how dietary non-coding sRNAs can target human genes, and their potential role as bioactive molecules through RNAi silencing mechanisms.

In previous studies, nanovesicles (NVs) were isolated from tomato fruits by differential ultracentrifugation-based method (DGUC). In cryogenic transmission electron microscopy (cryo-TEM), low-density DGUC fractions resulted enriched in NVs, thus they have been chosen for further characterization and subjected to high-throughput sequencing (HTS) analysis in this study. HTS data revealed that NV-associated sRNAs included about 1.5% known miRNAs. NV miRNAs' target genes were found to be mostly involved in plant innate immune response, RNA silencing, cell wall metabolism and plant growth and morphology. Other classes of host sRNA retrieved in NV libraries were novel miRNAs, NAT-siRNAs and ta-siRNA among others. Intriguingly, sRNA with putative target on human messenger RNAs were retrieved.

Moreover, viral siRNAs from one of the most important tomato viral pathogens, i.e. tomato brown rugose fruit virus (ToBRFV), was found in the analysed NVs, although those were obtained from fruits of asymptomatic tomato plants. The presence of viral siRNAs in plant vesicles is worthy of further investigation because it can contribute to clarify the possible role of NV-driven messages in plant-virus interactions.

Keywords: Extracellular vesicles; Nanovesicles; Tomato; Small interfering RNA; Dietary miRNA; Plant antiviral immunity.

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Soilless cultivation systems for tailored vegetable production to meet specific nutritional needs

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Biofortification, the enhancement of plant nutritional quality, involves increasing organic and mineral factors or reducing antinutritional elements. A multidisciplinary approach is essential for evaluating biofortified products, employing *in vitro* and *in vivo* protocols to assess parameters like bioaccessibility and bioavailability. Market-available successes include selenium-enriched potatoes and iodine-enriched carrots. The evolving challenge focuses on tailored plant nutrition, producing foods for specific populations, known as "tailored food." Soilless cultivation systems prove ideal, allowing precise mineral modulation for human health benefits or, if required, reducing harmful elements for individuals with metabolic disorders. Examples include high-silicon vegetables for osteoporosis patients, low-potassium plants foods for kidney disease patients and vegetables biofortified with iodine. Modularity in plant nutrition, achievable through soilless systems, offers promising prospects for tailored foods addressing nutritional needs. This innovation, easily integrated into existing production facilities, aligns with global health initiatives, promoting nutrient-rich diets and countering malnutrition. The simplicity, sustainability, and cost-effectiveness of this approach, alongside emerging technologies, position customized plant-based foods as versatile ingredients for fortified products and daily consumption.

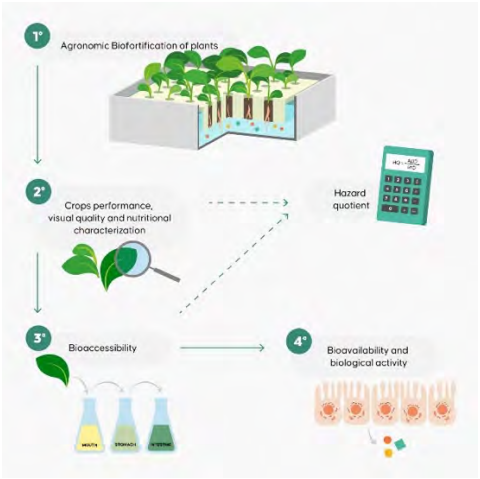

Figure 1. The workflow proposed to evaluate the agronomic, nutritional, and bioefficiency of biofortified products. Estratto da: Renna et al., 2022. Frontiers in Nutrition, 9, 966018.

Keywords: personalized nutrition, tailored vegetables, biofortification, soilless system, therapeutic diet

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New biotechnological strategies to improve the nutritional content of crops

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Biofortification for the nutritional improvement can include conventional breeding, agronomic practices, fertilization strategies, or biotechnological approaches, such as transgenic modification or genome editing technologies. Among the genome editing technologies (also known as New Breeding Technologies, NBTs), the CRISPR-Cas9 system is the most widely used to induce specific tailor-made changes that can be applied in many different research areas, including the nutritional improvement. Using this system, novel plant dietary sources can be developed to addressing vitamin deficiencies, as in the case of vitamin D. Approximately 40% of the European population have an estimated average of vitamin D intake below the RDA (Recommended Dietary Allowance), and the main dietary sources are mushrooms and animal-based foods, with alternative plant-based foods so far lacking.

To this end, the CRISPR/Cas9-mediated genome editing was first used to knock-out the 7-dehydrocholesterol reductase (*7-DR2*) gene in tomato to improve the levels of the vitamin D3 precursor (7-dehydrocholesterol, 7DHC). Two single guide RNAs (sgRNAs) were designed on the second exon and after stable transformation, we found different mutants edited in the *7-DR2* gene with increased levels of 7DHC. We estimated that 1-2 of engineered ripe tomatoes could provide 10µg/day of vitamin D, almost reaching the RDA for healthy individuals (15µg/day). We also extended our work to pepper, with specific sgRNAs targeting the *7-DR2* gene that were validated in a hairy root transient expression system. Approximately the 30% of the collected samples were correctly edited within the *7-DR2* gene.

These results indicate that the CRISPR/Cas9 system is effective in targeting the *7-DR2* gene in tomato and pepper, providing new perspectives for stable transformation to generate new edited lines. In conclusion, NBTs can be a valuable approach to speed up the breeding process and obtain novel and more nutritious crop varieties.

Keywords: biofortification, biotechnologies, CRISPR/Cas9, Solanaceae, vitamin D.

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Recovery of polyphenols from agrofood by-products by using membrane systems

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Membrane systems, already widely consolidated in the agro-food sector thanks to their intrinsic properties compared to conventional separation technologies, also represent an innovative approach for the treatment of wastewater and by-products of the supply chain in a circular economy logic.

In this work, studies relating to the development of eco-sustainable processes for the recovery of natural antioxidants from olive mill wastewaters (OMWs) and from aqueous extracts of solid fennel residues through the use of membrane systems, also in integrated systems, are presented.
A combination of straw filtration and nanofiltration (NF) has been investigated for the first time as a sustainable approach for the recovery of phenolic compounds from OMWs. Ground straw filters with different granulometry (120, 250 and 500 mm) were tested in the first step to clarify the raw wastewater. Polymeric NF membranes, with molecular cutoff in the 150-500 Da range, were studied in dead-end filtration tests to obtain concentrated phenolic fractions from clarified waters. Their performances, in terms of productivity, degree of fouling and rejection towards the components of interest (e.g. total polyphenols, flavanols, hydroxycinnamic c acids) were properly analysed.

The combination of microfiltration (MF) and NF processes has also been investigated to obtain concentrated polyphenolic fractions from an aqueous fennel extract. The study was particularly focused on the analysis of the performance of a flat NF polymeric membrane in the treatment of the clarified extract, in cross-flow mode, under different operating conditions of pressure and axial flow rate of the feed solution. The optimal operating conditions have been defined for obtaining phenolic fractions to be used as raw materials for the production of functional foods.

Keywords: Agrofood wastewaters, phenolic compounds, circular economy, membrane processes, integrated membrane systems.

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The NMR approach for the characterization of nutraceuticals and the delivery of bioactive molecules

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Introduction
EPSs are natural polymers synthetized by lactic acid bacteria (LAB), also in the presence of sugars, mainly to protect the cells from environmental stresses (change in temperature, pH, ionic force, etc), and to enable recognition mechanisms. Their chemical structure consists of monosaccharide units linked by glycosidic bonds to form a branched or not-branched polymer with a high molecular weight (> 105 Da). Depending on the composition of the chain, EPSs are classified in homo- and hetero-polysaccharides. In the field of health-promoting compounds, exopolysaccharides (EPS) play a predominant role due to their prebiotic, anti-inflammatory, antioxidant, immunomodulatory and antimicrobial activities. Novel approaches are available for extending the availability and enhancing the delivery of bioactive molecules over time include the use of cryogels and hydrogels.

Research
The chemical analysis of EPSs is fundamental to establish their composition providing useful information related to food and health applications. In this context, NMR has been largely employed to the chemical characterization of mixtures with the aim of both structural elucidation of bioactive molecules and to investigate the metabolite profiling with the omics view. NJMR can be successfully employed to analyse the delivery of nutraceuticals to enhance their availability, depending on the specific applications. Selected active molecules will be delivered by polysaccharides-based polymers and through NMR spectroscopy the best carrier and the release profiles will be evaluated over time.

Results
Preliminary structural data will be presented on the characterization of EPS in solution.
NMR data on the delivery of biomolecules from polysaccharides will also be presented.

Keywords: NMR, biomolecules, cryogels, delivery systems

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Assessment of Sourdough Fermentation Impact on the Antioxidant and Anti-Inflammatory Potential of Pearl Millet from Burkina Faso

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Millet, a gluten-free cereal, has received attention for its environmental friendliness and higher protein content than other grains. It represents a staple food in many African countries, where fermentation is traditionally used for preserving food products and preparing different cereal-based products. This study aimed to assess the impact of sourdough fermentation on bioactive compounds and antioxidant and anti-inflammatory properties of pearl millet from Burkina Faso. Phenolic compounds were investigated spectrophotometrically and by HPLC-DAD. The antioxidant activity of unfermented (MF) and fermented (FeMF) millet was evaluated in vitro by spectrophotometric and fluorometric assays and ex vivo on oxidized human erythrocytes for hemolysis inhibition. Finally, the potential anti-inflammatory effect of FeMF and MF was evaluated on human adenocarcinoma cell line (HT-29) exposed to TNF-α inflammatory stimulus. Results revealed significantly higher levels of polyphenols, flavonoids, and in vitro antioxidant activity following millet fermentation. Notable differences in phenolic composition between FeMF and MF are observed, with fermentation facilitating the release of bioactive compounds such as gallic acid, quercetin, and rutin. A dose-dependent protection against oxidative hemolysis was observed in both FeMF- and MF-pretreated erythrocytes. Similarly, pretreatment with FeMF significantly reduced the levels of inflammatory markers in TNF-α-treated cells, with effects comparable to those of MF. Fermentation with sourdough represents a simple and low-cost method to improve the bioactive compounds content and in vitro antioxidant activity of millet flour with promising nutraceutical potential.

Keywords: pearl millet; sourdough fermentation; antioxidant capacity; HT-29 cell line; anti-inflammatory capacity

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Development of a composite bread exploiting common bean (*Phaseolus vulgaris* L.) flour fermentation with lactic acid bacteria and yeasts

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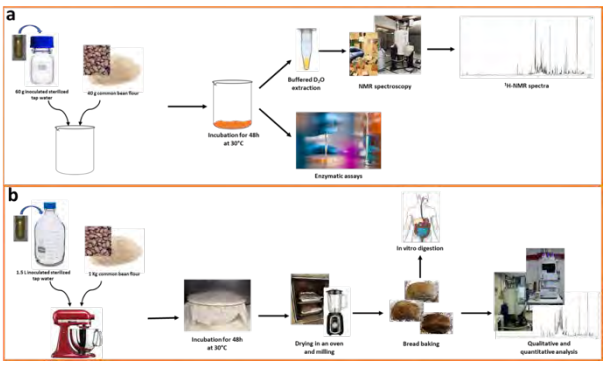
Legumes, especially common beans, are recognized as sustainable and nutritious crops. However, their consumption is hindered by antinutritional factors like lectins, phytic acid, and raffinosaccharides, impacting nutrient absorption and bioavailability and causing intestinal discomfort. Lactic acid bacteria (LAB) fermentation, widely applied in the food industry, enhances various products, including milk, meat, cereal, and legume-based items, by acidification, extending shelf life, and producing bioactive metabolites with health benefits. LAB fermentation can also reduce antinutritional factors, sugar content, and increase bioavailability of nutritional factors.

Incorporating legume flours into novel, convenient and healthy food products is one of the possible approaches that may increase legume consumption. The development of a legume-supplemented bread with a better consumer acceptability while being highly recommended is also challenging as the partial replacement of wheat flour with alternative flours generally results in a poor texture and loaf volume of the bread. In this study we utilized LAB and yeast fermentation to improve common bean flour, aiming to enhance nutritional and technological properties for baked goods. In our step-by-step study, we firstly selected 5 out of 11 microbial starters based on the nuclear magnetic resonance (NMR)-based metabolomic approach. Thereafter, a fermented bean-enriched bread at 25% level was prepared and characterized, evaluating changes in both technological and functional traits due to the fermentation process: we observed reductions in antinutritional factors, enrichment in bioactive compounds, and improved digestibility. While fermented bean flour showed technological advantages, residual antinutritional factors remain. Using tailored bean genotypes lacking lectins and phytic acid could further enhance the health and quality of bean-based foods.

In our step-by-step study, we firstly selected 5 out of 11 microbial starters based on the nuclear magnetic resonance (NMR)-based metabolomic approach. Thereafter, a fermented bean-enriched bread at 25% level was prepared and characterized, evaluating changes in both technological and functional traits due to the fermentation process.



Experimental design: a) preliminary study based on small-scale fermentations to select the most effective microorganisms in improving the common bean flour; b) large-scale set up to prepare common bean-based bread (25%) as final baked product.

Keywords: Antinutritional factors, Baked goods, Bioactive metabolites, Lactic acid bacteria (LAB) fermentation, Legumes

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Evaluation of broccoli enriched pasta for quality traits

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Brassica oleracea L. var. *italica* Plenck is a popular vegetable in the Brassicaceae family and is becoming more recognized for its bioactive compounds, such as antioxidants and phytochemicals; for this reason, it can be considered a functional food. A Sicilian landrace 'Broccolo Nero' (BN) of Brassica was used to fortified pasta. The pasta was made with durum wheat semolina partially substituted by BN 5% freeze-dried powder. Control pasta without BN was also produced. The obtained pasta was analyzed for quality traits during dough formation, drying, and cooking. Raw and cooked pasta were evaluated for their rheological, biochemical, and sensorial properties. BN enriched pasta showed a higher amount of total polyphenol content (6.87 mg/g) and total flavonoid content (0.14 mg/g). β-carotene was recorded only in BN fortified pasta. A decrease of antioxidant compounds was observed after cooking (from 5.71 mg/g to 3.3 mg/g).

Keywords: Brassica crops, pasta, antioxidants, polyphenols, sensory properties

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"Pasta samples"

"Broccolo Nero"

The consumption of an obesogenic diet, enriched in saturated fatty acids, alters serum sphingolipids associated with age-related diseases

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Lipids have recently reached the spotlight as mediators of signaling, immunity, inflammatory pathways. Alterations in lipid metabolism has been associated with the onset/progression of oncological and aging-related diseases. However, the role of lipids as disease biomarkers is still not well-defined. The increased consumption of saturated fat-enriched high-fat diets and the alarming exponentially-growing rates of obesity in western countries contribute to increased risk of oncological and neurodegenerative diseases. Whether changes in serum lipidome due to obesogenic diets may contribute to aging-related diseases and whether serum lipids may be used as early biomarkers are still open questions. Male FVB mice were subjected to a control diet (CTD, 10% kcal from fat) and obesogenic high-fat diet (HFD, 60% kcal from fat) after 3 weeks of weaning. Mice fed with a HFD significantly increased their body weight, developed liver steatosis, and displayed obesity-associated metabolic and hormonal changes. Serum was collected in mice of different ages that were subjected to CTD and HFD for different time periods (9, 21, 33 weeks). Serum from mice fed a CTD or HFD for 21 weeks was used to perform quantitative lipidomics using the instrument Sciex SelexION-5500 QTRAP in positive and negative elettrospray mode. Principal component analysis showed HFD-induced significant remodeling of serum lipidome. Differential analysis further covered significant alterations in lipids belonging to the sphingolipid class. Data mining confirmed association of these alterations with aging-related neurogenerative (*i.e.*, Alzheimer e Parkinson) and oncological diseases. Our preliminary data suggest a potential role of HFD/obesity-induced lipidoma alterations in the development and progression of oncological and aging-related diseases and support "*diet intervention*" approaches to counteract their onset.

Keywords: High-fat diet, serum lipidoma, early biomarkers, aging-related oncological and neurodegenerative diseases

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RNA-dependent molecular circuits in the pathophysiology of neurons and muscles

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A compelling perspective emerging from modern functional genomics conceives the cell as an "RNA machine", capable of dynamically perceiving, processing, and responding to environmental stimuli and genetic programs through RNA-based mechanisms. This interpretation encompasses both coding and non-coding RNAs (ncRNAs), which participate in gene expression as functional, structural, or regulatory macro-complexes, as well as, in broader terms, the biochemical pathways required for RNA synthesis and activity.

Within the complexity of this view, the research group at IBPM in Rome is engaged in exploring multiple biological areas, ranging from cellular differentiation to the acquisition of specific identities, to the execution and deregulation of distinctive functional activities. Deepening these processes from an RNA-centric perspective contributes to the understanding of physiological cellular states, such as development, homeostasis, and senescence, as well as pathological conditions, such as degenerative diseases and cancer.
We will provide an overview of some ongoing activities in various laboratories contributing to this subtask, with a focus on the role of ncRNAs and, specifically, of the neuronal isoform of the long ncRNA HOTAIRM1. In our previous studies, we characterized HOTAIRM1 as a regulator of temporal control of neuronal differentiation. Recently, our research has revealed additional functions in spinal motor neurons, where the long ncRNA is particularly enriched. Through the application of genome editing and transcriptomic techniques in transdifferentiated motor neurons from induced pluripotent stem cells, we have demonstrated that nHOTAIRM1 plays a role in regulating the specification of motor neuron identity and the functional maturation of post-mitotic motor neurons.

These results contribute to a deeper understanding of the mechanisms guiding cellular fate and open perspectives for understanding the pathophysiological conditions related to these processes.

Keywords: (moto)neurons, muscle cells, non-coding RNAs, cell differentiation, cell activity, plasticity, memory, neurodegeneration

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Translational biomarkers for the diagnosis and monitoring of degenerative diseases related to ageing

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The diagnosis of Non-Communicable Diseases (NCD) as tumors and brain disorders occurs when diseases are in advanced phase, reducing the treatment effectiveness.
We developed a computational approach through Genome-Wide Association studies with the aim of identifying pathology markers linked to aging and NCDs. As proof of concept, a mouse model of colon cancer (human HT29 cells) was monitored with Positron Emission Tomography (PET) and [^{18}F]-FDG to study glucose metabolism. At the end of the monitoring, the animals were sacrificed for the collection of serum, tumor and other tissues for the miRNAs analysis. Furthermore, a Parkinson's disease model (Syn120) was evaluated at different ages with Magnetic Resonance Imaging (MRI) and PET with [^{18}F]-FDG, [^{18}F]-FP-CIT for dopamine transporter (DAT), [^{18}F]VC701 for Translocator Protein (TSPO), to identify early disease markers. Conventional image analysis was accompanied by radiomics, with extraction of 93 texture and gray scale features for the correlation with ex vivo markers.

In silico analysis identified 6 microRNAs (miR-21-5p, -103a-3p, -195-5p, 16-5p, 148a-3p, -06a/b-5p) differentially expressed between healthy subjects and suffering from degenerative diseases (solid tumors, multiple sclerosis, psoriasis and type 2 diabetes). Rt-PCR performed in HT29 model partially confirmed the in-silico data. Indeed, miR155 and miR195-5p were highly expressed in serum of tumoral animals while miR103-3p was iper expressed in tumoral mass compared to normal colon tissue. PET imaging evidenced a higher glucose accumulation ([^{18}F]-FDG uptake) at tumor site compared to background tissue.

In the PD model, MRI and radiomics revealed significant differences between PD and control animals at an earlier age (5 months), in particular related to the atrophy and texture of brain areas as striatum and cortex. PET imaging found significant change in striatal DAT expression at 5-8 months of age, in a phase preceding the clinical signs.

Keywords: Colon cancer, Parkinson's Disease, miRNA, Genome-Wide Association screening, PET-CT imaging.

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Explicit and implicit emotional responses to sensory stimulation

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According to perceptual theories, emotions provide information about psychophysiological reactions to external stimuli. Also, body signals following a sensory stimulus can be detected and computed. Complex, although relevant in the human-food interaction, are chemosensory stimuli, like taste and smell.
Several methods allow exploring the mechanisms emotions are based on, with explicit or implicit approaches. The first, most common, apply visual and verbal procedures and require the subject to describe their feelings towards a product or situation. They are quick and easy to manage, but possibly affected by cognitive and judgment biases.

Thanks to advances in technologies, implicit methods have become increasingly relevant in research and industry, and even neuromarketing[1,2]. These methods allow to continuously measure emotions during sensory analysis, exploiting various biological responses, like cardiovascular, cerebral, electrodermal, respiratory ones[3].
A pilot was carried out to study the explicit and implicit emotional responses to olfactory and gustatory stimuli of a small cohort of trained panelists.

Notably, the subjects were administered two olfactory and gustatory tests. In the first test, 5 food-related odors were presented, three of which usually positive (coconut, hazelnut, caramel) and two with negative features (rancid butter, rancid oil), each for 20s spaced out for 40s. After a break, a taste test was administered, presenting the 5 standard flavors (sweet, salty, bitter, sour, umami) each for 20s with an inter-stimulus of 60s. Each test was preceded by a 1-minute baseline acquisition. For each stimulus, the subject had to indicate the perceived pleasantness and familiarity. Wearable sensors were used to acquire electrocardiogram, galvanic skin response and electroencephalogram.

Technologies to capture biomedical signals have enabled obtaining relationships between implicit (i.e. psychophysiological) and explicit (i.e. those from questionnaires) measures.

Keywords: ECG, GSR, psychophysiology, sensory analysis, wearable sensors

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Reference

1. Mastinu, M., et al. (2023). Emotional responses to taste and smell stimuli: Self-reports, physiological measures, and a potential role for individual and genetic factors. Journal of Food Science, 88(S1), A65-A90.
2. Tonacci, A., et al. (2021). Wearable sensors for assessing the role of olfactory training on the autonomic response to olfactory stimulation. Sensors, 21(3), 770.
3. Tonacci, A., et al. (2023). Taste the emotions: pilot for a novel, sensors-based approach to emotional analysis during coffee tasting. Journal of the Science of Food and Agriculture, Nov 27.

The Tale of the Mediterranean Diet

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Introduction
Mediterranean Diet (MD) is commonly recognized as one of the healthiest diets, with many centenary individuals, who followed this nutrition style, displaying an immune system, which is younger than their biological age. Our WP task is, therefore, aimed at telling this "story" to as many people as possible, with particular respect to the younger and the holder ones.

Activity
This task involved five Institutes, each one participating to this objective with its own competencies, yet able to compose a single coherent framework.

ISA: Educational activities, including interactive games, were organized for children to raise awareness of healthy and sustainable diet. Additionally, on World Water Day, an event for high school students was organized to reflect on the MD as a sustainable model.
ISB: Medicinal and Wild Edible Plants for human health were deeply analysed in scientific Webinars but also explained to students of secondary schools and their families.
ISEM: Geographical historical evolution of typical agri-food products will be presented in scientific webinars and dissemination events. The research has a specific focus on Sardinia, one of the world's five blue zones, and aims to deepen the relationship between longevity, active ageing, and the MD.
IPSP: "Beekeeping Campus on the nutritional value of honeybee products": 3 days of seminars, congress and trade show on honeybee products (and medicinal plants, that are source of nectar and pollen, in collaboration with ISB) to be held in autumn 2024 in Portici (NA), with beekeeping associations, beekeepers and Vesuvius National Park.
ISPA: Ongoing seminars in secondary schools on fermented foods in the MD as an emerging target of interest for nutritional and functional features, but also as a source of dietary microbes.

Perspective
We plan to continue the effort to communicate how MD can promote healthy and active ageing of the population.

Keywords: Citizen science, Mediterranean Diet, Phytoalimurgia, Wild edible Plants, honeybee products, fermented foods, sustainable diet, geographical food history, children education.

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Advancing elderly nutrition: practices and innovation opportunities in collective catering

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The aging of the population presents significant challenges concerning the preservation of the elderly well-being and the prevention of age-related diseases.

Diet and food practices emerge as central concerns, particularly within the context of collective catering for the elderly (CCE). This service addresses interconnected issues such as food safety, public health, environmental sustainability, and social welfare. Literature from different scientific domains shows that CCE serves as a prime intervention area for promoting active aging, particularly in the development of programs and services aimed at fostering and facilitating healthy eating habits among the elderly. Key research themes include understanding elderly food preferences to minimize waste, tailoring menus to nutritional requirements, improving food quality and sustainability, and actively engaging the elderly in service enhancement.

Given the heterogeneity of settings offering CCE, with diverse management and organizational systems, as well as operational constraints, understanding the functioning of CCE, current practices, and innovation opportunities stands as a crucial research objective.

The study is based on a qualitative investigation, including case studies, in-depth interviews, surveys, document analysis, and participant observation.

Among the initial findings is a comprehensive overview of the various types of CCE services. Efforts are also ongoing to identify virtuous cases of CCE, while simultaneously analysing interventions in food education for the elderly and their intermediaries in nutrition.

Ultimately, a survey conducted among researchers within the scientific community of the CNR NUTRAGE project also allowed the identification of their potential involvement in CCE through experimental activities and innovative technologies and solutions related to food, processes, and preparations.

Keywords: elderly people; collective catering; food practices; nutrition; innovation

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The role of a diet rich in polyphenols on the prevention and reduction of nonalcoholic fatty liver disease

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Nonalcoholic fatty liver disease (NAFLD) is considered the hepatic disease strongly linked to metabolic syndrome and its incidence in Western countries is estimated to be around 20-30% of the population. However, this value is certainly underestimated for its close association with insulin resistance and obesity. Currently, given the limited availability of effective therapies, much attention is focused on identifying effective dietary strategies for the prevention and treatment of the disease. It is well known that a healthy lifestyle, with a focus on diet and exercise, reduces the risk of NAFLD, and in particular, the Mediterranean Diet (DM) can help to prevent and reduce the incidence of diseases also affecting the liver. The "health promoting" effects of DM have been attributed to the high concentration of bioactive compounds (BACs), particularly polyphenols, found in several typical DM foods. Polyphenols are plant secondary metabolites that can prevent the NAFLD by decreasing lipid accumulation, acting as antioxidant and anti-inflammatory molecules, and enhancing insulin sensitivity.

Therefore, an experimental study was conducted in order to evaluate the effects of a high-fat (HF) diet enriched in polyphenols extracted from the table olive cv Cellina di Nardò (CNE) on obese mice affected by NAFLD. This effect was also evaluated after cyanidin 3-O-D-glucoside (C3G) administration, the phenolic compound that gives to the Cellina di Nardò its typical red-purple color.

Results indicate that enrichment with CNE and C3G reduces negative effects related to HF diet and is able to positively modulate the gut microbiota. Further analyses are underway to confirm this preliminary experimental evidences.

Keywords: NAFLD; Table olives; polyphenols; cyanidin 3-O-D-glucoside; gut microbioma, Mediterranean Diet

Funding: Italian National Research Council (CNR), Joint lab project 2021-2023, "Anti-aging metabolites from traditional Mediterranean foods: fate and mode of actions"; CNR project "NUTRAGE", FOE-2021 DBA.AD005.225.

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A healthy lifestyle improves the gut microbiota diversity and brain morphometric correlates: an exploratory analysis in older adults participating in the NutBrain study

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Introduction

Healthy lifestyle has recently been linked to gut microbiota diversity and several brain outcomes, but the few studies conducted in humans have mainly focused on the effects of single domains (diet, physical activity, etc.), while evidence in multi-parametric models is still scarce. We investigated the relationship of adherence to an antioxidant-rich diet, smoking habits and physical activity with gut microbiota diversity and morphometric correlates in a cohort of older adults.

Methods used

A cross-sectional analysis was conducted in a community-based sample of 200 individuals (mean age 75.4 ± 6.2 years, 58.5% women) participating in the NutBrain study (2019-2023). Dietary intake was assessed using a 3-day food diary and total dietary antioxidant capacity was calculated. Physical activity and smoking habits were assessed by questionnaires. Gut microbiota α-diversity indexes (Chao1, observed species, Faith's PD and Shannon's diversity) were derived by amplicon-sequencing of the 16S rRNA gene using bacterial DNA extracted from stool samples. Brain volumes and ventricular cerebrospinal fluid (vCSF) were obtained from magnetic resonance imaging of the brain. Bivariate correlation analyses were performed to examine the relationship between the joint effect of the three lifestyle factors considered and gut α-diversity and brain measures.

Results

High adherence to a healthy lifestyle was positively and statistically significantly correlated with greater gut biodiversity (all indexes), total brain, white matter and grey matter volume ($p \leq 0.05$). A negative but not significant correlation was found with vCSF ($p=0.20$).

Preliminary results suggest that the greater the adherence to a healthy lifestyle, the greater the biodiversity of the gut microbiota and the greater the integrity of the brain. Further multivariate analysis is needed to confirm these initial findings in order to implement lifestyle interventions in older people to modulate the gut microbiota and promote brain health.

Keywords: Lifestyles, gut microbiota α-diversity, brain morphometric correlates, cross-sectional study.

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Sex-specific and age-dependent proactive involvement of adipose tissue in response to neuropathy in preclinical models: new therapeutic and nutraceutical targets

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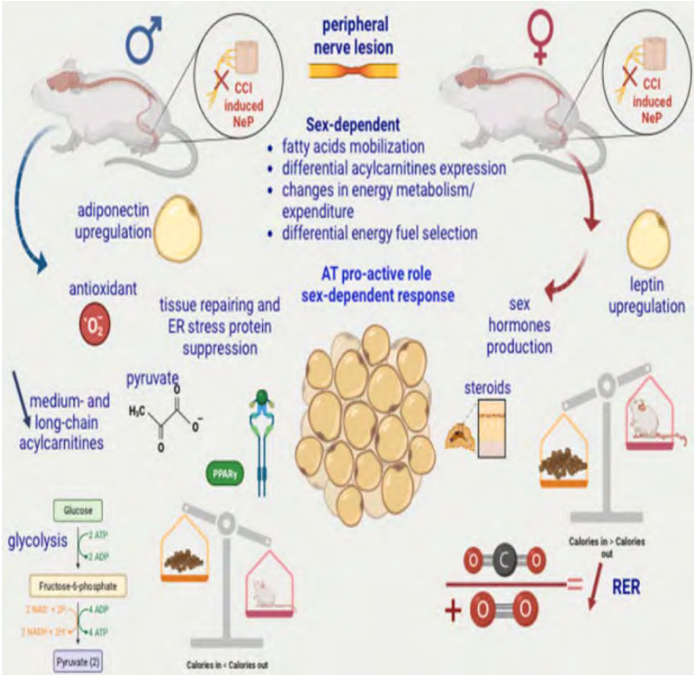
Studying the metabolic response of adipose tissue (AT) to neuropathy in adult mice of both sexes, we discovered that it plays a crucial role in the early response to neurological insult, influencing the phases of Wallerian degeneration, with implications on the immune and inflammatory system. Given the increased neuropathy and chronic pain during aging and menopause, it is important to understand the role of AT in these processes, also considering gender differences. Despite the known impact of aging on the pathophysiology of peripheral nerves, the underlying mechanisms of pain in relation to age and sex remain unclear.

The interaction between aging and metabolism leads to changes in body composition, such as increased adiposity and sarcopenia, also influenced by age and sex-related differences. The endocrine activity of AT regulates various physiological processes, with variations in adipokine levels implicated in neurodegenerative diseases.

We propose a comprehensive investigation on a preclinical model of peripheral nerve injury (neuropathy), with a multidisciplinary approach that includes -omics, behavioral, imaging, and molecular analyses. Our primary goal was to understand the role of AT in neuropathies, identifying sex and age-specific biomarkers and new metabolic targets. The current challenge lies in correcting these alterations through the use of selective nutraceuticals, which could be used as dietary supplements for the prevention and treatment of peripheral neuropathies, inflammation, and neuropathic pain in the elderly.



iScience. 2023 Sep 15;26(10):107914. doi: 10.1016/j.isci.2023.107914. eCollection 2023 Oct 20.

Keywords: adipokines, steroids, inflammation, adipose tissue, nutraceutical targets, neuropathy, pain

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Daily profiles of plasma short-chain fatty acids after the intake of three different cereal fiber sources

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Short-chain fatty acids (SCFAs), produced by intestinal bacterial fermentation of cereal fibers, improve metabolic control and prevent type 2 diabetes mellitus. Molecular mechanisms responsible for these effects are not fully known. Furthermore, it has been shown that the intake of different dietary fibers leads to different plasma concentrations of SCFAs. The aims of this study were: i) to investigate the plasma profiles of acetate, propionate and butyrate after the intake of single meals of food products enriched in solubilized arabinoxylan (AX), wheat bran or cellulose (Vitacel), in individuals at high cardiometabolic risk and ii) to identify any differential response clusters.

Twenty overweight/obese volunteers participated in the randomized, controlled study, conducted according to a cross-over design. They consumed 3 experimental products containing 11g each of fiber (rusks containing AX, wheat bran puffs and cellulose puffs) incorporated into a standard breakfast, on three different occasions. Consumption of breakfast was followed by a standard lunch and dinner which were the same on all 3 occasions. Plasma SCFAs were measured using a LC-MS/MS method.

The postprandial kinetic profile of the three SCFAs after the intake of the three fibers was different, that of acetate being monophasic and that of propionate and butyrate being biphasic. No statistically significant differences were observed in the mean postprandial concentrations of the 3 SCFAs after the 3 fibers. SCFA responses to the 3 fibers were highly variable among the study participants. The cluster analysis identified almost half of the participants as low producers of any SCFA and the remainder as good producers. The results of this study provide important information on the kinetics of SCFAs, which allow us to optimize sampling times for the evaluation of plasma profiles of acetate, propionate and butyrate in relation to their effects on cardiometabolic markers in the context of intervention studies and show a great heterogeneity in relation to fermentation ability of the study population.

Keywords: Arabinoxylan, Wheat bran, Cellulose, Fiber fermentation, Short Chain Fatty Acids.

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A pervasive architecture for elderly lifestyle monitoring

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World Health Organization (WHO)'s work on the UN Decade of Healthy Ageing (2021–2030) underlines the multidisciplinary approach as a critical asset for the prevention of the main age-related pathologies.

The use of smart or bluetooth devices and pervasive architectures allows health professionals to monitor elderly patients' health status directly from their homes. Parameters collected by wearable devices allow tailoring the therapy based on each patient's specific needs. The monitoring is not only related to patient diagnosis and therapy, but also to highlight their lifestyles and quality of life, in the light of a holistic approach. This supports family members also in managing the elderly person's nutrition habits and intervening in potentially dangerous situations.
The main contribution of IBB-CNR related to the design and deployment of a Pervasive Architecture, for fragile and chronic elderly patients (either bedridden or able to move) Remote Monitoring, to handle their care processes at home. This makes it possible to get to a new level of the Telemedicine model, based on an information structure capable of expanding the idea of health status monitoring, from a clinic perspective to a broader "quality of life"- based vision.

The main result so far is the creation of a prototype of the architecture, which is capable of collecting, without specific interactions with the patients, a series of clinical and behavioral parameters that allow for the overall assessment of the patient's status and quality of life. Currently, the architecture has integrated a range of both medical and non-medical devices, e.g., smartbands, sphygmomanometers, glucometers, exercise bikes, thermometers, and scales. Patients have all tolerated the interaction with the architecture well, and the data flow has been continuous. Future prospects primarily involve refining the architecture, expanding the set of available devices, and deploying deep learning techniques for predictive analysis purposes.

Keywords: Home Monitoring, Health related Quality Of Life, Pervasive Telemedicine Architecture, Elderly Patient Empowerment, Ubiquitous Computing for Nutrition Habits Monitoring

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PROMO-TT Instrument: a Technology Transfer Tool of the National Research Council of Italy (CNR) and Italian Union of Chambers of Commerce (Unioncamere)

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The PROMO-TT Instrument is a joint project developed by National Research Council of Italy (CNR) and Italian Union of Chambers of Commerce (Unioncamere) for the promotion of CNR technologies to the Productive World, in collaboration with the Chambers of Commerce and with all the relevant Stakeholders (https://promott.cnr.it/it). PROMO-TT started in September 2020.
The main aims of the PROMO-TT Instrument are: a. To create new partnerships at different levels between Researcher Teams, Enterprises, Investors and No-Profit Organizations; b. To systemize a shared methodology focused on a better exploitation of the results of research carried out at the National Research Council of Italy; c. To accelerate the entry on the market of new technologies; d. promote the creation of new high-tech companies (start-up and spin-off).

Within the frame of the PROMO TT instrument, an additional tool is represented by the establishment of a Strategic Table on Nutraceuticals and Functional Foods. This Open Structure lead by IRIB-CNR will analyze the needs of the local territorial production making proposals for specific activities interest of the territory (event days; encounters between the world of production and research; training and information, etc).
During the period of activity PROMO-TT achieved the following results: 195 scouting cards submitted; 174 validated promotion cards; 14 active Thematic and/or Territorial Strategic Tables with 52 Institutions and approximately 90 participants; 27 events promoting the project and technologies; 50% promotion cards in contact with companies and/or investors; 2 start-up companies established.

Keywords: Technology Transfer; Innovation; R&S; Collaboration with companies and SMEs

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Vegetables with high nutritional and nutraceutical content

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Organizations such as FAO and OMS recommend the constant consumption of fruit and vegetables: that regular consumption of vegetables contributes in the prevention of certain diseases, in a wide range of pathologies: diabetes 2; metabolic syndrome; obesity; cancer; cognitive decline; cardiovascular risk. The effectiveness of this intake, however, is strongly influenced by the quality of the products, conditioned by the production process: vegetables are increasingly lacking in nutritional principles such as vitamins, minerals and bioactive substances (phytocompounds): these elements are capable of acting positively on the health through an antioxidant, anti-tumor and antibiotic action. EDO in collaboration with DiSAAA-a of the University of Pisa has been carrying out studies with the aim at cultivating various types of vegetables in aeroponic process with a high content of antioxidant compounds. Biofortified vegetables with selenium, iodine, zinc and copper added separately or simultaneously with the nutrient solution, provide high nutritional and nutraceutical content while reducing nitrate concentration, with the intent to supply the fourth range and advanced first range vegetable industry with new goods. Although there are numerous works in the bibliography that deal with the biofortification of leafy vegetables with iodine (Incrocci et al.,2019, Frontiers in Plant Science 10,1494;) and selenium (Puccinelli et al.,2017, Scientia Horticulturae 225,271–276;) or with both (Smolén et al.,2019, Frontiers in Plant Science, 10,143), work on biofortified vegetables with multiple elements simultaneously is practically non-existent. The results obtained from the tests on the products highlighted that the treatments significantly increase the content of microelements in the leaves of the plants without any negative effects, either when applied separately or simultaneously; Leaf quality during post-harvest and storage was not affected by any of the biofortification treatments.

Keywords: Aeroponics; Dietary supplement; Functional foods; Soilless culture

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FLASH TALKS

Green, efficient and scalable extraction, and reuse, of byproducts from agrifood and forestry supply chains

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Food ingredients and supplements derived from extracts of fruits and other vegetables have long been available on the market. However, waste streams and byproducts of various agrifood and forestry supply chains, although abundant, geographically concentrated, and often richer in bioactive compounds, are still underutilized or intended for disposal, due to the lack of reliable, affordable, effective, efficient, and scalable extraction techniques.

The emerging green technique of hydrodynamic cavitation, using water and electricity as the only solvent and power source, respectively, efficient and straightforwardly scalable up to the commercial scale, has been used at the pilot and real scale for the extraction of natural products, such as waste citrus and pomegranate peels, whole almonds, and byproducts from certain forestry supply chains. Substantially higher process yields were achieved, due to higher extraction rates and lower energy consumption (few tens to few hundreds of Wh per kg of fresh biomass), short process time (15 to 60 minutes), and moderate process temperature (up to 40 to 70°C). The integral phytocomplexes showed good to high levels of standardization, water solubility, and bioavailability, as well as, sometimes, the spontaneous complexation of pectin, polyphenols, and volatiles. Superior antioxidant, antimicrobial, anti-inflammatory, neuroprotective, and anti-proliferative activity was observed both *in vitro* and *in/ex vivo*, along with the same effectiveness at lower dose, compared with isolated bioactive compounds or reference drugs (Figure 1).

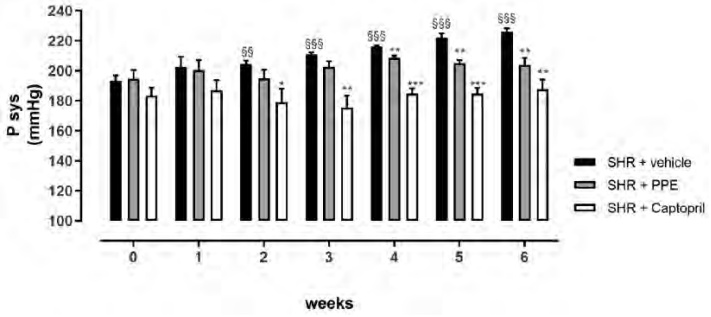

Figure 1. Antihypertensive effects of pomegranate peel extract in chronic protocol on spontaneously hypertensive rats. Reproduced from doi:10.3390/nu16040506, Creative Commons License.

Hydrodynamic cavitation emerges as a technique enabling the bioeconomy of agrifood and forestry supply chains, with resulting products suitable for both food enrichment and the manufacturing of food supplements.

Keywords: Bioeconomy; Extraction; Hydrodynamic cavitation; Agrifood; Forestry; Food supplements.

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Extraction and characterization of microalgae polysaccharides: potential and innovative functional ingredients for bioactive molecules and phytocomplexes encapsulation.

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The properties of microalgal polysaccharides have been recently described in the medical, agri-food, and cosmetics fields, for their significant antioxidant, antifungal, cosmeceutical, and nutraceutical activities [*Molecules* 2023, 28(3), 1185; *Polysaccharides* 2021, 2(4), 759-772]. Remarkably, high molecular weight natural polysaccharides contain proteins or non-polar groups in their hydrophilic carbohydrate chains conferring intrinsic emulsifying properties, which enable their use as building blocks for trapping bioactive molecules [*Carbohydrate polymers* 2020, 242, 116388]. Here, we propose the development of innovative and sustainable polysaccharides-based complexes extracted from microalgae cells, not harmful to humans and the environment, to be used as emulsifier and/or delivery systems of bioactive molecules, including phytocomplexes retrieved from agrifood byproducts.

To this purpose, microalgae strains of marine and freshwater origin were selected and cultivated to enhance accumulation of natural polysaccharides, and a green extraction protocol was optimized. The chemical composition and activity of obtained polysaccharide mixtures were determined by using Fourier-transform infrared spectroscopy, elemental analysis. Additionally, the activity of the polysaccharides was assessed through spectrophotometric measurements, evaluating their antioxidant and antifungal properties.

The results indicate that the complexes show promise as efficient emulsifiers and delivery systems for bioactive molecules, including those from agrifood byproducts. Furthermore, utilizing microalgae-derived polysaccharides aligns with sustainability principles due to their renewable and eco-friendly nature. Further studies could focus on refining the extraction process, optimizing the properties of the complexes, and exploring their applications in various fields, thus contributing to the development of innovative and sustainable products.

Keywords: microalgae, polysaccharides, agrifood byproducts, delivery systems

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"Baby" fruits from pomegranate and prickly pear, underrated by-products rich in gut bowel health promoting compounds

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Pomegranate (*Punica granatum L.*) and prickly pear (*Opuntia ficus indica* L. Mill.) are two of the most iconic fruit products cultivated in the Mediterranean area. A great interest in pomegranate has recently arose due to the peculiar properties of both its juice and side products, that in fact have been extensively investigated, whilst other pomegranate by-products, such as those originating from the fruit thinning process, have not been so far studied in deep. Similarly, prickly pear fruits, cladodes and post-production side products are well known for their distinguished compositional features as well as biological and rheological attributes. No report exist in literature on the content, in terms of small sized molecules and polysaccharides, of the flowers removed at the spring flush, practice realized to promote the growth and development of fruits of a late crop coming from the second bloom.

To this end, immature pomegranate fruits from cultivar "Wonderful" and immature prickly pear fruits set from varieties red "Sanguigna", white "Muscarella" and yellow "Sulfarina" were subjected to a targeted, innovative extraction procedure[1] to yield a series of matrices, which have been preliminary investigated and whose compositional characterization and biological validation is still undergoing[2].

Keywords: pomegranate, prickly pear, fruit thinning, tannins, oligosaccharides

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Reference

1. Laura Siracusa, Carmelo Drago, Giuseppe Ruberto, Giovanni Mario Pitari. IMMATURE POMEGRANATE EXTRACT FORMULATIONS (MBI17065-IT, depositato il 12/10/2020 e concesso il 26/10/2022 N. 102020000023920); PCT/IB2021/059338 (EU), CA3198627A1 (Canada), WO2022079592A (USA)
2. Venera Russo, Alberto Continella, Carmelo Drago, Alessandra Gentile, Stefano La Malfa, Claudia Giovanna Leotta, Luana Pulvirenti, Giuseppe Ruberto, Giovanni Mario Pitari, Laura Siracusa. Secondary metabolic profiles and anticancer actions from fruit extracts of immature pomegranates. PLoS ONE 2021, 16, e0255831.

Development of uniform micro/nanocapsules based on biopolymers using green membrane dispersion processes for the encapsulation of bioactive molecules

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Membrane technology represents an innovative and valid resource in the production of micro-nanostructured materials for the development of products with advanced properties with low ecological impact. The membrane puts in contact two phases having different chemical and/or physical properties, allowing the dispersion of one phase into the other as a form of micro/nanoparticles of target size and highly uniform distribution, with high productivity and encapsulation efficiency and reduced energy consumption.

In the present work, hydrophilic biopolymers, such as alginate, chitosan and starch, were used individually or in combination for the development of micro/nanocapsules of uniform size by membrane emulsification. In membrane emulsification process, the polymer solution (dispersed phase) permeates through the pores of the membrane generating uniform and regular drops at the membrane pore level in contact with the continuous phase. Once the drops reach a certain size, under the action of the shear forces, they are detached drop-by-drop and collected in the continuous phase since the two phases are immiscible. An appropriate solidification reaction is coupled to the emulsification process to obtain the formation of polymer capsules.

The results relating to the ongoing research activity will be presented with particular emphasis on: i) the optimization of fluid-dynamic (dispersed phase flux and shear stress) and chemical parameters (biopolymer concentration, alternative green solvents) for the production of a water-in-oil emulsion whose dispersed phase is made up of one of the selected biopolymers or a mixture thereof; ii) identification of the operating conditions to obtain capsules starting from emulsions produced by ionotropic gelation or non-solvent induced precipitation.

Keywords: Biopolymer, membrane emulsification, microcapsules, nanocapsules, encapsulation

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Metabolomic approach based on NMR spectroscopy to explore the nutraceutical and sensorial profile of tomato fruits produced by effective micro-organisms

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The use of ecofriendly strategies, such as the use of Plant Growth Promoting Bacteria, to improve the yield and quality of crops has become necessary to satisfy the growing demand of food and to avoid the use of chemical fertilizers and pesticides.

In this study, a metabolomic approach based on NMR spectroscopy coupled with multivariate data analysis was used to explore the effect of an innovative agricultural corroborant based on Effective Microorganisms (EM®) technology aiming to improve the nutritional traits and taste of two Campania tomato varieties: Corbarino and San Marzano. EM Technology™ is a tool that blends the power of specific microorganisms with specialized know-how to obtain several benefits, including improvements in plant biometric parameters (such as plant height and fruit yield), as well as enhancing the fruit quality and favoring the production of tasty and beneficial fruits.

For the metabolomic investigation, the samples (whole tomatoes, including seeds and peel) were at first freeze-dried and subsequently extracted. All 1H NMR and 2D-NMR (DIPSI, HSQC, HMBC) experimnents were acquired on a Bruker AVANCEIII 600 MHz spectrometer equipped with a CryoProbe and an automatic and cooled sample changer. The preliminary results on the polar and lipid extracts of the Corbarino tomato variety, obtained from different Campania cultivars, gave indication of the positive effects of the use of microorganisms (EM®, Effective Microorganisms) in the term of carotenoids and fatty acids content. In fact, the Corbarino di Nocera Inferiore sample, cultivated with EM technology, showed a higher content in the aforementioned bioactive metabolites compared to the other Corbarino samples grown with traditional cultivation techniques. Preliminary analyses of the polar metabolic profiles suggested some discriminating compounds in sample pairs. In particular, in Corbarino di Agerola vs Corbarino di Corbara Tramonti the discriminant metabolites were citrate, lactate, alanine, valine and glutamine, while in Corbarino di Nocera Superiore vs Corbara Sud) glucose, tyrosine and aspartate showed distinct and characteristic levels.

The aim is to correlate the NMR metabolomic fingerprints acquired for Corbarino and San Marzano tomato samples from EM® crops with their nutraceutical properties and sensory descriptors (bitterness, sweetness, sourness, saltiness, “umami taste” of tomato, redness, and density), suggesting that the NMR approach might be a very useful tool for fast and complete chemical characterization of fruits, as well as indicating the high potential of EM technology as a sustainable agricultural practice.

Keywords: Effective Microorganisms (EM®) technology, NMR spectroscopy, tomato extracts profiling, metabolomic approach

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Recovery of bioactive molecules from plant or waste biomass through sustainable extraction methodologies

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Plant and agri-food waste biomasses are used to develop valuable materials. Components from these sources show promising properties, representing eco-friendly alternatives for food additives. Research is focusing on developing sustainable extractions to minimize environmental impact and maximize yields. Herein, different biomasses, as *Cannabis sativa L.*, citrus fruits and oil industry wastewaters, were selected to recover biopolymers and bioactive molecules.

C.sativa is a renewable source of several bioactive molecules (BMs), and it is employed for textile, food, cosmetics, and medicine. Different extraction procedures were carried to recover and use hemp seed (HS) bioactive components to prepare animal feed, oil, and protein powder. Namely, Microwave-Assisted-Extractions (MAEs) were performed in hexane to isolate antioxidant HS oils, and compared to Soxhlet extraction. Results indicated that oil extraction yield (30%) and antioxidant activity were comparable between the two methods, but shorter operating time were needed for MAE.

Citrus fruits exhibit many health benefits, due to the high content of vitamins and antioxidants. MAEs were performed to extract both pectin and BMs in one-pot solution. Citric and acetic acids were used as reference. pH and acid type were able to modulate pectin physico-chemical properties (e.g., methylation degree and MW) and to allow the recovery of polyphenols.

Wastewaters from the vegetable oil industry were used to selectively recover BMs by ad-hoc adsorbent polymer synthesis. A vinylpyridine-based hydrogel was synthesized with different templating molecules, oleuropein and polydatin, to produce a Molecular Imprinted Polymer (MIP) for extraction of target molecule from a complex solution. The purification in water of MIP created nanocavities, able to bind target molecule. Then, β-cyclodextrin (CD)-based cryogels were synthesized at different polymer polarity. This approach allows a sustainable recovery of molecules, and polymer reuse for further cycles.

Keywords: Biomass valorization, Sustainable extraction, Bioactive molecules

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Hydroxytyrosol mitigates anxiety-like behaviors after a traumatic experience in old mice by promoting neurogenesis in the ventral and dorsal dentate gyrus and by maintaining biodiversity of gut microbiota

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Hydroxytyrosol (HTyr), a phenolic compound present in olive oil, exerts a protective effect in several chronic age-associated diseases due to its antioxidant, anti-inflammatory and neuroprotective properties (PMID: 37049607). We previously observed that oral administration of HTyr, in aged mice reactivates stem cells present in the neurogenic niche of the dentate gyrus of the hippocampus and promotes the generation and survival of new neurons (PMID: 32027412). It is known that the dorsal part of the hippocampus is involved in learning and memory, and the ventral part in the response to stress. Moreover, it is now widely recognised that there is a bidirectional microbiota-gut-brain axis, which exerts a significant influence on behaviour and learning.

We therefore wondered about the effect of HTyr treatment on the cognitive behaviour of aged mice and the potential contribution of the microbiota. We observed that oral administration of HTyr, synthesised in our laboratory using a procedure we optimised: i) promotes the production of new neurons in both the dorsal and ventral part of the dentate gyrus of the hippocampus, with a prevalent effect in the ventral region; ii) decreases the inflammatory status of microglia; iii) reduces anxiety symptoms in a model of post-traumatic stress disorder, although it is not able to recover the contextual memory decline observed with ageing. In parallel, treatment with HTyr preserves the gut microbiota biodiversity, which tends to decrease after a traumatic event. Specifically, HTyr prevents the decrease in the Ruminococcaceae family, which is known to participate in gut-brain interaction by enhancing serotonin and glutamate biosynthesis, promoting neurogenesis and neuron survival.

This suggests that HTyr promotes resilience to stress by increasing neurogenesis directly in the brain and/or through modulation of the microbiota-gut-brain axis.

These studies are supported also by Project Lazio Innova 2020 36407.

Keywords: Hydroxytyrosol, olive oil, neurogenesis, post-traumatic stress disorder, microbiota-gut-brain axis.

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Looking for the functional and molecular mechanisms of metabolism-synaptic plasticity interplay in health and disease

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During the initial months of the project, we have started to investigate the interplay between metabolism and neural plasticity.

First, we have designed a behavioral test for assessing entorhinal cortex-dependent episodic memory in mice, which was combined with the use of chemogenetic tools to analyze the action of thyroid hormones and their metabolites on this specific memory function.

To understand how metabolic regimens, chiefly high-fat diet, affect the molecular composition of synapses, we have created new genetically encoded tools for proximity labeling of the synaptic proteome. These gene constructs were expressed and validated in primary neuronal cultures and are now being packed in adeno associated viral (AAV) vectors for in vivo expression.

Finally, we have analyzed the effects of dietary supplementation with barley beta-glucan on cognitive performance and anxiety behavior on obese mice subjected to psychosocial stress.
Our preliminary results provide insight into the multifaceted aspect of the impact of diet and metabolic messengers on synaptic plasticity and on cognitive performance.

Keywords: synaptic plasticity, high-fat diet

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The multimodal action of polydatin, a polyphenol with a very high bioavailability, to prevent bioenergetic alterations linked to early aging and neurodegeneration in down syndrome

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Down syndrome (DS), caused by the trisomy of chromosome 21 (T21), is a human genetic anomaly associated with neurodevelopmental deficits in children and early onset of symptoms of aging and neurodegeneration in adults. Natural plant polyphenolic compounds are found interesting candidates for the management of DS for their capacity to stimulate bioenergetic metabolism and for neurostimulator and anti-inflammatory activities. Many polyphenols have been tested in DS; however, their rapid metabolism and poor bioavailability underestimate their clinical efficacy. Polydatin from *Polygonum cuspidatum,* a natural resveratrol glucoside (trans-resveratrol-3-O-glucoside, PD) is, instead, highly bioavailable and resistant to enzymatic oxidation. PD supplementation in several human diseases has demonstrated many therapeutic effects including cardio- and neuro-protective activity. There are no studies reporting the effect of polydatin in DS and in aging.

With an experimental approach already validated in our laboratory, we tested the effect of treatment of cultured human T21 fibroblasts with PD (20 µM for 24 h, chosen by preliminary tryouts of cytotoxicity) on mitochondrial bioenergetic functions, on cell proliferation and oxidative stress. Modulation of polydatin of some crucial miRNA and signaling pathway has been assayed through RT-PCR and Western Blotting analyses.

PD strongly improves mitochondrial ATP production through oxidative phosphorylation and the activity of the mitochondrial respiratory chain Complex I and ATP synthase. PD also reduces cellular senescence, the over-production of free radicals and DNA damage induced by oxidative stress. We discovered a new mechanism of PD action involving the chromosome 21 encoded miR155 and its crucial target genes CBL and BAG5 that regulate mitochondrial bioenergetics and mitophagy. From our findings PD emerges as a treatment with a good translational potential for improving critical metabolic alterations causing early aging in DS.

Keywords: Polydatin supplementation, Down syndrome, mitochondrial bioenergetics, senescence, oxidative stress, aging

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Moderate intake of beer improves nonalcoholic fatty liver disease (nafld) in high fat diet (hfd)-induced mouse model

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Scenario. Both beer and some of its components, particularly polyphenols and iso-alpha-acids, have proven to be able to attenuate hepatic lipid accumulation or perturbed blood parameters. The current study aimed to evaluate the anti-steatotic capacity of beer in an HFD-induced NAFLD mouse model.

Methods. The beer was characterized for bioactive molecules content and individual phenolic compounds using UHPLC-ESI-MS/MS. In the in vivo study, forty-eight six-weeks-old male mice (C56BL/6) were randomly divided into four groups and supplemented daily for 10 weeks as follows: 1) normal diet (CTR); 2) a CTR diet and 0.14 ml/day beer (CTR+Beer); 3) a HFD (HFD); 4) a HFD and 0.14 ml/day beer (HFD+Beer).

Results. The beer displayed a good content in total phenols (25.01±1.27 mg GAE/100 ml), flavonoids (3.17±0.17 mg CE/100 ml) and flavonols (3.07±0.23 mg QE/100 ml). Among the single phenolic compounds, isoquercetin emerged as the predominant polyphenol (14.68±2.68 mg/100 ml). Compared to CTR, HFD group showed significantly higher levels of AST, ALT, TC, LDL-C, glucose, body weight and liver lipids, indicating the presence of steatosis, confirmed also by histological analysis. In HFD+beer group all the parameters returned to levels like those of CTR. Analysis of hepatic transcriptome and CpG methylation profile showed a clear separation between CTR and HFD groups. Beer consumption only partially affected gene expression whereas specifically changed the DNA methylation profile. RNA-Seq revealed 162 differentially expressed genes (DEGs) between CTR and HFD, whose biological function was related to cellular inflammatory processes and regulation of lipid metabolism. Beer consumption ameliorated the HDF effect (CTRvsHFD+beer, DEGs=43) showing alteration in the inflammatory response but not in the lipid homeostasis in liver. In summary, beer was capable to improve NAFLD likely due to the ability of polyphenols to modulate lipid metabolism.

Keywords: steatosis, beer, polyphenols, RNA-seq, DNA methylation

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Protective effect of some natural antioxidants on olfactory glial cells exposed to toxicity caused by β-amyloid: potential role in the prevention of neurodegenerative diseases

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In recent years, attention has grown on neuro-nutraceuticals and their role on the health of the nervous system; they, able to cross the BBB, modulate redox-dependent signalling pathways and exert significant anti-oxidative and anti-inflammatory effects both *in vitro* and *in vivo*. These properties could have a beneficial role in counteracting the onset and progression of neurodegenerative diseases. Alzheimer's disease (AD) is characterized by intracellular and extracellular protein aggregates in the brain, as microtubule-associated protein tau and cleavage products of the amyloid precursor protein, Amyloid-Beta (Aβ). The accumulation of Aβ is responsible of oxidative stress, inflammation and neurotoxicity.

In the present study, the protective effect of some natural compounds (CN), such as astaxanthin, curcumin and berberine, was evaluated using immunocytochemical techniques on glial cells of the olfactory system, the Olfactory Ensheathing Cells (OECs). The expression of some cytoskeletal proteins, such as vimentin, GFAP and nestin, was investigated on the cells exposed to Aβ toxicity. Furthermore, both the percentage of cell viability by MTT test and the apoptotic pathways were monitored.

Our results highlighted that exposure of cells to Aβ induced an increase in the expression of vimentin, GFAP and a decrease in the expression of nestin. Pre-treatment of OECs with CN was able to reduce the expression of GFAP, vimentin, suppressing gliosis. Furthermore, these compounds inhibited the activation of the apoptotic pathway caused by Aβ and induced an increase in nestin expression.

These findings highlight that CNs exert a protective effect on OECs against Aβ toxicity and could represent a promising tool for neural regeneration and for a potential therapy to slow or prevent the progression of neurodegenerative diseases, such as AD.

Keywords: natural antioxidants; olfactory ensheathing cells; amyloid-beta; neuroprotection; neurodegenerative diseases

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Chromatin conformation of muscle stem cells in physiological and pathological muscular aging

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The correct 3D organization of the genome is known to influence the spatiotemporal expression of lineage-specific genes during stem cell differentiation and aging processes. We introduce a novel evolution of the SAMMY-seq technique to precisely map genomic regions separated by their biochemical properties. This single-handedly technique enables the identification of heterochromatic and euchromatic domains and their compartmentalization in the nuclear space. Crucial practical advantages of this method include: its applicability on as little as 10K cells; reduced costs; few manipulation steps and short execution time. In postnatal Muscle Stem Cells (MuSCs) we observed a reproducible distribution of euchromatic and heterochromatic genomic domains, in line with known epigenetic signatures. Our findings highlight how MuSCs over life exhibit a global steady chromatin organization, accompanied by solubility changes that favor processes such as MuSCs activation but may become obstacles during aging for proper pool maintenance. Still, we describe similar chromatin defects in a mouse model of accelerated aging. Our extensive characterization of the chromatin organization in MuSCs expands our understanding of quiescence, activation and aging processes, laying the groundwork for the study of the role of the epigenome in other pathological conditions.

Keywords: chromatin architecture, transcription, stem cell, aging

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Overexpression of patz1 increases oxidative stress in anaplastic thyroid carcinoma cells and activates programmed cell death

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PATZ1 is a transcriptional regulator and chromatin remodeler implicated in the response to genotoxic damage and cellular aging across various contexts, including tumorigenic and endothelial settings. Its depletion correlates with premature senescence in murine embryonic fibroblasts, accompanied by oxidative stress and DNA damage. Moreover, PATZ1 can exhibit both oncogenic and tumor-suppressive behaviors depending on the cellular context. Our study aims to elucidate PATZ1 role in senescence and oxidative stress processes and to analyze the associated molecular mechanisms in both physiological and tumorigenic contexts.

In anaplastic thyroid cancer cells, we observed that PATZ1 overexpression not only inhibits senescence but also reverses the neoplastic phenotype, inhibiting proliferation, migration, invasion, and in vivo tumor growth promotion. This effect is partly mediated by the direct transcriptional regulation of genes involved in epithelial-mesenchymal transition, amoeboid migration, and invadopodia formation. To better understand the molecular mechanisms involved in this cellular system, we conducted proteomic and metabolic analyses. Among the various significant alterations observed in PATZ1-overexpressing cells compared to controls, a general reduction in antioxidant proteins and metabolites piqued particular interest, suggesting a predisposition to oxidative stress accumulation. Consistent with this hypothesis, we demonstrated that tumor cells overexpressing PATZ1 exhibit reduced levels of both reduced and oxidized glutathione, indicative of cellular antioxidant system imbalance and increased oxidative stress, which could render them more susceptible to programmed cell death activation. Consistently, PATZ1-overexpressing cells encounter spontaneous apoptotic cell death after few days in culture. Further studies will be necessary to delineate PATZ1's role in oxidative stress response and chemotherapy drug sensitivity, with the aim of developing targeted and personalized therapeutic strategies.

Keywords: PATZ1, senescence, oxidative stress, tumor suppression, programmed cell death

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Structure-activity relationship in the sigma-1 receptor and pnp oxidase, two proteins involved in age-related pathologies

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A wide spectrum of geriatric diseases is associated with alterations in cellular homeostasis of calcium ions and vitamin B6. In this context, we have initiated the study of the structure-activity relationship in the Sigma-1 receptor (S1R), an endoplasmic reticulum receptor involved in several crucial metabolic processes, including the flow of calcium from the endoplasmic reticulum to the mitochondria. Additionally, we are investigating the pyridoxine 5'-phosphate oxidase (PNPO), which plays a role in vitamin B6 biosynthesis.

Despite the physiological and pharmacological importance of S1R, the molecular mechanisms underlying its activation remain not completely understood. Additionally, the endogenous ligand for S1R has not yet been identified. Through Molecular Dynamics experiments, we have identified a cavity on the protein surface in contact with the membrane, which allows ligand entry. Furthermore, using *in silico* and *in vitro* methods (Virtual Screening, Fluorescence Titration, and Electron Density Fitting), we have determined that steroidal ligands exhibit the strongest binding affinity to the S1R (*Pascarella et al. Int J Mol Sci. 2023, 24:6367. doi: 10.3390/ijms24076367*).

Moving on to PNPO, this enzyme is responsible for synthesizing pyridoxal 5'-phosphate (PLP), (vitamin B6) essential for numerous enzymatic activities. We have highlighted the crucial role of PNPO in regulating cellular PLP levels through negative feedback inhibition due to PLP binding at an allosteric site. By analysing docking and site-directed mutagenesis experiments, we have identified the allosteric binding site in human PNPO (*Barile et al. Protein Sci. 2024;33:e4900. doi:10.1002/pro.4900*). Recently, increased PNPO expression has been associated with various tumor forms, making PNPO a potential therapeutic target. We are studying through the X-ray protein crystallography the mode of binding of specific PNPO inhibitors, selected for their potential role in treating PNPO-dependent tumors.

Keywords: Sigma-1 receptor (S1R), pyridoxine 5'-phosphate oxidase (PNPO). Neurodegeneration, Tumor, Structure-Based-Drug-Design

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POSTERS

In vitro study of the cytoprotective effects of chitosan polymeric nanoparticles carrying active ingredients in response to exogenous stimuli of oxidative nature

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Scenario: Oxidative stress plays a central role in the pathophysiology of neurodegenerative diseases Therefore, it is urgent to promote researches aimed at identifying antioxydant systems capable of protecting and/or correcting the pathological processes in a targeted manner. Nanotechnological approaches provide many advantages to drug delivery systems, also several studies showed the neuroprotective activity of the chitosan nanoparticles (NPs). Hence, our aim is to promote cellular protection from oxidative insults in vitro, through the use of functionalized chitosan nanoparticles targeting both specific cell lines and mithocondria and carrying anti-oxidant substances, including plant extracts.

Methods Used: Folic acid functionalized NPs were prepared according to the ionic gelation technique, and their physicochemical characteristics were evaluated. Different concentrations of chitosan nanoparticles were screened to investigate the cytotoxicity in Hela cells by MTT assay. *Gentiana lutea* plants were collected in Pollino National Park and secondary metabolites were extracted from flower and leaves with EtOH 80% for 24h. Extracts were subjected to HPLC analysis. Selected concentrations of extracts were screened to investigate the cytotoxicity in SH-SY5Y cells by MTT assay.

Results: NPs had a narrow size distribution (PI < 0.3), small sizes (<400 nm) and high colloidal stability. Cell viability was higher than 80% after 72 h of incubation with empty systems in the range of concentrations investigated. Plant tissue extract chromatograms showed specific tissue profiles. Further, in vitro tests showed a cytoprotective effect against ethanol-induced damage in SH-SY5Y prompted by the free extracts.

Perspectives: in vitro tests for oxidative stress and mitochondrial functionality assessment will be performed, also in neuron-like differentiated SH-SY5Y, using functionalized NPs carrying compounds with anti-oxidant activity.

Keywords: Chitosan Nanoparticles, Oxidative stress, Plant extracts

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Influence of harvest date on physiological activity, physicochemical parameters, and bioactive compounds in globe artichoke cv. Spinoso sardo

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The aim of this study was to characterize the physiological, nutritional and nutraceutical features of 'Spinoso Sardo' artichoke over the harvesting season.
In Sardinia, the 'Spinoso Sardo' artichoke is mainly grown as an annual crop, adopting the forcing technique which allows lengthen the harvesting window, which begins at the end of October and continues until April.

Artichoke heads were periodically collected, starting from November until the end of April, distancing one collection from the next one by about a month. At each sampling time 30 commercial heads weighing about 150 g and disease-free were selected. Artichoke heads were used after removing the first two layers of external bracts and the apical portion containing the thorns. Assessments and analyses included: respiratory activity, fiber content, sucrose, glucose, fructose, bioactive compounds, total phenols and antioxidant activity were determined.

The highest respiratory activity was detected at the beginning and at the end of the sampling time with values ranging from 14 to 45 mg CO2 kg-1s-1 at 5 °C and 20 °C respectively, while the lowest in January-February, when the values dropped to approximately 10 and 25 mg CO2 kg-1s-1 at 5 °C and 20 °C, respectively. Similarly, the fiber content varied according to the harvest period, with the minimum values of hemicellulose and cellulose detected in January and February and the maximum values in November and April harvests.
The level of simple sugars was highest in January and February, with values of 1.0, 0.6 and 0.6 g per 100 g of fresh weight of glucose, fructose, and sucrose, respectively. Total phenols and the antioxidant activity gradually increased from November to April, peaking to approximately 3500 mg kg-1 and 0.9 mmol TEAC kg-1 as trolox equivalents, respectively. The main identified bioactive compounds were neo-chlorogenic acid, 1-O-cafeoylquinic acid, 3,5-O-dicafeolquinic and 1,5-O-cafeoylquinic acids and apigenin 7-O glucoside and chlorogenic acid.

Keywords: Artichoke; Spinoso Sardo; physiology; quality; nutraceutical

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Diet affects numb function in cancer stem cells and adult tissues

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Diet impacts on lifespan and incidence of a number of non-communicable diseases, including cancer. In particular, high fat diet correlates with increased cancer incidence, progression and mortality. Conversely, caloric restriction (CR) protects from cancer and reduces cancer chemoresistance. At least part of these effects is mediated by the action of diet on stem cells, which can influence transformation from normal to cancer stem cells, promoting cancer onset, maintenance, and drug resistance. Pathways connecting diet with stem cell function are only partly known: their complete characterization would be crucial for identifying the mechanisms behind the effects of diet on health and cancer, as well as for the development of nutraceuticals.

NUMB is an endocytic protein controlling a number of functions in stem and non-stem cells, such as stem cell fate, symmetric/asymmetric division, cell-cell and cell-substrate adhesion, migration, epithelial-mesenchymal transition (EMT) and regulation of spatio-temporal function of membrane receptors, including NOTCH and EGFR. Loss of NUMB function is found in several aggressive cancers and has been found responsible of hyperglycemic memory and chemoresistance in pancreatic cancer cells.

In order to better understand the mechanism responsible of the effects of diet on cancer incidence and resistance, we assessed the effects CR mimetics on NUMB/pNUMB expression in cancer stem cells. We observed that pNUMB (but not NUMB) was increased in CR mimetic conditions, and that this effect was affected by HMGA1 expression.

We also analyzed the expression of NUMB/pNUMB in tissues from high fat diet (HFD) mice. We found that NUMB expression and/or the rate of NUMB/pNUMB were altered in organs including pancreas, liver and visceral adipose tissue of HFD mice. These data suggest that diet and nutrients might alter NUMB function, not only impinging on organ functionality, but also on resident stem cells, potentially leading to pro-tumorigenic alterations.

Keywords: NUMB, diet, caloric restriction, cancer, drug resistance, endocytosis

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Effects of different radiation wavelenghts on polyphenol content in ready-to-eat salad vegetables

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The manipulation of the UV/light spectrum allows shaping plant growth and production of secondary metabolites. In particular, light-emitting diodes (LEDs) are used to produce high-quality food in controlled environments, while UV radiation is one of the main elicitors of plant antioxidant polyphenols. Chicory (*Cichorium intybus* L.) and lettuce (*Lactuca sativa* L.) are widely cultivated as ready-to-eat (RTE) salads, being a rich source of vitamins and phytochemical compounds of interest, such as polyphenols. The aim of this study was to investigate the possible modulation in leaf polyphenol and chlorophyll content by applying UVB LEDs radiation on lettuce, and the blue and red LED light on two cultivars of chicory (Rossa di Treviso and Precoce). Two-month-old tunnel growth lettuce plants were irradiated for five days by a low-dose UVB radiation, and the effect of the UVB treatments was monitored daily by the Multiplex® optical sensor, providing indices of the leaf chlorophyll and epidermal phenolics (EPhen). Chicory plants were grown under blue and red LEDs for three to four weeks, and Dualex® was used to measure chlorophyll leaf content. White LED radiation was supplied to control plants. The leaf polyphenols of both lettuce and chicory plants were characterized and quantified by HPLC-DAD-Q-TOF-MS analyses. The highest levels chlorophyll and polyphenols were recorded in response to blue light in chicory while under UVB radiation only polyphenols increased significantly in lettuce plants. Particularly, in chicory plants blue LED exposure induced the accumulation of the highest level of quercetin derivatives, whereas a significant increase in caffeic acid derivatives and flavonols was detected in UVB-treated lettuce plants compared to control plants. These results suggest that blue LED and UVB LED radiation can enhance the antioxidant polyphenol content in chicory and lettuce plants, respectively, for improving the nutraceutical properties of RTE salads.

Keywords: Cichorium intybus, Lactuca sativa, high pressure liquid chromatography coupled with diode array detector and quadrupole time-of-flight mass spectrometry (HPLC-DAD-Q-ToF), Light-emitting diodes (LED), UV radiation, polyphenols.

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Sustainable extraction of oil from myrtle seeds, by-products of the myrtle liqueur production industry

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The by-products generated by the myrtle liqueur production industry could be employed to extract bioactive compounds that may be used in food and cosmetic industries. At present, such biomasses are underexploited as soil amendment or flammable biomass. The seeds are particularly rich in lipids and phenolic compounds with high antioxidant activity (Antioxidants, 2023 *12*(1), 154).

In this work, an oil rich in phenolic compounds was extracted from the seeds of myrtle, by-products of the liqueur production. For the extraction, bio-based, non-toxic and biodegradable solvents (ethyl acetate and 2-methyltetrahydrofuran), and a mechanical process were compared.

The oils obtained were characterized for yield, peroxide value (PV), fatty acids composition, and total phenolic concentration (TPC). The extraction method affected the oil yield and oil quality in terms of TPC and PV.

The oxidative stability of myrtle oils was studied by EPR (Electron Paramagnetic Resonance) spectroscopy coupled with the spin trapping method. The radical species produced during oil thermal treatment at 90 °C are trapped by PBN (N-*t*-butyl-α-phenylnitrone) forming relatively stable adducts. The evolution of the intensity of the adducts over time depends on several factors like the fatty acid composition of the oils and their antioxidants content.

The EPR evaluation of the oils' oxidative stability highlighted the effect of the extraction method on the oxidation status of the oils and the role of phenolic compounds in the evolution of radical species over time. The oils with a higher amount of antioxidant compounds revealed a better response to heat treatment.

Keywords: myrtle, oxidative stability, EPR, by-products.

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Use of microalgae and endophyte as bio-stimulants: antioxidant and anti-inflammatory properties of *Cannabis sativa* L. sprouts obtained under standard and enrichment conditions

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Daily consumption of sprouted seeds in diets has increased in recent years with interest in exploring their potential beneficial effects on human health. This study evaluated the germination rate and nutraceutical properties of *C. sativa* seeds cultivar "Futura 75" under standard and enrichment conditions using the microalgal strain *Chlorella* sp. (C2) and the bacterium *Sphingomonas* sp. (CAN_S11), isolated from hemp seeds, as bio-stimulants. The anti-inflammatory property of *C. sativa* sprouts was evaluated on a TNFα-inflamed human pulmonary cell line (A549) and compared to the seeds one.
The phytochemical profile and antioxidant activities of hemp sprouts were evaluated by *in vitro* assays. The gene expression of IL-8 and COX-2 inflammatory markers was analyzed in A549 cells exposed for 4 hours to TNF-α, following 1-hour pre-treatment with *C. sativa* extracts, by Real-Time RT-PCR and immunoblot analysis.
Significantly higher levels of polyphenols (2.95 ± 0.01 vs 2.20 ± 0.02 GAE/g FW, $p<0.01$) and flavonoids (2.68 ± 0.01 *vs* 1.63 ± 0.01 CE/g FW, $p<0.05$) were observed in hemp sprouts obtained from combined treatment with C2 (dry biomass) and CAN_S11 (seed bio-priming) compared to the standard condition. Likewise, C2+CAN_S11 treated sprouts showed better antioxidant activities, mainly DPPH (27.01 ± 0.35 *vs* 22.60 ± 0.68 % ARA, $p<0.01$), ORAC (81.83 ± 14.55 *vs* 41.29 ± 1.94 µmol TE/100 g FW, $p<0.01$), FRAP (909.58 ± 7.95 *vs* 787.17 ± 2.91 Fe^{2+} µM, $p<0.01$), and ABTS (1.48 ± 0.01 *vs* 0.89 ± 0.03 µM TEAC, $p<0.001$). Moreover, pre-treatment with *C. sativa* seed extract significantly reduced the expression of IL-8 and COX-2 in TNF-α treated cells, whereas *C. sativa* sprout extract slightly decreased the expression of IL-8 under inflammatory conditions.
In conclusion, microorganisms and microalgae might represent a good strategy to promote the development of hemp sprouts and increase their phytochemical content and their antioxidant and anti-inflammatory properties.

Keywords: Cannabis sativa; germination; sprouts; bioactive compounds; polyphenols; biostimulants; microalgae; endophytes; elicitation; pulmonary cells; inflammation.

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Biosynthesis and activity of Nanoparticles from Extremophilic Microorganisms

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Nanoscience and nanotechnology attract a great interest due to their potential impact on many areas such as energy, medicine, pharmaceutical industries, electronics, etc. This technology deals with small structures and small-sized materials of dimensions in the range of 1- 100 nm. Nanoparticles (NPs) show unique physical and biological properties, due to their high surface-to-volume ratio. Methods chemical and physical for the synthesis of nanoparticles, are considered unfavourable due to high capital cost, use of toxic reagents and the generation of hazardous wastes. Synthesis of nanoparticles by biological means offers cheap, non-toxic and eco-friendly alternative to the common physical and chemical methods. The use of biological samples like bacteria, plant extracts, fungi, polysaccharides and enzymes for the synthesis of NPs, provides various advantages like eco-friendliness and compatibility for biomedical and other pharmaceutical applications. In this frame, we used extremophilic bacteria to produce biogenic AgNPs and SeNPs.

Ag NPs were produced extracellularly by means of the thermophilic strain *Thermus thermophilus* strain SAMU; the haloalkaliphilic *Halomonas campaniensis* strain 5AG was used for the intracellular synthesis of SeNPs. The structural characterization was carried out by means of UV-visible spectroscopy, dynamic light scattering (DLS), transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FT-IR) and zeta potential.

Both the Ag and se NPs possessed a protein coating on their surface, they were organized in aggregates and showed antibacterial properties versus *Escherichia coli* DSM 648 and *Kokuria rhizophila* DSM 348. In addition, levan-type polysaccharide from psychrophilic *Pseudomonas* strain 2ASCA, develops particles in acidified water with heavy metal chelating capability revealing a strong affinity for Cr(III), never reported before for microbial levans. This behavior was studied using DLS and scanning electron microscopy (SEM).

Keywords: biogenic nanoparticles; green synthesis, extremophiles; antibacterial; bioremediation

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Persistence of fructose-induced dysregulation of neurotrophins and neurotransmitters homeostasis in rat frontal cortex

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Fructose consumption has been dramatically grown in the last decades. Although high fructose intake was suggested to negatively affect brain physiology and cognitive function very little information is available on the impact of this sugar on frontal cortex. Moreover, poor information is available on the persistence of alterations induced by fructose intake after returning to a healthy diet.
To shed light on this issue, male rats were fed a fructose-rich (F) or control diet (C) for 3 weeks. At the end of the treatment, fructose-fed rats underwent a control diet for a further 3 weeks and were compared with animals that received the healthy control diet from the beginning.

We investigated sugar impact in frontal cortex, focusing on the main neurotrophins and synaptic proteins, as well as on inflammatory and redox status. A mass spectrometry-based metabolomic analysis was carried out to assess whether fructose intake influences the homeostasis of polar metabolites, particularly the main neurotransmitters.

Fructose diet was found associated with neuroinflammation and oxidative stress, and reduction of the levels of brain derived neurotrophic factor (BDNF), neurotrophin receptors, synaptic proteins, dopamine and glutamate. Further a rise of acetylcholine amount, acetylcholinesterase and mono amine oxidase activities, and increased formation of the glycation end-products Nε-carboxymethyllysine (CML) and Nε-carboxyethyllysine (CEL) were observed in F rats. Notably, many of these alterations (BDNF, CML, CEL, acetylcholinesterase activity, dysregulation of neurotransmitters levels) persisted after switching to the control diet.

In conclusion, this study demonstrates that the fructose feeding causes a perturbation of various biochemical machineries involved in brain metabolism and function, pointing out that extreme attention should be devoted to limit an excessive consumption of processed sweet food, that can impact brain physiology in the long term.

Keywords: frontal cortex; fructose diet; brain derived neurotrophic factor; neurotransmitters; inflammation.

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Mineral bioaccessibility of pistachio-based fermented beverages: the effect of lactic acid bacteria

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In the recent years, the consumption of plant-based milk substitutes (PBMS) has spread rapidly around the world due to their numerous positive health effects and their popularity among vegetarian, vegan, and flexitarian consumers, as well as those suffering from cow's milk allergy, lactose intolerance, and hypercholeterolemia. PBMS made from almond, oat, rice, soy and coconut are those most commonly produced, but novel PBMS are being developed worldwide using new plant sources, including pistachio, which has recently been evaluated for the production of this type of beverage.

Despite the many benefits of PBMS, they have some negative aspects compared to dairy products, including lower protein content and lower bioavailability of minerals and vitamins. The lower bioaccessibility of mineral in this type of product could be related to the presence of phytic acid, which can interfere with mineral absorption by forming insoluble complexes with divalent cations. However, fermentation of PBMS with lactic acid bacteria (LAB) could overcome mineral bioavailability issues.

This study aimed to evaluate the effect of lactic acid bacteria fermentation on phytic and ascorbic acid contents, and mineral bioaccessibility of pistachio-based beverages.
Results highlighted that LAB strains and the pistachio variety used to produce the fermented beverages influenced the final content of fitic and ascorbic acid, which affected the mineral bioaccessibility.

Mineral bioaccessibility increased mainly due to acidification, reduction of antinutrients such as phytic acid, and increased ascorbic acid content, which enhanced iron bioaccessibility.
Pistachio beverages fermented with LAB could be an interesting plant-based milk analogue due to their health-promoting properties. Further studies should be carried out to optimize the fermentation times and to analyze the ascorbic acid content and mineral bioaccessibility in formulated fermented beverages during their shelf life.

Keywords: Plant-based beverage; pistachio; lactic acid bacteria; mineral bioaccessibility

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Single-cell transcriptomic analysis to identify endomembrane regulation of metalloproteins and motor proteins in aging related autoimmunity

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TMEM230 regulates the endomembrane system of organelles and vesicles. The endomembrane system connects the extracellular with the intracellular environment of cells. Loss of proper endomembrane activity contributes to aging, age-related autoimmunity, and inability to properly utilize nutrients. The Golgi apparatus is the hub of the endomembrane system and essential for phagosome dependent nutrient utilization, and in the recycling and "waste disposal" of toxic, damaged or un-necessary cell components. While not fully understood, loss of normal phagosome and autophagosome activities in age associated autoimmunity are due in part to exposure of environmental insults, infection, and poor nutrition. The ability to re-activate normal autophagosome activity holds promise in mitigating aging and effects from environmental toxins. Mitochondrial metalloproteins necessary for ATP synthesis power motor protein transport of endomembrane cargo. Glycan modifying enzyme in the Golgi apparatus are also essential for the trafficking of cargo between the endomembrane system and the plasma membrane and the external environment of cells. Aberrant secretion of certain factors is a major contributor to chronic destructive tissue remodeling and inability for tissue to regenerate in aging and nutritional disorders. For instance, destructive remodeling of the synovial membrane and joint tissue in rheumatoid arthritis (RA) is promoted by infiltration of blood vessels, and bone erosion and loss of cartilage by phagocytes. In this study, we identified using patient tissue by single cell sequencing of mRNA specific glycan processing enzymes that are upregulated in certain cell types (fibroblast, macrophages or endothelial cells) that function in destructive tissue remodeling in rheumatoid arthritis compared to osteoarthritis (OA). TMEM230 as a regulator of the endomembrane system isa candidate therapeutic target for autoimmune disorders associated with aging.

Keywords: TMEM230, endomembrane system, disorders in aging, pollution and nutrition, autophagy, mitochondria, RNASET2, heparanase, glycobiology.

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Long-term culture of patient derived mammary organoids in non-biogenic electrospun scaffolds for identifying secreted glycoconjugates in aging and senescence

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We recently identified TMEM230 as a master regulator of transport and secretion of glycoconjugates in autophagy and phagosome dependent clearance of senescent tissue in disease and aging. Secreted cellular components modulate immune response and tissue regeneration in aging. Additionally, intracellular packaging, trafficking, and secretion of glycoconjugates while necessary for tissue homeostasis and normal wound healing, also promote proinflammatory and pro-senescence factors such as age associated pro-inflammatory secretome and senescence-associated secretory phenotype factors in tissue cells. Identifying secreted factors in young patients and patients of advanced age will promote discovery of age associated targets that aberrantly promote or inhibit or reverse aging. Ex situ culture of patient primary cells or tissue for identifying secreted factors in tissue regeneration and aging provides opportunities in developing therapeutic and personalized medicine strategies. Moreover, validation of human secreted factors in tissue regeneration requires long-term stabile scaffold culture conditions that are different from those reported for tissue culture established cell lines used as cell models for aging. We describe in a recent study, a 3-dimensional (3D) platform utilizing non-biogenic and non-labile poly ε-caprolactone that supports maintenance of long-term continuous cultures of human stem cells and in vitro generated 3D organoids and patient tissue. Combined with animal component free culture media, non-biogenic scaffolds are suitable for proteomic and glycobiological analyses to identify human factors in aging. Applications of electrospun nanofiber technologies in 3D cell culture allow for ex situ screening and the development of patient personalized therapeutic strategies and predicting their effectiveness in mitigating or promoting aging.

Keywords: TMEM230, electrospun nanofibers, personalized therapies in aging, 3D tissue cultures without animal components, RNASET2, mitochondria, SASP, glycoconjugate.

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Tritordeum bulel and aucan: promising cultivars to improve health

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Cereal-based foods are indispensable constituents of the diet in both developed and developing countries as they are a fundamental source of daily energy, carbohydrates, protein, and fibre. Tritordeum is an amphiploides species resulting from the hybridization between durum wheat (*T. durum*) and wild barley (*H. chilense*). This new cereal is considered a natural crop as it is obtained by traditional breeding techniques. Given its appreciable organoleptic characteristics, agronomic features, presence of interesting components, and good technological properties, Tritordeum is of promising interest for the development of health-oriented foods.

In this study, we evaluated two registered Tritordeum cultivars, Bulel and Aucan. *T. durum* (Provenzal) was employed as the positive control. The extracted proteins were digested by gastric /pancreatic proteases and their biological effects on Caco-2 differentiated on transwell inserts were determined. Changes in cell viability, monolayer permeability, organization of F-actin microfilaments, and ER stress, triggered by protein-digested samples (DPs) were inspected. Proteomics was used to analyze the gastro-resistant protein component comparatively.

Our results showed that exposure to Provenzal-DPs promptly disrupted the tight junction barrier. Conversely, Aucan-DPs did not enhance monolayer permeability; whereas, Bulel-DPs exerted only slight effects. Provental-DPs-induced toxicity was also confirmed by changes in cell viability and by the deep reorganization of the enterocyte cytoskeleton. In contrast, Aucan-DPs and Bulel-DPs did not affect monolayer viability and cytoskeleton structure. Overall, our findings suggest that both Tritordeum cultivars could be potential candidates for mitigating the toxicity of wheat flour and as a source of components for health-valued foods [*Foods* 2024, *13*(5), 661; https://doi.org/10.3390/foods13050661].

Keywords: cereal; protein-digested samples; gluten-related disorders; proteomics; Tritordeum

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Potential prebiotic effect of inulin enriched pasta

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The functional food market is constantly increasing all over the world, for satisfying the needs of consumers for a healthier diet, thus leading to the development of several innovative products. Among innovative functional foods, several products fortified with prebiotic substances, known for their beneficial effect on the gut microbiome, have been developed. Inulin represents a noteworthy ingredient widely used in a variety of foods selectively fermented by a limited number of bacteria in the large intestine. In the current study, inulin enriched pasta was obtained adding 12% (w/w) of commercial chicory root inulin to the formulation, and characterized for sensory attributes, cooking quality parameters, protein and amino acid contents in comparison to the not enriched pasta (CTRL). The incorporation of inulin, significantly affected some organoleptic traits and cooking quality of the final product giving an overall score significantly higher respect to the CTRL. The essential amino acids content resulted similar in both pasta samples while the total protein content was lower in inulin enriched pasta for the polymer substitution to durum wheat flour. *Lacticaseibacillus paracasei* IMPC 2.1 was selected among seven strains for the simulated colonic fermentation studies. The ability to grow and to produce short chain fatty acid (SCFA) in digested inulin enriched pasta was compared to glucose and fructo-oligosaccharides (FOS) and to digested CTRL pasta. The positive prebiotic activity score registered with the probiotic strain at the expense of the enteric strain suggested the suitability of the inulin enriched pasta to act as a prebiotic source favoring the growth of the probiotic strain at the same extent of FOS. As a results, the SCFA production was higher in the presence of inulin enriched pasta respect to the pasta CTRL. Further studies will be also necessary to evaluate the influence of the degree of polymerization of inulin for the gut microbiota modulation thus improving intestinal health benefit.

Keywords: Lacticaseibacillus paracasei IMPC 2.1, SCFA, inulin, pasta, functional food

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Social agriculture for life quality and environmental sustainability

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Social Agriculture (SA), regulated in Italy by the Law n. 141/2015, is part of a welfare model in which environmental protection, enhancement, as well as people well-being and social integration, are able to find their maximum expression. For older people, the experience in Social Farms is an opportunity for aggregation and improvement of life quality and psychophysical well-being, according to the WHO's definition of active aging as a "process of optimizing health opportunities, participation and safety to improve people's quality of life".
We conducted a preliminary desk analysis to size the total number, the related sectors of specialization and the recipients of companies operating in SA in Italy. Therefore, it was possible to identify a sample of companies located in Calabria and Sicilia available for the case study both to analyse their activities and the psychophysical well-being parameters linked to the stay in natural environments by the over65 people attending them on daily basis or residential mode.

For the data selection, we used the ISTAT 2020 National Census, the CREA 2020-2023 Regional Registers, various search engines, and comparisons with trade associations as well as direct telephone contact.

In the next months a case study will be conducted on the 45 identified sample companies and the over65 people frequenting them, by means of online questionnaires (Google Forms) and face to face interviews.

From the desk analysis carried out, emerges, in Italy, an ever-increasing presence and legislative protection of SA, but also the necessity to improve the knowledge of the phenomenon, since the information on operators, activities, recipients and above all effects of these practices on people and territorial contexts are, at the moment, poor.
The case study will provide further elements of knowledge for the identified sample Regions.

Keywords: Social Agriculture, Well-being, Active Aging, Case Study

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Comprehensive Morphometric and Biochemical Characterization of Seven Basil (Ocimum basilicum L.) Genotypes: Focus on Light Use Efficiency

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The choice of basil (*Ocimum basilicum* L.) genotypes determines key attributes such as yield, flavor, and adaptability, contributing significantly to the overall success and sustainability of basil cultivation practices. As the primary aim of this study, seven basil accessions were characterized for both their growth performance and biochemical profile of volatile compounds, enabling the differentiation among distinct chemotypes. As secondary objectives, growth performance and production were evaluated under natural solar radiation conditions (SR100) and with a 30% reduction in solar radiation using a net (SR70).

Light use efficiency (LUE) determination revealed the plants' biomass production capability under different solar radiation (SR) conditions. Genotypes A, B, C, and G were characterized by a high levels of linalool, which is typically associated with the "pesto" sauce smell. Lemon basil D exhibited a different chemotype due to the presence of neral and geranial. E and F displayed a different chemotype due to the higher concentration of α-bergamotene. The total fresh harvested biomass was significantly higher in SR70 than SR100 conditions. The second harvest in both SR conditions was the most productive one, while genotype E under SR70 displayed the highest yield. The landraces D and E showed the highest LUE values, indicating their capability in converting the solar radiation into fresh biomass. Plants grown in SR70 conditions registered significantly higher values of plant height, number of branches, and leaf weight.

This work aimed to provide valuable insights into the selection of basil genotypes suitable for sustainable agriculture and lays the basis for cultivation aspects pertaining to the crop's adaptability in peri-urban, marginal lands, which are characterized by limited solar radiation. Improved light use efficiency presents a promising prospect for future agriculture, facilitating plant cultivation even in peri-urban marginal lands. This study could offer valuable insights into genotype selection for various agronomic products, ranging from fresh shoots to pesto sauce.

Keywords: organic farming; marginal lands; sustainable vegetable production; shading system; essential oils

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Quinoa-based liquid sourdough enriched in exopolysaccharides as prebiotic ingredient for bakery products

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The research aims to investigate on the ability of lactic acid bacteria (LAB) strains, used as fermentation starters, to produce exopolysaccharides (EPSs) during liquid sourdough fermentation and to evaluate their potential to act as prebiotics. Actually, EPSs are known as food technological improvers and at a lesser extent for their functional traits. EPSs can protect probiotic bacteria during and after the gastrointestinal transit acting, respectively, as a barrier and as prebiotics for their resistance to the gastric transit.

In the current study, ten LAB strains belonging to *Lactiplantibacillus plantarum* (ITM21B, P24, P25, P102, C21-41), *Lacticaseibacillus paracasei* (P101), *Lactococcus rossiae* (C21-11), *Leuconostoc mesenteroides* (C43-2), *L. citreum* (C2-27) and *Weissella cibaria* (C43-11) species, were investigated. The ability of strains to produce EPSs was performed by agar-plate assay on medium enriched with seven carbon sources: glucose, fructose, sucrose, maltose, raffinose, galactose and lactose. As a safety trait, the absence of decarboxylase activity linked to the production of biogenic amines, was investigated using agar plates containing 1% of the precursor amino acids (L- tyrosine, lysine, histidine and ornithine). The screening tests revealed that strains did not show decarboxylase activity, indicating that they were not able to produce biogenic amines. Among tested strains, C43-11, C2-27 and C43-2 produced EPSs in the presence of sucrose as carbon source and strain *W. cibaria* C43-11 was selected to obtain a liquid sourdough (LS), based on quinoa flour and sucrose as additional carbon source (6% w/w LS), suitable for bread production. After fermentation, LS resulted enriched in EPSs (23.56 g/kg) which were purified and subjected to *in vitro* gastric digestion: a slight reduction (7.7%) of the EPSs content was observed, suggesting the potential of the quinoa-based LS to be used as a prebiotic ingredient for bakery products.

Keywords: quinoa, fermentation, lactic acid bacteria, exopolysaccharides, in vitro *gastric digestion, prebiotics.*

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Extraction and characterization of phycocyanin and allophycocyanin from spirulina using the caco-2 cellular model

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Spirulina, a blue-green microalgae, has garnered attention in recent years due to its remarkable nutritional and health-promoting properties. Rich in proteins, vitamins, minerals, and bioactive compounds, Spirulina exhibits diverse potential applications in the field of nutraceuticals. Phycocyanin and allophycocyanin, natural pigments, are precious safe bioactive compounds derived from Spirulina. This study aimed to investigate the crude extract, phycocyanin and allophycocyanin from Spirulina and characterize their biological properties. The extraction process involved cell lysis, followed by separation and purification of molecules using techniques such as centrifugation and chromatography. Characterization was conducted using various analytical methods, including UV-visible spectroscopy and high-performance liquid chromatography (HPLC). The purity and concentration of phycocyanin and allophycocyanin were determined, along with their stability under different environmental conditions in an intestinal cell model. Furthermore, cytocompatibility, antioxidant activity, and cellular uptake were explored. Overall, the results highlight the importance of Spirulina-derived phycocyanin and allophycocyanin as a promising natural pigment with several potential applications.

Keywords: Phycocyanin; biological activity, pharmaceutical; nutraceutics.

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Association between urinary ages and circulating mirnas: a pilot study

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Contemporary dietary habits are characterised by elevated exposure to Advanced Glycation End products (AGEs), primarily due to the growing consumption of ultra-processed foods. Body levels of these compounds fluctuate with dietary intake and are closely linked with age and health status, serving as formal indicators of oxidative stress and inflammation in adults. However, the relationship between AGEs and health outcomes in children remains uncertain, with conflicting findings from various pediatric studies, particularly concerning structural tissue damage that may predispose individuals to chronic issues in adulthood. Moreover, despite extensive research efforts, there is no universally agreed-upon methodology for quantifying AGE levels in humans.

This pilot study investigated the association between urinary AGEs, measured using spectrofluorimetry-based assays, and circulating microRNAs (c-miRNAs) in a subsample (n=22) of Italian children of the I.Family Study. Anthropometric measurements, biochemical markers, and miRNA profiles were assessed. The first evidence of a link between urinary AGEs and c-miRNAs in obesity was discovered. Specifically, four miRNAs (miR-10b-5p, miR-501-5p, miR-874-3p, and miR-2355-5p) showed significant associations with urinary AGE levels (J Clin Med. 2023. doi: 10.3390/jcm12165362).

This connection underscores the intricate relationship among AGEs, obesity, inflammation, and specific miRNAs, suggesting potential impacts on cellular and tissue equilibrium. Identifying altered c-miRNA profiles presents promising avenues for early assessment of changes in AGE levels, offering insights into heightened disease susceptibility before metabolic complications arise. These findings are particularly significant considering the challenges of *in vivo* testing for the different classes of AGEs, which typically remains low in young healthy individuals but progressively increase with age, contributing to adverse health outcomes and reduced life expectancy.

Keywords: circulating miRNAs; urinary AGEs; disease propensity biomarkers; obesity; children and adolescents

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Prunus Mahaleb fruits as source of novel foods and beverages with high polyphenolic content

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Prunus mahaleb L. is a widespread tree resistant to drought, poor soils and high summer temperatures in the Mediterranean basin. Previous studies demonstrated that P. mahaleb fruit could represent a new source of bioactive substances, mainly represented by anthocyanin, endowed with high antioxidant capacity and anti-inflammatory activity, when tested on in vitro cell cultures. More recently, it was demonstrated that P. mahaleb extracts protects treated mice against toxic effects of chemically induced colitis. However, P. mahaleb fruits, are not edible because of their sourness and bitterness. This study aims to improve the sensory characteristics of P. mahaleb fruits after fermentation with different Saccharomyces cerevisiae and Lactobacillus plantarum strains, paying attention to the development of new functional foods rich in bioactive molecules. With this aim four different strains of L. plantarum and one of S. cerevisiae were inoculated individually or in co-culture (bacterium + yeast) in an aqueous suspension of intact fruits. Microbial growth kinetics were monitored during 20 days of fermentation. Fermented fruits and fermentation broth were characterized for their organoleptic properties evaluated by hedonic panel. The results obtained indicated that all the starters used were capable of growing and fermenting fruits. Mixed (bacterium + yeast) starters had the best impact on the sensory characteristics of both the fruits and the fermentation medium. Moreover, the antioxidant activity and polyphenol content of both fermentation liquid and fermented fruits appeared to be higher using a mixed inoculum than using a single bacterium or yeast starter. The results of this study demonstrate that fermentation of P. mahaleb fruits using a starter co-culture composed of L. plantarum and S. cerevisiae will allow the development of a promising new functional and probiotic food and drink starting from fruits of a neglected and underutilized species.

Keywords: Prunus mahaleb fruits; fermentation; Lactobacillus plantarum; Saccharomyces cerevisiae; polyphenols; antioxidant activity.

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Food from wine by-products: effects of gastrointestinal digestion on pasta fortified by grape pomace flour

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Grape pomace is a winery byproduct and is a rich source of phenolic compounds and dietary fibers. The grape pomace phenolic component is highly accessible and available for metabolization in the human gut. In this study, grape pomace is used as an ingredient to fortify pasta. Analyses of soluble and bound phenols and volatile compounds in raw and cooked pasta were performed. The fibre component increased by at least double, the soluble polyphenol component increased by at least 10-fold and doubled the isoprenoids, after cooking. In accordance with the polyphenol content, antioxidant activity resulted higher than that of the control pasta.

Moreover, Infogest in vitro digestion protocol was used to compare the carbohydrate and polyphenol contents of cooked fortified pasta. The ability of digested samples to modulate the secretion of the satiety hormone GLP-1 in STC-1 cells was also evaluated. The analysis of carbohydrate content showed a decrease of maltotriose and glucose (from 10 to 25%) in fortified pasta. The total polyphenol content of fortified pasta was higher than control pasta overall in pasta functionalized by white grape pomace flour (45%). After simulated digestion, a complete characterization of phenolic compounds was carried out by HPLC-HRMS. The data show a good concentration of phenolic acid, along with the occurrence of hydroxybenzoic acid. The fortified pasta with red wine pomace exhibits a complete loss of anthocyanins and a 10- fold increase in p-coumaric acid concentration. The satiety effects of digested pasta were also investigated on the STC1 cell line. All digested pasta samples decreased the release of active GLP-1 secretion compared to the basal control. In conclusion, our results show that pasta fortified with pomace flour could potentially improve the nutritional properties by increasing antioxidant and polyphenol content. More experiments are required to deeply understand their possible role in satiety mechanism regulation.

Keywords: grape pomace; polyphenols; functional food; in vitro digestion; circular economy

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Molecular basis of the health effects of red fruits

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Polyphenolic compounds are noteworthy for anti-inflammatory, anticancer, anti-microbial, and antioxidant properties and for benefit in the prevention of cardiovascular, diabetes mellitus and neurological diseases. Among foods rich in these compounds, red fruits have caught the attention of the scientific community due to the increase of their worldwide consume, their sensory characteristics along their high nutritional value and their small size, which makes them easy to carry and be consumed. Moreover, red fruits are often not processed therefore preserve all their bioactive compounds. Scientific evidences supporting the positive role of red fruits consumption on insulin resistance, glucose intolerance, anti-diabetic effect, and a lower cardiometabolic risk have multiplied; however, several of the mechanisms at the base of these effects are still unclear.

This project aims to study the direct impact of almost 70 polyphenolic compounds from red fruits on human proteins, in order to highlight which are the main bioactive compounds and which metabolic pathways they predominantly affect.

To achieve this goal, bioinformatics and computational biology methods have been involved. In particular, possible human protein targets of the selected compounds have been found exploiting reverse docking approach. The most promising proteins, selected on the base of their docking scores, have been analyzed to define the metabolic processes in which they were involved, the eventual relationships among them and their possible functional roles in specific related diseases.

Preliminary results have highlighted that about ten compounds may have a strong impact on specific proteins of the carbohydrate metabolism, in particular amylases, transporters and signaling proteins already known for their role in the regulation of the insulin resistance and the type 2 diabetes prevention, thus suggesting possible mechanisms of the health effects of red fruits.

Keywords: red fruits, docking, polyphenols

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Wellness apps towards personal nutrition guide

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Individual wellness is a major focus in digital technology, with particular emphasis on the use of mobile technologies to improve physical health. The wellness app market is experiencing rapid growth due to increased awareness of health issues and advances in technology. The key factors driving this growth are modern lifestyle pressures and the accessibility of connected devices that encourage a health-conscious and proactive approach to health. While it should be emphasized that the role of the nutritionist in following and advising people from a dietary point of view, devising personalized nutritional regimens/plans, cannot be replaced by a smartphone app, these resources can be a valuable aid in monitoring the activity carried out by the users, in making them more aware of the food consumption and choices they are making, and in showing the progress of the plan they are carrying out. In this work, we analyzed the state-of-the-art of wellness apps associated with nutrition, looking at features ranging from the simple collection of user-supplied information to more advanced technologies such as interfacing with wearable devices and sensors. Thus, features for monitoring daily nutrition, physical activity performed, autonomously collecting measurable parameters from wearable devices, and even integrating the different information collected can be found in the available apps. Artificial intelligence applications further support the field of wellness apps toward a future level more customized to the user. All these features are related to the characteristics of a market such as smartphone apps, and the necessary requirements for the protection of privacy and sensitive user data.

Keywords: wellness, smartphone app, nutrition.

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Older consumers involvement in nutrage project

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Introduction
An adequate nutrition for elderly population is presently a major social challenge. Poor eating habits are closely linked to some of the major diseases associated with aging and a consistent intake of food that meets the specific age and health needs of the elderly population should be promoted and encouraged. However, to motivate the elderly to adopt an appropriate diet, also hedonic expectations and life-long mature consumers habits should be satisfied. An integrated approach, including educational seminars on healthy-aging and a direct involvement of groups of elderly in providing/maintaining a food diary, could be a basis for exploring/understanding food behavior and propose beneficial diet changes and healthier food choices.

Research carried out
Aged people were recruited in senior community centers in two Italian Regions (Emilia-Romagna and Lazio). As a first step, they participated to a seminar focused on correct eating behaviors, in line with Mediterranean Diet features. Then, they were requested to fill-in/maintain a daily food diary for seven days. The diary included a list of breakfast, lunch, dinner, and other meal components.

Results and perspectives
Data were collected from 52 participants aged between 65 and 85, including 37 women and 17 men. Each subject filled a 7-day food diary, reporting all meals consumed in a week. Selected food types/categories were examined (Tab. 1). Results show difference between genders, with women consuming more fruit, vegetables and sweets, while men prefer pasta. Other differences between meals, weekdays and regions will be discussed.
Data collected from participants' diaries will be useful to plan further activities, which will include elderly-tailored sensory and hedonic tests on functional foods.

Consumption Frequency (%)	Pasta	Vegetable	Legumes	Fruit	Meat	Fish	EVOO	Dessert
Overall	**40,5**	**73,6**	**9,9**	**51,8**	**33,4**	**15,2**	**66,6**	**16,8**
Lunch	66,8	73,1	13,5	61,3	33,0	14,6	72,5	15,7
Dinner	14,3	74,2	6,3	42,3	33,8	15,9	60,7	17,9
Weekdays	40,2	77,9	9,8	51,7	30,2	16,9	69,4	16,3
Weekend	41,3	63,0	10,1	51,9	41,3	11,1	59,6	17,8
Lazio	39,6	68,0	10,6	45,9	34,2	15,6	68,8	20,1
Emilia R.	42,1	83,5	8,6	62,0	32,0	14,7	62,8	10,9
Women	39,0	75,1	9,1	55,0	33,6	15,3	70,7	17,2
Men	44,3	70,0	11,9	43,8	32,9	15,2	56,7	15,7

Keywords: Older people, food education, eating behavior, food diary

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Multimodal, multiparametric, intelligent: the new era of sensory analysis

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Sensory analysis is gaining momentum in scientific research, with technological advancements playing the starring role for a new perspective in the field. Until some years ago, the overall sensory analysis pathway was focused on the assessment of organoleptic features of a food/drink through self-reported questionnaires, with significant limitations and methodological biases. Nowadays, this part was empowered with the application of implicit measures, based on psychophysiological features, enabling merging such results with the explicit data above mentioned[1,2].

Human emotions and perceptions should go side by side with the characterization of the chemical composition of edible compounds, nowadays made possible both with laboratory analyses, like Gas Chromatography coupled with Mass Spectrometry (GC-MS)[3] and using portable, low-cost tools like Electronic Nose (E-Nose) and Electronic Tongue (E-Tongue), to quickly characterize the olfactory (or gustatory) fingerprint of a substance[4].

All those methods mentioned above have the capability of providing large amounts of data, to be properly collected and analyzed, using state-of-the-art methods. To this end, a careful selection of technological tools devoted to safe, secure, smart data collection is pivotal, with a web-app developed under the Software-as-a-Service (SaaS) paradigm that could serve for the role, putting together modules that can be added or removed upon the needs of the specific use case scenario. At the same time, involving sensitive data, collected on human subjects (e.g., panelists), such a solution should also take care about data safety, security and privacy, in compliance to the EU GDPR 2016/679 regulation[5].

Data collected in this way can be analyzed by data scientists by applying Artificial Intelligence methods to infer relationships between chemical, sensory and emotional features of a given product, paving the way for a “new era” for sensory analysis applied to foods and drinks.

Keywords: ECG, GC-MS, GSR, privacy, psychophysiology, sensory analysis, software, wearable sensors

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Reference

1. Tonacci, A., et al. (2021). Wearable sensors for assessing the role of olfactory training on the autonomic response to olfactory stimulation. Sensors, 21(3), 770.
2. Tonacci, A., et al. (2023). Taste the emotions: pilot for a novel, sensors-based approach to emotional analysis during coffee tasting. Journal of the Science of Food and Agriculture, Nov 27.
3. Koziel, J., et al. (1999). Field air analysis with SPME device. Anal Chim Acta, 400(1-3), 153-162.
4. Modesti, M., et al. (2022). E-Senses, Panel Tests and Wearable Sensors: A Teamwork for Food Quality Assessment and Prediction of Consumer’s Choices. Chemosensors, 10(7), 244.
5. Conte, R., et al. (2022). Privacy-by-Design and Minimization within a Small Electronic Health Record: The Health360 Case Study. Applied Sciences. 12(17), 8441.

Mitochondrial functionality and metabolic alterations in aging and alzheimer disease: the therapeutic potential of pterostilbene

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Introduction. Aging and Alzheimer's disease (AD) pose significant challenges to global health. They are characterized by cellular and molecular dysfunctions that include mitochondrial impairment and metabolic alterations. In this context, pterostilbene (3,5-dimethylresveratrol; Pt), a plant phenol, holds therapeutic promise due to its ability to positively influence key processes related to aging and neurodegeneration, and to cross the blood-brain barrier.

Methodology. Obesity is known to induce alterations in the central nervous system, resembling those observed during aging and neurodegeneration. Hence, an obesogenic diet was exploited to mimic aging-related changes. Obese mice were treated with Pt, and the expression levels of genes related to aging and AD pathogenesis were monitored. Additionally, a murine model of AD was employed to assess mitochondrial functionality and metabolism.

Results and conclusions. In AD mice, alterations in calcium exchange between mitochondrial matrix and cytoplasm were observed. Moreover, significant metabolic differences and reduced acylcarnitine levels were detected, suggesting lipid metabolism defects. Additionally, AD neuron cultures exhibited alterations in oxidative metabolism, indicating a reducing stress. Chronic Pt treatment increased AMPK phosphorylation and the gene expression of Tfeb and Pgc-1α in brain tissue, supporting the therapeutic potential of this natural compound, which can cross the blood-brain barrier for cerebral therapy. These findings highlight the potential of Pt in modulating mitochondrial function and countering metabolic alterations associated with aging and AD, offering intriguing prospects for future therapies.

Keywords: Pterostilbene, Aging, Alzheimer's Disease, Mitochondrial Functionality, Metabolism

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Determination of oxidative stability and antioxidant capacity of beer samples with electron spin resonance spectroscopy

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Spin trapping technique coupled with Electron Spin Resonance (ESR or EPR) spectroscopy has been proposed as a method for the prediction of *shelf life* of beer, based on the determination of the *lag time* (*Spectroscopy* 16, 16-19, 2001). The radical species produced during the heating of beer at 60 °C (or at other temperature values), which could not be detected because of their high reactivity, are trapped by PBN (N-*t*-butyl-α-phenylnitrone) forming relatively stable adducts. The intensity signal of the adducts as a function of time allows the determination of the *lag-time*, that is the time at which there is a sudden increase of the intensity signal.

The *lag-time* determination is not always possible, both changing the PBN concentration and/or the alcohol content of the heated samples (*Oxygen*, 2, 605-615, 2022). Another variable which has been considered is the temperature at which the analysed samples are heated: even changing this parameter the determination of the *lag-time* is not always possible (*Eur. Food Res. Technol.* doi: 10.1007/s00217-024-04525-9). For the determination of the beer oxidative stability, which is in direct relationship with its *shelf life*, other parameters have been considered: the intensity signal of the adduct after 150 min (I_{150}) and the area under the curve (AUC) intensity signals of the adducts as a function of time.

Since the availability of an ESR spectrometer is precluded to most of the breweries, the oxidative stability of beer determined with ESR spectroscopy was effectively related to other analytical parameters: i) the antioxidant capacity measured with the DPPH assay, ii) the total polyphenolic content, iii) the thiobarbituric index. The proposed methodology can be used for other food matrices for the determination of their oxidative stability.

Keywords: oxidative stability, beer, EPR, antioxidants, spin trapping.

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Establishing suspension cell cultures of dittrichia viscosa as source of nutraceuticals

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Dittrichia viscosa (L.) Greuter (syn. Inula viscosa L. (Aiton), is a plant belonging to the Asteraceae family, spontaneously growing in the Mediterranean regions. Having a rich specialized metabolism, the plant has been used since many years in traditional medicine for treating human health. Several bioactive compounds from D. viscosa plant tissues were identified and could find different applications as agrochemicals, cosmetics or food ingredients. While the content of bioactive compounds in plant tissues are influenced by plant adaptation to different soil and climatic conditions, plant cell and tissue cultures can be effective continuous bio-factories of valuable natural compounds, characteristic of the original plants, to be used for industrial applications. For this purpose, callus cultures of D. viscosa were established by optimizing culture medium composition, light and temperature. Optimal growth rates and friability of D. viscosa callus cultures were obtained using Gamborg B5 medium added with peptone 0.2 g/L; BAP 0.2 mg/L and 2,4-D 1.3 mg/L as plant growth regulators. Aiming at scaling up culture volumes, fast-growing cell suspensions were obtained from friable calluses into liquid medium, characterized by a subculture cycle of 21 days, with an increase of about 10-fold fresh weight. At regular intervals, samples from callus and suspension cultures were harvested and extracted for biochemical analyses. Several bioactive compounds, such as antioxidant molecules, vitamins and carbohydrates were found and their characterization is in progress.

Keywords: plant cell cultures; bioactive compounds; Dittrichia viscosa;

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Recognition and analysis of dietary mobile apps available on the marketplaces

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Nutrition and healthy lifestyle Apps provide a low-cost and efficient way to disseminate information to the general and targeted population, such as healthy, pathological, overweight elderly people. They offer opportunities for consumers to monitor and manage their food purchasing and consumption as well as to integrate additional physiological, vital and anthropometric parameters gathered from sensors and other Apps. Different studies have shown that these types of Apps are the most popular among the health ones with 22% of older adults adopting them specifically for nutrition and weight loss/control. Based on these premises, aim of this work is to provide an overview of the Apps available in the main marketplaces (i.e., iOS and Android) highlighting: 1) the main information/features describing them and made available by the developers, 2) eventual clinical or well-being aspects integrated, 3) additional technological aspects such as integration with other Apps or databases, use of sensors for monitoring anthropometric and/or vital parameters. A preliminary analysis has been conducted considering 20 Apps among the first 100 Apps available within the nutrition and health category of both iOS and Android marketplaces. Relevant results highlight that calorie counting and the indication of intermittent dieting are widely diffused among them, while the selected Apps lack in the possibility of exchanging data between smartwatches or smartphones. This system integration will be the focus of the next analysis, in particular to analyse how this data is used for other types of Apps.

Keywords: mobile Apps, mobile health, elderly, system integration

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Analysis of food and nutrition guidelines for collective catering dedicated to the elderly population

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Currently the over 65s represent almost 25% of the Italian population and this percentage is set to grow to 36% by 2050. Aging represents a challenge for societies, in particular the prevention of the frailties such as cognitive decline, cardiovascular diseases and tumours. Based on epidemiological studies, factors that protect against severe cognitive decline have been identified, including genetic, environmental and lifestyle factors, including diet and nutrition habits. This is evident considering elderly people who live in retirement or nursing homes where meals are supplied by collective catering services that should ensure the application of food, nutritional, environmental and social policies. Aim of this work is to provide an overview of guidelines and protocols available from macro to micro level, focusing on: good practices defined by the Word Health Organization (WHO), European recommendations, guidelines of the Ministry of Health (MoH) as well as regional and local initiatives available in Italy. A preliminary analysis highlighted great attention on the topic: the WHO studied the nutritional guidelines for healthy aging in the study *Keep fit for life: meeting the nutritional needs of older people* conducted in 2002. Constantly updated topic and included in Who's World on the UN Decade of Healthy Aging (2021-2030). The ESPEN (*European Society for Clinical Nutrition and Metabolism*) guidelines provide recommendations for particular pathologies and to prevent or identify cases of dehydration, promoting good practices in home care. At national level, MoH provides guidelines for collective catering to reduce waste and combating malnutrition in hospital settings, while regional initiatives deal with the nutrition of the elderly in structures with a greater level of attention. Future work will focus on comparing the various initiatives also highlighting to what extend they involve patients and caregivers in the definition of both guidelines and diet composition.

Keywords: guidelines, protocols, nutrition, Italy

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Phytocomplexes with antioxidant potential extracted from *Gentiana lutea* and *Hypericum perforatum*, two native plants from the Pollino National Park

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INTRODUCTION: With aging process, the body is subjected to increasing oxidative stress, responsible for the onset of various chronic pathologies. Plant-based medicines represent a source for human health, as plants synthesize a wide variety of organic molecules (flavonoids, terpenes, phenolic acids, carotenoids, etc.), defined as Secondary Metabolites (SM), able to exert antioxidant and protective actions against free radicals.

METHODS: Two native species from the Pollino National Park in Southern Italy, *Hypericum perforatum* and *Gentiana lutea*, were analyzed for their antioxidant potential and for the biotic and abiotic factors that influence it. The matrix was dried, pounded and subjected to extraction in EtOH 80%. The phytochemical profile of plants collected at different altitudes in both wild and cultivated fields was analyzed and compared.

RESULTS: As regards *H. perforatum*, the TLC analyses showed a ubiquitous presence of some components, such as hypericin and pseudohypericin, in the investigated tissues (leaves, flowers and fruits), while in HPLC analyses significant differences were observed at increasing altitude of the collection site. These data were consistent with antioxidant activity measured through ABTS assay. On the contrary, regarding *G. lutea*, both total polyphenol content and antioxidant potential appeared stable at increasing altitude. The phytochemical pattern obtained by TLC and confirmed by HPLC, showed a superimposable profile.

CONCLUSIONS AND PERSPECTIVES: Obtained results suggested how *H. perforatum* and *G. lutea* native species from the Pollino National Park, although exerting two different adaptation strategies to the environment, can be considered potential antioxidant agents for the improvement of risk factors related to the development of chronic diseases supported by the action of free radicals.

Keywords: Hypericum perforatum; Gentiana lutea; secondary metabolites, antioxidant activity

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Exploring sustainable membrane strategies for producing concentrated juice enriched of health-promoting compounds from red fruits

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Red fruits are among the most important dietary source of polyphenols, such as anthocyanins, flavonols, benzoic and hydroxicinnamic acid derivates. Numerous in *vitro* studies have reported that their ingestion is helpful in fighting different pathologies, such as cancer, heart disease, and type 2 diabetes. Given the wide spectrum of healthy activities of these fruits, the interest of researchers has been addressed, in recent years, towards new methods able of producing juices enriched in bioactive compounds with a high organoleptic profile. In this contest, membrane processes represent a very powerful alternative, to conventional technologies, reducing the heat-associated loss of nutritional and functional quality due to the moderate operating temperatures used in the process.

In this work, sustainable processes based on the combination of conventional and innovative membrane techniques including ultrafiltration (UF), nanofiltration (NF) and osmotic distillation (OD), in a sequential design, were studied for the production of concentrated juices with a high nutritional profile and improved antioxidant capacity, from two selected red fruit juices: pomegranate and a blend of pomegranate, cactus pear juice and red orange juices. Specifically, red juices were at first pre-treated by UF for the removal of suspended solids and then concentrated through a combination of NF and OD or submitted to a fractionation/concentration process by NF in order to produce concentrated fractions enriched in polyphenols and depleted in sugars. The investigated processes allowed to obtain three valuable products: *i)* a concentrated blend of red fruit juices (OD retentate at 60°Brix), with high antioxidant potential and enriched in health compounds of interest for the production of functional foods; *ii)* a concentrated pomegranate juice (NF retentate), enriched in anthocyanins that can be reused for the formulation of nutraceutical products or as natural colorant; *iii)* a NF permeate fraction enriched in sugar compounds can be reused as food additives or as bases for soft drinks.

Keywords: red fruit juices, integrated membrane processes, functional foods, health promoting compounds

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Polyphenols fate and impact on gut microbiota of Pomegranate Juice in Simulated Digestion Model SHIME®

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Human health and diseases are increasingly linked to the human microbiota condition. The gut microbiota plays an important role by contributing to the fermentation and release of nutritional food components, eliciting the immune system response, protecting from pathogenic agents, and synthetizing important vitamins.
Diet also impacts the intestinal microbiota, and particularly on its taxonomical composition and metabolism. The dietary polyphenols, microelements present in vegetables and fruits, provide a wide spectrum of biological responses with beneficial effects for human health. Polyphenols ingested with the diet are poorly absorbed in the stomach and small intestine. Up to 90–95% of total polyphenol intake reaches the colon and is metabolized by gut microbiota into several bioactive compounds that can both modify intestinal ecology and have beneficial health effects. Pomegranate juice is very reach in polyphenols (over 2 g/L juice) and anthocyanins (3-glucosides and 3,5-glucosides of cyanidin, pelargonidin and delphinidin), flavonols and ellagitannins (punicalagin) are the main identified compounds.

In this study, the ex-*vivo* Simulator of Human Intestinal Microbial Ecosystem - SHIME® was used to investigate the effects of a daily administration (for 1 week) of pomegranate juice on human gut microbiota and the fate of pomegranate polyphenols along the simulated digestion process.

The chemical analysis highlighted a polyphenols bioaccessibility ranging from 15 to 30% for anthocyanins and from 10 to 18% for ellagic acid and flavonoids. This trend was slightly lower than the bioaccessibility of polyphenols already reported in other food matrixes (artichokes, olives), although for juice administration this trend could be linked to the absence of matrix protection. The analysis of microbiota showed that a daily administration of pomegranate juice is able to positively modulate the gut microbiota. Further analyses are underway to deeply investigate these preliminary results.

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Keywords: SHIME, pomegranate, bioaccessibility, human microbiota, polyphenols

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Effects of pre-harvest application of harpin proteins on tuber yield and nutritional traits of two early potato cultivars

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Potatoes are characterized by nutritionally relevant traits and are considered the main source of minerals and antioxidant compounds among vegetables in the European diet. In recent years, among the innovative agronomic strategies seeking to improve quality attributes in a sustainable way, the application of harpin proteins, elicitors produced by gram-negative plant pathogenic bacteria, have drawn considerable attention. This research was undertaken in such context and aims at evaluating the effects of foliar applications of a product based on harpin proteins on tuber yield and nutritional profile in two potato cultivars.

The field experiment was conducted in Sicily (Italy), using a commercial product (HP400, Sipcam Italia SpA) at two different concentrations (manufacturer recommended and doubled concentration), compared to the untreated control and two cultivars: Monique (with yellow skin and intense yellow flesh) and Soprano (with light yellow skin and flesh). At tuber harvest, tuber yield and components, dry matter, total soluble solids, reducing sugars, starch, proteins, vitamin C, total phenolics contents and antioxidant activity (DPPH and FRAP essays) were measured.

The application of harpin proteins, regardless of the concentration, significantly increased tuber yield in both cultivars (mainly due to the increase in mean tuber weight), dry matter, total soluble solids, reducing sugars, starch and vitamin C contents, as well as the antioxidant activity measured by the DPPH and FRAP essays, whereas it decreased proteins and total phenolics contents. Overall, these preliminary results show the validity of applying harpin proteins to improve the yield and most nutritional traits of tubers in the studied cultivars, although they should be verified by further investigation.

Keywords: potato, elicitors, antioxidants, quality, health

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Influence of dynamic digestion by SHIME® on bioaccessibility of polyphenols from table olives extract and human microbiota modulation

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Table olives are a typical vegetable of the Mediterranean area, and their polyphenols content and composition can be influenced by several factors, such as cultivars, climate, fruits ripeness, and, mainly, the processing methods. The starter driven fermentation, using selected autochthonous LAB and yeast strains, demonstrates to be an excellent debittering method, reducing the time and preserving the polyphenols. In addition, scientific evidence permits to consider the table olives as functional foods since their polyphenols content (as hydroxytyrosol and its derivatives) is higher respect those estimated in extra-virgin olive oil for which the Nutritional Claim table EU (n. 433/2012 of 23 May 2012) was reported.

In this study, the Simulator of Human Intestinal Microbial Ecosystem (SHIME®) was used to evaluate the polyphenols fate during a daily administration of a polyphenolic extract from *Leccino* cv table olives, fermented with a selected LAB strain from CNR-ISPA microbial collection. The SHIME is a dynamic artificial digestive system that mimics all the sections of the GI tract and permit to follow the gut microbiome shift in response to various factors, including dietary supplements, pre-probiotic preparations, but also to simulate the GI digestion starting from healthy or non-healthy human microbiota inoculum.

The preliminary results showed the following polyphenols bioaccessibility: hydroxytyrosol 70%, tyrosol 103%, verbascoside 65%, caffeic derivatives 73%, cumaric derivatives 64%, quercetin glucoside 60%. In agreement with other studies, the results highlighted a high stability of olive polyphenols and, the high bioaccessibility recovered for some of them, could be probably related to a hydrolysis process of more complex molecules.

The analysis of microbiota reveals a taxonomic shift of microbial population along olive extract administration and a possible modification of gut microbial metabolism.

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Keywords: SHIME, table olives, bioaccessibility, human microbiota, hydroxityrosol

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Biochemical characteristics of two monofloral rosaceae honeys, and in vitro evaluation of their anti-inflammatory and tyrosinase-inhibitory effect

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Honey is linked to the history of man, and used since ancient time for therapeutic purposes. It is rich of bioactive molecules, such as polyphenols, vitamins, enzymes and sugars, which influence their health properties, such as anti-inflammatory, and antioxidant capacity. Some studies evaluated beneficial effects attributable to the honey in combating some of the most critical neurodegenerative diseases (NDDs), such as Parkinson's disease (PD), mainly manifesting in older people, which involves some enzymes, such as tyrosinase. Thus, the inhibition of tyrosinase may be helpful in the treatment of PD. NDDs can also be connected to the involvement of neuro-inflammation and the amassing of free radicals, taking place to subsequent neurodegeneration. The objectives of the present study were to increase knowledge on some biochemical characteristics (determination of the total polyphenols and vitamin C content) of hawthorn (*Crataegus monogyna*) and raspberry (*Rubus idaeus*) honey. Their potential healthy properties were also evaluated by studying their in vitro antioxidant, anti-inflammatory, and tyrosinase-inhibitory activity. Hawthorn honey exhibited better tyrosinase-inhibitory activity than raspberry honey (IC50 = 13.48 and 20.32 mg, respectively). The antioxidant activity, evaluated through DPPH method, indicated a more remarkable performance of raspberry honey (EC50= 52.78 mg/ml) compared to hawthorn honey (EC50= 92.19mg/ml). This behaviour was probably due to the higher vitamin C content exhibited by raspberry honey (28.09 mg/100 gr, compared to 19.15 mg/100 gr content found in hawthorn honey), being the total polyphenols present in the two kinds of honey substantially the same (108.93 and 112.17 □g GAE/gr in hawthorn honey and raspberry honey, respectively). The IC50 values resulting from the in vitro analysis of the anti-inflammatory activity highlighted a similar behaviour between the two types of honey (48 and 46.43 mg for hawthorn and raspberry honey, respectively).

Keywords: honey, neurodegenerative diseases, anti-tyrosinase activity- anti-inflammatory activity

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Broccoli-rabe/cime di rapa (*brassica rapa* l. subsp. *sylvestris*) in organic farming: omics targeted to nutritive variation in packaged product and in fresh florets treated with lavender essential oil

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Broccoli rabe is traditionally consumed in central-southern Italy (local names *cime di rapa/friarielli*) and is recognized for its health value. It is a low-input crop, grown outdoors in autumn-winter cycles, and the floret (inflorescence) is appreciated provided that is green (with a pungent taste). The vegetable has spread from niche markets to large retail outlets as a minimally processed product (MP) with good market value. MP product valorization is envisaged as well as novel tools aimed at delaying flower opening (anthesis) to avoid the undesirable yellow trait and prolong shelf-life.
In this context, two model studies have been set up. One consisted of leaves and florets of 'Bat' and 'Olter' genotypes (2 production cycles) as packaged products compared to those at harvest. The other model used 'Bat' florets treated with lavender essential oil (LEO), which is effective in delaying anthesis, compared to controls. Profiles of ca. 30 hydrosoluble compounds obtained by an untargeted qNMR approach were compared with the underlying gene networks derived from RNA-seq analyses.

As for product valorisation, targeted compounds included amino acids (AA), carbohydrates, organic acids, and others; genotype had a minimal effect, organ type affected several metabolites (e.g. flowers had higher AA levels than leaves), status had the strongest impact on all groups causing higher levels of specific AAs and lower carbohydrate contents. Analyses targeting GABA nutrient allowed the construction of a gene-metabolite network underlying its accumulation in packaged florets.

Interestingly, LEO treated florets had lower levels of several AAs, such as Ile, Val, Thr, Ala, Pro, Asp, as well as lower levels of fructose and glucose, while glucosinolate levels were higher than controls. AA variation contents were consistent with the expression patterns of key genes governing AA metabolism and integrated omics analyses will be extended to build a network that underpins flower opening.

Keywords: "cime di rapa", nutritive valorisation, essential oil treatment

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Effects of microalgal biostimulants on growth, antioxidant molecules content and total antioxidant capacity in two quinoa varieties exposed to salt stress

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Scenario: Quinoa (*Chenopodium quinoa* Willd.) is a plant of South American origin, which has been highly valued for its nutritional and nutraceutical properties. The adaptability to diverse soil and climate conditions has led to its spread in many nations with consequent selection of the best adaptable varieties. Quinoa is a halophytic plant that can grow in marginal soils with high salinity. Despite its great adaptability, the use of biostimulants can contribute to a greater resistance to adverse conditions, to an increase of the qualitative characteristics of the harvest and, lastly, of the final product.

Methods: The effects of treatments with microalgae extracts (*Ettlia pseudoalveolaris* and *Chlorella vulgaris*) at different concentrations were analyzed on germination and growth of two quinoa varieties, Tunkahuan and Regalona, in the presence or absence of salt stress (NaCl 100, 200, 300mM). The sprouts, collected at 3 and 7 days, were analyzed for antioxidant molecules content (total polyphenols, flavonoids, chlorophylls, carotenoids, anthocyanins) and total antioxidant capacity (DPPH and FRAP assay). Analysis of reactive oxygen species (ROS) was done by histochemical and fluorometric approach. Besides, the content of lutein, □-carotene, chlorophyll *a* and *b* was quantified using DAD-HPLC.

Results: No effects were observed on germination and seedling growth of the two quinoa varieties, but the results highlighted that the microalgae induced an increase of the analyzed antioxidant molecules in the treated sprouts and in some cases the effect was amplified in presence of salt stress. This indicates that the nutraceutical properties of sprouts in terms of content of antioxidant substances can be increased by the presence of microalgae biostimulants and by salt stress, in appropriate combinations of the two factors. This approach can be further considered to obtain vegetable foods with high nutraceutical value to be exploited both as supplements and fortified foods.

Keywords: quinoa; biostimulants; microalgae; salt stress; seed germination; seedling growth; antioxidants and antioxidant activity; halophytes

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Assessment of nutrition literacy in caregivers of older people

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Introduction
Malnutrition is a highly prevalent condition in older adults and is associated with several negative clinical outcomes, such as frailty, delirium, decreased immunocompetence, muscle wastage, osteoporosis, mood changes, cognitive impairment, lowered quality of life, and premature mortality (Dent et al, 2023). Therefore, following an appropriate healthy diet can help older people to maintain a good general health. Nutrition literacy (NL) is defined as "the degree to which individuals have the capacity to obtain, process, and understand nutrition information and skills needed in order to make appropriate nutrition decisions" (Vettori et al, 2019). The caregivers' level of NL becomes particularly relevant in older people with functional dependence since it can affects their diet quality and therefore their health status. This observational and cross-sectional study aims to assess the level of NL in caregivers of hospitalized older adults.

Methods
The current study will enrol 134 caregivers of older people hospitalized at the UOC Geriatria and at the Community hospital of the Azienda Ospedale – Università di Padova. The following information will be obtained from each caregiver by a dietician: socio-demographic characteristics and lifestyle behaviours of caregiver; socio-demographic characteristics, lifestyle behaviours and comorbidity of the older person; Nutrition Literacy questionnaire (Vettori et al, 2019).

Conclusions/perspectives
The findings of the current study will enable us to identify caregivers' educational needs on nutrition and, therefore, to implement adequate interventions.

Keywords: malnutrition, Nutrition Literacy, caregiver, older people

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Study on the preventive action of physical activity and probiotics in response to brain trauma in an elderly mouse model

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Traumatic Brain Injury (TBI) is a devastating condition leading to structural damages and long-term cognitive impairments. In this context, neuroinflammatory processes play a crucial role in modulating post-traumatic neuro-regenerative and neuro-reparative mechanisms. Aging correlates with increased susceptibility to injuries, with reduced resilience in elderly individuals due to a generalized increase in inflammatory status. Changes in the Gut Microbiome (GM), which regulate physiological processes throughout the body, seem to actively participate to inflammatory regulation. However, aging is marked by a physiological alteration in intestinal permeability and/or flora composition, a pathological condition known as dysbiosis. Modulating the microbiota is considered a viable tool to positively contribute to organismal well-being. Nevertheless, it remains unclear whether modifying it through preventive use of probiotics and/or physical exercise can modulate neuroinflammatory and neurorepair processes following TBI in elderly subjects.

In this project, aged C57B6/J mice were orally administered probiotics (*L. Farmicinis* enriched) for 15 days and/or given access to a running wheel for 4 weeks before being subjected to moderate TBI. Molecular and behavioral evaluations to test the inflammatory/neuroreparative as well as neurocognitive responses were performed at both 24 hours and 30 days post-trauma.

Our preliminary results indicate a specific effect of probiotics and running in modulating the neuroinflammatory response and, more importantly, the long-term cognitive improvement 30 days post-injury. These data suggest that a healthy lifestyle contributes to promoting neurorepair processes even in elderly subjects.

Keywords: microbiota, probiotic, gut-brain axis, neurogenesis, aging, lifestyle

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Natural polyphenols curcumin and quercetin protect human immune cells from oxidative stress by activating autophagy and the nrf2 antioxidant pathway

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Introduction: This study delves into the burgeoning interest in natural agents and their potential to act at low doses in chemoprevention. We previously characterized two types of immune cells derived from HG-3 and K-562, differentiated with All-Trans Retinoic Acid (ATRA) and phytoalexin Resveratrol. Our exploration of the molecular mechanisms of natural polyphenols at very low concentrations, in line with their low bioavailability in human tissues, suggests their ability to protect the differentiated cells by activating the antioxidant response dependent on the transcription factor Nrf2 and modulating autophagy.

Research/Methods: Curcumin and Quercetin at 1 µM concentrations pre-incubated for 16 hours protected cells against H_2O_2-induced oxidative stress (DCFDA probe), improved cell viability, (CyQuant) activated the antioxidant response dependent on NQO1 expression, and modulated autophagy measured with $p62^{SQSTM1}$, Beclin-1 and a specific fluorescent probe (Cyto-ID).

Results: Our discovery that Quercetin and Curcumin protect immune cells from H_2O_2 cytotoxicity by inducing an Nrf2-dependent antioxidant response and a significant increase in NQO1 protein correlated to a protective form of autophagy dependent on the expression of $p62^{SQSTM1}$, even at low doses, which is compatible with their low bioavailability after their ingestion in food, enriches the field of biochemical properties of natural bioactive molecules.

Conclusion/Perspectives: Given that specific populations, such as the elderly and individuals living in areas with environmental stress (pollution), may be more susceptible to chronic degenerative diseases, this finding holds significant promise for the potential use of these natural agents in chemoprevention, underscoring the relevance and importance of our research.

Keywords: quercetin, curcumin, Nrf2, H_2O_2 p62, autophagy

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Nutraceutical value of pomegranate (*punica granatum l.)* Juice: a superfood

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Increasing consumer demand for "superfoods," foods with high health properties, is increasing the consumption of foods enriched with nutraceutical compounds. Pomegranate (*Punica granatum* L.) is one of these kinds of foods, whose fruits have relevant beneficial properties attributable to its high content of bioactive compounds, which can vary according to genotypes, environmental growing conditions and agronomic technique adopted. In particular, pomegranate juice is a fortified source of dietary polyphenols with antioxidant effect due to its content of tannins, anthocyanins and flavonoids.

The objective of this research was to identify pomegranate genotypes characterized by a high presence of bioactive compounds. To achieve the goal, fruits of 10 pomegranate genotypes (G1-G10) were collected and compared with the Wonderful (Wo) commercial variety, all grown in the same environment. Morphological traits were measured on the whole fruit, peel, arils and juice, and on the latter were also evaluated pH, °Brix, color, total phenolic content (TPC), antioxidant activity (AA) and polyphenolic profile by HPLC.

The study showed marked variability in morphological traits among the genotypes analyzed. In addition, significant differences also emerged in TPC and AA, with higher levels in G1 (2225 mg GAE/L juice and 21 mmol TE/L juice) and G2 (1835 mg GAE/L juice and 18 mmol TE/L juice) significantly higher than in WO (1428 mg GAE/L juice and 15 mmol TE/L juice). Among the polyphenols analyzed, anthocyanins, particularly delphinidin 3-glucoside and cyanidin 3-glucoside, are the predominant class of compounds. In conclusion, this project made it possible to identify, among all the samples under study having "superfood" characteristics, two pomegranate genotypes (G1 and G2) that stand out for their high polyphenol content.

Keywords: Punica granatum L., antioxidant activity, polyphenols, anthocyanins, bioactive compounds

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Use of salt stress to stimulate the production of phenolic compounds in hydroponically grown Cynara cardunculus seedlings

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The agronomic biofortification process improves the nutritional value of food plants by modulating their accumulation of healthy substances. In this context, biofortification through salt stress is widely used as a specialised metabolism stimulation trigger for vegetable plants. In recent times, the spread of soilless farming systems, such as hydroponics, has paved the way to manage all phases of plant cultivation and treatment in a more precise manner.

The wild cardoon, C. cardunculus L. var. sylvestris Lam., is a Mediterranean herbaceous species with well-known nutraceutical properties related to its high content of antioxidant compounds. The present project aims to stimulate the metabolism of phenolic compounds in the wild cardoon through the use of salt stress in a hydroponic cultivation system. For this purpose, wild thistle seedlings were cultivated in a hydroponic system for three weeks, followed by salt stress treatment by adding 0, 100, or 200 mM NaCl for a further two weeks.

The results show a significant increase in the production of phenolic compounds with increasing salt concentrations ($p < 0.01$), associated with an increased antioxidant capacity ($p< 0.001$). Furthermore, in vivo measurements indicated that flavonol content increased significantly in seedlings exposed to 100 mM NaCl, while chlorophyll and anthocyanin concentrations did not vary significantly between the control (0 mM) and intermediate stress (100 mM) conditions. In conclusion, this contribution provides promising results on the biofortification of the wild cardoon through a sustainable cultivation technique.

Keywords: cardo selvatico, stress salino, germogli, biofortificazione, composti fenolici

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Influence of the fermentation process driven by selected microbial starters and pasteurization treatment on functional traits of fermented table olives

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Table olives are one of the most known fruit consumed as fermented food worldwide, since they are highly appreciated by the consumers and they represent an important economic source for producing countries. The modernization of the debittering process by fermentation is one of the most stimulating challenges for the agro-food sector. Concerning table olives, both producers and consumers are increasingly interested in final products improved in their functional traits as well as in more reproducible and safer production methods, also reducing health risks and food losses.

In this study, microbial starters from different sources have been used to highlight their influence to technological and safety aspects (specific enzymatic and microbiological profiles) together with nutritional and functional traits (with a particular attention to bioactive compounds) of fermented black table olives.

Two different temperature conditions, such as constant at 20°C and oscillating between 7-17 °C, and as well as the effects of the pasteurization treatment were tested for each fermentation assay on the final products. Functional aspects, in terms of total phenolic content and total antioxidant activity, were improved carrying out the fermentation process driven by selected microbial starters. In terms of technological and functional properties, the fermentation of black table olives under not controlled environmental temperature conditions was more promising than the constant value of 20°C, and the pasteurization treatment seemed to enhance the antioxidant compounds concentrations.

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Keywords: Fermentation; polyphenols content; antioxidant activity; functional product; nutritional aspects

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Senescence and genome instability are markers of cornelia de lange syndrome cells

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Cornelia de Lange syndrome (CdLS) is a rare developmental disorder with an incidence of between 1:10,000 and 1:30,000 live births. Common characteristics of CdLS include cognitive impairment, pre- and postnatal growth retardation, microcephaly, facial dysmorphia, hirsutism, and upper extremity defects. CdLS is caused by mutations in *HDAC8*, *NIPBL*, *RAD21*, *SMC1A* and *SMC3* genes belonging to the cohesin-core or its regulators. Recently, we showed that two CdLS patients carrying a mutation in *SMC1A* gene are characterized by reduced cell life span, high level of oxidative stress and genome instability. Up until now, no systematic study has been performed to investigate whether genome instability is a marker of CdLS patients. To gain insight into this topic, we cultured CdLS cell lines harboring mutations in *SMC3*, *NIPBL* and *HDAC8* genes. We found that CdLS cells became senescent around the 25th passage with a considerable decrease in their in vitro lifespan compared with control cell lines. This senescence was confirmed with a □-galactosidase assay. Next, we analyzed the level of oxidative stress during cell progression through in vitro culture. To study global oxidative stress, we measured the level of protein carbonyls by ELISA. At early passage, the protein carbonyl content in CdLS cells was significantly higher than control cells. In addition, the frequency of spontaneous chromosome aberrations was also found to be significantly higher in all mutated cell lines. These results indicate that senescence and genome instability may be considered specific markers of CdLS.

Keywords: Senescenza, instabilità del genoma, sindrome di Cornelia de Lange

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Fruit quality and nutraceutical traits in open-field tomato under long-lasting water stress conditions as affected by biostimulant application

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Recently, new strategies have been proposed in agriculture for a sustainable improvement of production systems under adverse environmental conditions. One promising is the use of plant-derived biostimulants, as eco-friendly tools for reducing the negative environmental impact on crops. Among them, protein hydrolysates (PHs) from legumes are a well-known group of natural biostimulants that have been proven to prevent yield losses and improve quality in vegetables under stressing conditions.

An open field experiment was conducted on four cultivars of tomato (*G*) (two commercial tomatoes and two local landraces of long shelf-life tomato), to assess the crop response to the foliar application of a plant-derived PH biostimulant (*T*), under opposite water regimes (*I*) (no irrigation and full irrigation), in a semi-arid environment of South Italy.

The present study revealed that changes in fruit sensory and nutritional quality occurred in tomato in response to long-lasting drought conditions. The biostimulant application during the growing season significantly promoted plant productivity (up to +65%), either under no and full irrigation. Biostimulant had no effect on fruit quality in terms of total solids, soluble solids, reducing sugars, but significantly enhanced the contents in antioxidants (vitamin C, phenols, lycopene) under both water regimes. However, significant *G* x *I* x *T* interactions suggest the need of a better knowledge of biostimulants management, to make their use more appropriate and sustainable, taking into account the increased production costs implied by their application.

In this regard, future multi-sites and multi-year research should be carried out in open field tomato under restricted environmental conditions, to fine-tune the use of biostimulants and, ultimately, make the crop more economically and environmentally convenient than the cultivation of untreated plants.

Keywords: Solanum lycopersicum L.; water stress; local landraces; plant-derived biostimulant; antioxidants

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Silibinin-loaded nanoparticles boost silibinin citotoxicity by increasing its bioavailability in lung cancer

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Lung cancer ranks as the second leading cause of cancer-related mortality globally, in both men and women. Silibinin (SLB) is a polyphenolic flavonoid derived from *Silybum marianum* seeds that has anticancer activity in different cancer types, including lung cancer. In particular SLB acts by regulating cell cycle, by inducing apoptosis and by reversing multi-drug resistance. Despite its potential, SLB faces severe limitations due to its poor water solubility and oral bioavailability. To overcome these limitations, we have developed specific nanoparticles (NPs) to encapsulate SLB with the aim to increase its delivery and efficacy. NPs were made up of an amphiphilic blend of poloxamers and poly(lactic-co-glycolic acid) (PLGA), a formulation that enhances permeability and retention (EPR) effect.

The efficacy of that SLB-loaded NPs was analysed using three different lung cancer cell lines, H1299, H1975 and H358. The results showed that our formulation after 24 hours treatment, was able to reduce cell viability with a SLB amount ten-fold lower respect to the naked SLB. In fact, 6mg/mL of SLB-NPs were able to reduce cell viability as 60mg/mL of naked SLB. This suggests that SLB-loaded NPs greatly increases its bioactivity, probably raising its bioavailability.

The significant cytotoxicity enhancement suggests that the produced NPs hold substantial promise for augmenting the therapeutic efficacy of SLB alone. This indicates that the pharmacological potential of this molecule is not affected by both the preparation technique and the loading in the nanoparticles.

Keywords: polyphenols, nanoparticles, cancer

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Protective effects of hydroxytyrosol, a component of olive oil, and extracts from olive oil by-products on cognitive decline, loss of muscle function and alterations in the gut microbiota in aged mice

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Hydroxytyrosol (HTyr) is a phenolic compound present in olive oil known for its anti-inflammatory, neuroprotective, and antioxidant activities (PMID: 37049607). We have previously observed that oral treatment with HTyr stimulates the production of new neurons in the neurogenic niche of the hippocampal dentate gyrus, in aged mice (PMID: 32027412).

Objective. Study the potential beneficial effects of HTyr treatment, in an experimental model of aged mice, on the following characteristic traits of aging: 1) neurogenesis decline, and hippocampal-dependent cognitive impairment and anxiety, 2) alteration in the composition of the gut microbiota, 3) loss of muscle function. Special attention is given to studying the microbiota-gut-brain axis, and the gut-muscle axis.

Results. Treatment with HTyr, synthesised in our laboratories using a procedure we optimised: 1) promotes the production of new neurons in both the dorsal and ventral part of the dentate gyrus with a prevalent effect in the ventral region, and reduces anxiety symptoms in a model of post-traumatic stress disorder; 2) preserves the biodiversity of the gut microbiota, which is reduced after a traumatic event; specifically, HTyr prevents the decrease in the *Ruminococcaceae* family, which is known to participate in the promotion of neurogenesis and neuron survival. Moreover 3) muscles of HTyr-treated mice show reduced myofibre atrophy and increased expression of genes involved in mitochondrial biogenesis, defence against oxidative stress, autophagy and lysosome biogenesis. We are now testing the effect of treatment with HTyr-enriched extracts we have obtained with green technology from oil production waste.

Our data show that in aged mice HTyr promotes stress resilience by increasing ventral hippocampal neurogenesis and modulating the microbiota-gut-brain axis. Moreover, HTyr counteracts muscle atrophy modulating the expression of specific genes.

These studies are supported also by Project Lazio Innova2020-36407.

Keywords: Hydroxytyrosol, olive oil, neurogenesis, post-traumatic stress disorder, microbiota-gut-brain axis, muscle atrophy

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Longitudinal association between insulin clearance and age and targeted metabolites in individuals at risk of type 2 diabetes

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Insulin clearance has emerged as a potential key player in the deterioration of glycaemic control. Links between diet, age, and insulin clearance are unexplored, as well as associations between circulating metabolites (partially linked to diet) and insulin clearance, especially in longitudinal terms. Here, we investigated significant associations between temporal changes in oral glucose tolerance test (OGTT)-assessed insulin clearance (ICL) and changes in circulating targeted metabolites over the same period, with potential age adjustment, in individuals at risk of developing type 2 diabetes (T2D).

In the IMI DIRECT cohort of white North European individuals at risk of developing T2D (*N*=1983), aged 38-75 years (median 63), targeted metabolomics were assessed using the AbsoluteIDQ Biocrates p180kit and OGTTs were conducted at months 0, 18, and 48. Longitudinal slopes for 128 metabolites and for ICL were computed over the 48 months. ICL slopes were adjusted for insulin sensitivity slopes. The relationships between slopes for ICL and for metabolites were investigated through nested cross-validated LASSO multivariate analysis, including as potential confounders mean insulin secretion and BMI slopes, age, sex, and smoker status.

LASSO selected 8 metabolites slopes and three confounders as important variables for ICL slope multivariate linear regression (figure; cross-validated R^2 = 0.14). The highest importance was reported for slopes of proline (Pro), with negative association, and acetyl-L-carnitine (C2) and octadecenoylcarnitine (C18:1), with positive association. Age was not selected.

We identified a set of metabolites longitudinally and independently associated to OGTT-assessed insulin clearance, adjusted for insulin sensitivity, whilst age showed no independent effect. The identified metabolites are mostly involved in protein and fatty acids metabolism. Amino acid proline, the most important metabolite from the analysis, is abundant in milk, salmon, eggs, and meat.

Keywords: type 2 diabetes, insulin clearance, metabolomics, age

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Exploring the connections between senescence, telomere homeostasis and autophag

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Cellular senescence hallmarks are telomere attrition, oxidative stress, epigenetic alteration, genomic instability, SASP and proteostasis dysregulation. ATM deficiency recapitulates well all these pathways alteration in a genetically controlled model system. Telomeres are sensitive sites for oxidative stress, and, when eroded or damaged, they activate a DDR able to induce an autophagic cell death which constitutes a barrier for cancer initiation. Telomere erosion, besides replicative shortening, is also caused by guanine oxidation. The long noncoding RNA containing telomeric repeats TERRA, is transcribed at very low level in healthy cells. Its abundance has been found anti-correlated with telomere length and can represent a marker for senescence. In lymphoblastoid cell lines derived from healthy donors and ATM-/- patients we observed a direct correlation between ATM and the autophagic gene ATG4C expression levels. In this cell context we found that ATG4C overexpression in ATM -/- context rescues cell proliferation and survival to oxidative stress and only partially autophagy. More interestingly, we found that ATG4C overexpression protects telomeres from DNA damage. Notably, IF analysis of ATG4C showed the presence of nuclear spots which occasionally colocalized with telomere signals. Finally, with the aim of finding new biomarkers for senescence, we measured the expression of long non-coding RNAs called TERRA (Telomere Repeats containing RNAs) transcribed at subtelomeric loci, in ATM +/+ and ATM-/- conditions, finding that TERRAs are hyper transcribed in ATM-/- cells compared to controls, suggesting that these molecules could be employed as senescence biomarkers. This preliminary evidence suggests that there are multiple levels of crosstalk between autophagy, telomere homeostasis and senescence, and that ATG4C could be one of the players involved in these connections.

Keywords: ATM, senescence,autophagy, telomeres

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Neuroprotective potential of polyphenols from elderberry extract

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Neurodegenerative diseases include a heterogeneous group of chronic pathologies which, in terms of human suffering and economic cost to society, represent the highest percentage of diseases in high-income countries. Addressing these conditions is a public health priority due to their chronic and incurable nature. Several studies suggest as polyphenols, non- nutritional components present in foods, can exert neuroprotective effects. They are mainly known for their antioxidant properties; however, they are also able to modulate numerous biological processes underlying the onset of neurodegenerative diseases. Starting from these considerations, our main objective was to evaluate the potential neuroprotective and antioxidant effect of a methanolic extract obtained from the elderberry, Sambucus nigra. To verify the neuroprotective potential of the extract we employed an in vitro model of neurodegeneration: differentiated IMR-32 cells treated with hydrogen peroxide (H2O2) and/or oligomerized beta amyloid peptide (Aβ). We observed that the pre-incubation with the S. nigra extract protected neuronal cells against neurotoxic stimuli, assessed by MTT assays. Moreover, pre-incubation of differentiated IMR-32 cells with S. nigra extract restored levels of Reactive Oxygen Species (ROS) and glutathione altered by treatment with H2O2 and/or Aβ. The polyphenolic extract alone caused an increase in intracellular ROS levels (15-20%) and this pro-oxidant activity was also confirmed by the increased activity of the Plasma Membrane Redox System (PMRS). We hypothesized that the pro-oxidant activity generated an adaptive response responsible for protection against the pro-oxidant action exerted by neurotoxic molecules. Future studies will be dedicated to deepening these preliminary data, trying to define the molecular details and chemically characterize the bioactive components responsible for the biological activity that emerged.

Keywords: neuroprotection, Sambucus nigra, polyphenols

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Nutrition knowledge assessment among students

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Introduction:
Nutrition Knowledge refers to awareness of practices and concepts related to major nutrient sources, the importance of adequate food intake, dietary guidelines, and diet-related diseases. *Nutrition knowledge* influences people's food choices and, consequently, their health status. Indeed, following an unhealthy diet is one of the main risk factors for chronic diseases such as diabetes, cardiovascular diseases, some forms of cancer, and other obesity-related conditions.
Several researches show that adolescents tend to skip meals, snack frequently and consume high amounts of junk food, highlighting the need to improve their nutritional knowledge; it should be considered that dietary habits acquired during childhood and adolescence can strongly influence lifestyles adopted throughout life with a consequent impact on future health. Therefore, the purpose of the present study is to assess *Nutrition Knowledge* in a sample of Italian students in order to identify the main educational needs of adolescents in the area of nutrition.

Methods:
The present observational and cross-sectional study will enroll 460 students from secondary schools in Italy. During the period between May and June 2024, students will be asked to answer to an online questionnaire prepared with LimeSurvey. Data on the sociodemographic characteristics of the respondents and on their lifestyle will be collected; the questionnaires on *Nutrition Knowledge* by Grosso et al. (2012) and on Mediterranean diet adherence KidMed will be administered. Questions about the sources used to find information on food and nutrition, and on the relationship between nutrition and health will also be asked.

Conclusions/perspectives:
This study will allow to estimate the prevalence of inadequate *Nutrition Knowledge* among secondary school students in Italy, identifying the knowledge domains with greater gaps, to define focused nutritional educational interventions for adolescents.

Keywords: Nutrition Knowledge; adolescents; Mediterranean diet; nutritional educational interventions

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Valorization of local food components by means of synergistic collaborations at the CRISEA center

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UMG, Net4Science and CRISEA are institutions working together in Calabria with the aim to push the valorization of improve local food properties by means of research activities carried out mainly in the field of Medicinal Chemistry and Nutraceutics. They share a common cultural matrix, which in Italy at an academic level coexists in the organization of the GSD 03/07 (Pharmaceutical, Toxicological, Nutraceutical-Food Chemistry, Fermentations and Products for Wellbeing and Health) which replaces the previous SC 03/D1. This matrix is also perfectly reproduced in the research activities carried out at the CRISEA Center in Belcastro (figure 1), a non-profit association recognized by the ANR of MUR1. Since 2021, the year in which the center is actually carrying out scientific collaborations with the university spinoff Net4Science and with the “Magna Græcia” University of Catanzaro, there have been various synergies that have led to the publication of scientific contributions in international journals2, to the organization of training events and research activities in regional and national projects3,4.

Figure 1: logos of UMG, Net4Science and CRISEA, aerial photo and location of the CRISEA center (www.crisea.it).

This poster presents the aims of the CRISEA center, illustrates the scientific results achieved on funded projects and future research synergies.

Keywords: Medicinal Chemistry, Nutraceuticals, CRISEA, UMG, Net4Science

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References

1. *https://www.anagrafenazionalericerche.mur.gov.it/Consultazione?Filter=crisea*
2. *https://pubmed.ncbi.nlm.nih.gov/?term=”CRISEA”[Affiliation]*
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