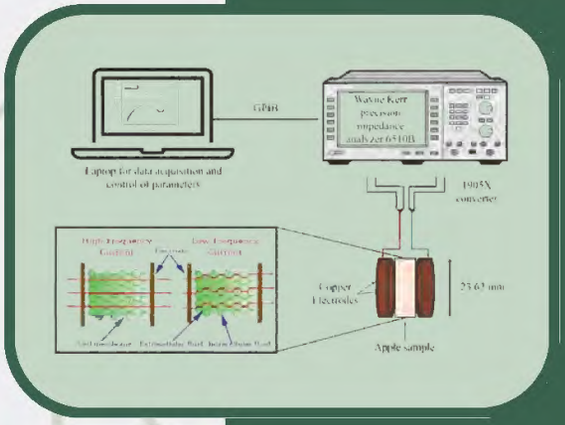
FOOD INNOVATIONS, FOOD ALLERGIES AND TRADITIONAL FOODS (FIFATF-2025), NATIONAL CONFERENCE BOOK OF ABSTRACTS

BOOK OF ABSTRACTS

(FIFATF-2025)



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National Conference, Book of Abstracts

Food Innovations, Food Allergies and Traditional Foods

National Conference, Book of Abstracts

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भारत सरकार

सत्यमेव जयते

MINISTER
FOOD PROCESSING INDUSTRIES
GOVERNMENT OF INDIA

Chirag Paswan
चिराग पासवान

MESSAGE

I am pleased to extend my warm greetings and best wishes to all participants and the organising team of the National Conference on "Food Innovations, Food Allergies and Traditional Foods", to be held on 11–12 December at Sant Longowal Institute of Engineering & Technology, Longowal.

It is inspiring to note that this conference has attracted around 180 participants from 55 esteemed institutions and universities across 20 states, reflecting its nationwide relevance and the growing interest in advancing India's food sector.

The themes of this conference are of great significance. Academic and scientific platforms always play a pivotal role in strengthening the research and innovation ecosystem. They foster collaboration among scientists, industry experts, policymakers, entrepreneurs, and young researchers. The knowledge exchanged here will undoubtedly contribute to building a safer, healthier, and more resilient food processing sector aligned with the nation's developmental goals.

I commend the Department of Food Engineering and Technology at SLIET for organising this significant event and appreciate the collective efforts of all institutions involved. I encourage participants to engage wholeheartedly in deliberations, contribute innovative ideas, and explore opportunities for future collaboration.

I extend my best wishes for the success of the conference and hope it leads to impactful discussions and long-term contributions to the food sector and society at large.

(Chirag Paswan)

आज़ादी का अमृत महोत्सव

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Prof. Mani Kant Paswan, Ph. D.
Director, SLIET, Longowal

MESSAGE

I am delighted that the Department of Food Engineering and Technology, Sant Longowal Institute of Engineering & Technology (SLIET) is organizing the *National Conference on "Food Innovations, Food Allergies and Traditional Foods"* during 11–12 December.

This conference comes at a crucial time, as the food sector is rapidly transforming to address challenges in safety, sustainability, nutrition, and consumer health. The themes of this conference, ranging from emerging food innovations and advancements in processing technologies to understanding food allergies and revisiting the value of traditional foods, are highly relevant in today's scientific and industrial landscape.

The participation of experts, researchers, industry professionals, and young scholars from across the country will provide an excellent platform for knowledge exchange, research discussions, and collaborative opportunities. I am confident that the deliberations during this two-day event will significantly strengthen the nation's scientific base in food technology and inspire new ideas to address the evolving needs of the food sector.

The efforts made by the Chairman, FIFATF-2025 and his team are commendable. I extend my best wishes for the successful organisation of the conference, with the hope that the interactions and discussions held during the conference will pave the way for impactful research, innovation, and development for the future directions of research in food processing and will ensure the benefit of society and the country as a whole.

Best wishes,

Mani Kant Paswan
Director, SLIET

रवनीत सिंह
RAVNEET SINGH

राज्य मंत्री
खाद्य प्रसंस्करण उद्योग एवं
रेल मंत्रालय
भारत सरकार
MINISTER OF STATE
FOOD PROCESSING INDUSTRIES
AND RAILWAYS
GOVERNMENT OF INDIA

MESSAGE

I am pleased to extend my warm greetings to all the delegates, researchers, academicians, industry professionals, and participants attending the National Conference on "*Food Innovations, Food Allergies and Traditional Foods*" on 11th – 12th December 2025.

The tracks addressed in this conference are significant. With the growing global focus on functional foods, allergy awareness, and the scientific validation of traditional dietary practices, this event offers a conscious platform for meaningful discussions and knowledge exchange.

I appreciate the initiative of the organizers in bringing together experts from academia, research institutions, and industry to share insights and foster collaboration. Such efforts contribute significantly towards strengthening the nation's capabilities in food science and technology, supporting entrepreneurship, and promoting value-added food processing.

I encourage all participants to engage in the technical sessions actively, interact with experts, and explore opportunities for innovation and the application of scientific knowledge. I am confident that the outcomes of this conference will yield constructive ideas, enhanced understanding, and strengthened efforts to improve India's food processing ecosystem.

I extend my best wishes to the organizers for the successful conduct of this national conference and hope that the deliberations held will contribute positively towards the advancement of the food sector and well-being of the society.

(Ravneet Singh)

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सीएसआईआर-केन्द्रीय खाद्य प्रौद्योगिक अनुसंधान संस्थान
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ಡಾ. ಗಿರಿಧರ್ ಪರ್ವತಂ
ನಿರ್ದೇಶಕರು

डॉ. गिरिधर पर्वतम
निदेशक

Dr. Giridhar Parvatam
Director

MESSAGE

I am pleased to know that the Department of Food Engineering and Technology, Sant Longowal Institute of Engineering & Technology, Longowal is organizing the National Conference on "Food Innovations, Food Allergies and Traditional Foods" during 11–12 December.

The focus on modern food innovations, the increasing awareness of food allergies, and the scientific re-evaluation of traditional foods reflect the growing need to integrate research, technology, and cultural knowledge for the benefit of society.

The participation of researchers, academic experts, industry professionals, entrepreneurs, and young scholars from across the country will provide a meaningful platform for interaction, knowledge sharing, and collaborative engagement. I am confident that the discussions and scientific exchanges during this two-day event will significantly strengthen the nation's scientific and technological progress in food science and promote innovative solutions to current and future challenges.

I extend my warm wishes to SLIET and the organizing committee for hosting this important conference. I hope the deliberations and interactions during the event lead to impactful outcomes, new collaborations, and advancements that contribute to the overall development of the food sector and the well-being of society.

26th November, 2025
Mysuru

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National Institute of Food Technology Entrepreneurship and Management

MESSAGE

I am pleased to know that Sant Longowal Institute of Engineering & Technology (SLIET), Longowal is organizing the National Conference on "Food Innovations, Food Allergies and Traditional Foods" on 11–12 December.

The themes of this conference are highly significant in the current era, where the food sector is witnessing rapid advancements in technology, processing, safety, and nutrition. Emerging food innovations, increasing awareness of food allergies, and the renewed scientific interest in India's rich heritage of traditional foods make this conference timely and impactful.

Such academic gatherings play a crucial role in bringing together researchers, scientists, academicians, students, and industry professionals from across the country. I am certain that the deliberations during the conference will promote valuable discussions, foster new collaborations, and contribute to strengthening research and innovation in the field of food science and technology.

I extend my warm wishes to the organizing team, and all participants for the successful conduct of this national conference. I hope this event leads to meaningful outcomes, enhanced knowledge sharing, and continued advancements for the betterment of the food sector and society at large.

With best wishes,

Dr. Harinder Singh Oberoi

Dated: 21st November, 2025

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Prof. (Dr.) Tanweer Alam
Addl. Director & Regional Officer (RO-IIP Delhi)
Indian Institute of Packaging

MESSAGE

I am delighted to extend my best wishes and greetings to the participants, research scholars, faculty members, and industry delegates attending the National Conference on "Food Innovations, Food Allergies and Traditional Foods" on 11–12 December,2025.

The Indian Institute of Packaging recognizes the critical role of packaging in ensuring the safety, shelf-life, and proper delivery of food products, especially concerning food allergies and the preservation of traditional food quality. The themes of this conference are deeply interconnected with the challenges and opportunities in advanced food processing and packaging technologies.

This conference serves as a vital confluence for sharing cutting-edge research, discussing global best practices in food safety and innovation, and exploring sustainable packaging solutions that effectively address growing awareness of food allergies. It is an excellent opportunity to bridge the gap between academic research and industrial application.

I encourage everyone to utilize this platform for robust discussions, networking, and forging collaborations that will contribute significantly to establishing safer, more efficient, and consumer-friendly food supply chains. The insights gained here will undoubtedly strengthen the synergy between food technology and specialized packaging.

I extend my heartfelt wishes to the organizers for a highly fruitful and successful conference, confident that the deliberations will pave the way for meaningful advancements in the Indian food and packaging sectors.

With best wishes,

Prof. (Dr.) Tanweer Alam
Addl. Director & Regional Officer (RO-IIP Delhi)
Indian Institute of Packaging

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पत्रांक/Ref. : 255 दिनांक/Date : 26/11/2025

MESSAGE

I am pleased to convey my warm greetings and best wishes to all participants and organisers of the National Conference on ***Food Innovations, Food Allergies and Traditional Foods***, **FIFATF-2025** scheduled to be held on 11–12 December.

This conference brings together themes of great national relevance. Academic and scientific platforms of this nature play a pivotal role in strengthening India's research ecosystem and fostering collaboration among scientists, industry experts, entrepreneurs, and young researchers. The insights and advancements shared during the deliberations will significantly contribute to building a healthier, safer, and more resilient food processing sector.

I commend the dedicated efforts of the Chairman, organising team, and the institutions participating in this important event. I encourage all participants to actively engage in meaningful discussions, exchange ideas, and explore potential avenues for innovation and partnership. I am confident that the outcomes of this conference will further support research-led growth, promote evidence-based policymaking, and contribute to the nation's progress in the food processing domain.

I extend my sincere best wishes for the success of FIFATF-2025 and hope it leads to impactful conversations and long-term contributions to the food sector and society at large.

With best wishes.

(D.R. Singh)
Vice-Chancellor

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Prof. Kamlesh Prasad

Chairman, FIFATF-2025

MESSAGE

I am pleased to welcome all delegates, experts, researchers, industry professionals, students, sponsors and local progressive farmers to the National Conference on "Food Innovations, Food Allergies and Traditional Foods", being hosted from 11 to 12 December under the banner of FIFATF-2025.

India is a leading producer of many food commodities. The limitations of productivity, spoilage, and the proper supply chain have to be addressed to become a true leader. This conference, organised by the Sant Longowal Institute of Engineering and Technology (SLIET), comes at a critical time, as the food sector is rapidly evolving to address challenges in nutrition, sustainability, food safety, and consumer health. The conference themes, ranging from cutting-edge food innovations to the growing concern about food allergies and the scientific validation of traditional foods, are in demand due to current needs and the global food ecosystem.

As the host of this conference, I am confident that the two-day event will provide an excellent platform for scientific exchange, meaningful discussions, and the development of strong academic and industry linkages. The participation of distinguished speakers and enthusiastic young researchers will undoubtedly enrich the dialogue and contribute to new ideas, collaborative opportunities, and impactful research outcomes.

I extend my heartfelt welcome to all participants and express my sincere appreciation to the organizing committee members for their dedicated team efforts in making this event possible. I am incredibly thankful to Mr Shubhra Shekhar, Research Scholar at the School of Chemical Engineering, UNSW, Sydney, for his constant support and encouragement throughout from conceptualisation to implementation. I wish the conference a great success and hope that the deliberations here will significantly advance food science and technology for the benefit of society.

With best wishes,

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National Conference

on

Food Innovations, Food Allergies and Traditional Foods
(FIFATF-2025)
(December 11-12, 2025)

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PREFACE

It is a matter of great pleasure for the organizers to bring out the Book of Abstracts for the National Conference on “Food Innovations, Food Allergies and Traditional Foods” (FIFATF-2025). This conference is being organized by the Department of Food Engineering and Technology, Sant Longowal Institute of Engineering and Technology (SLIET), Longowal, Punjab, during 11–12 December 2025.

The aim of the conference is to provide a crucial platform to bring together faculty, researchers, scientists, engineers, research scholars, and industry experts to exchange the latest advancements in the food processing sector. The themes are timely and vital, focusing on how emerging Food Innovations can enhance safety, sustainability, and nutrition. At the same time, it simultaneously addresses the critical issues of Food Allergies and scientifically validates the rich heritage of Traditional Foods. Participants will have the opportunity to establish research collaborations with academia and industry through various interactive sessions with experts working at the forefront of food science.

Food science and technology is an interdisciplinary field that encompasses the complex interactions among materials science, chemistry, and engineering principles to ensure the quality, safety, and supply of food. The topics covered in FIFATF-2025 span a broad spectrum of contemporary research, including novel processing techniques, advanced food safety protocols, the development of functional and allergen-free products, and the study of nutraceuticals. Emphasis is placed on the interdisciplinary nature of food research and its applications in public health, sustainability, and technological development.

The organizers take great pride in the overwhelming response received for FIFATF-2025 from across the country. The abstracts compiled within this volume represent the intellectual commitment and dedication of all contributors.

We sincerely thank the Institutions and Sponsors for their support of the Conference. We are especially grateful to the members of the National Advisory Committee for their enthusiastic cooperation and guidance. We also thank all the authors who have contributed papers on these topics of importance, and the entire Organizing Committee for their valuable contributions in ensuring the high quality and academic integrity of the abstracts presented herein.

We are deeply grateful to Prof. Manikant Paswan, Director, SLIET Longowal, for providing all the support and motivation essential to organising this major national event.

Kamlesh Prasad, Chairman-FIFATF
Chief Editor

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Keynote address

My Journey to Explore the Celiac Disease Over 25 Years ……

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Celiac disease (CD), an autoimmune disorder triggered by gluten ingestion, remains a lifelong challenge for millions worldwide. My personal journey with (CD) spans more than twenty-five years has provided unique insights into its evolving clinical, diagnostic, and histopathological landscape. Initially presenting with vague gastrointestinal (GI) disturbances, my case mirrored the diagnostic challenges faced by many patients prior to the recognition of the disease's diverse manifestations. Over time, advances in serological screening and duodenal biopsy interpretation have transformed celiac diagnosis from a clinical suspicion to a histologically and immunologically confirmed entity.

This address highlights the dynamic nature of GI changes in CD, including villous atrophy, crypt hyperplasia, and intraepithelial lymphocytosis, and their partial or complete reversal following strict adherence to a gluten-free diet (GFD). My own histopathological follow-ups have reflected the dynamic interplay between dietary adherence and mucosal recovery. These findings underscore the crucial role of repeat biopsy in monitoring mucosal healing, particularly in cases of non-responsive or refractory celiac disease. A central feature of CD lies in its gastrointestinal histopathological spectrum. Esophageal disorders like lymphocytic esophagitis, eosinophilic esophagitis, follicular esophagitis, cervical esophageal web and esophageal motor abnormalities are associated with CD. Lymphocytic gastritis, nodular antritis and B-cell MALT lymphomas are also related to CD. There exists a strong association between microscopic colitis and CD. Histopathologists should be aware of these associations with CD to pick up typical/ atypical CD.

Ultimately, this keynote aims to inspire healthcare professionals, researchers, and food technologists to view CD not only as a medical condition but also as a lifelong partnership between science and self-management. Through reflection and forward-looking discussion, it reaffirms the importance of ongoing research, patient empowerment, and collaborative innovation in shaping a truly gluten-safe world.

Keywords: Celiac disease, gluten-free diet, histopathology, duodenal biopsy, villous atrophy, intraepithelial lymphocytosis

Invited talk

Opportunities and Strategic Pathways for the Fruit Wine Industry in Manipur

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The fruit wine industry in Manipur, a northeastern state of India endowed with rich horticultural diversity, offers significant potential for economic growth, value addition, and rural entrepreneurship. Abundant fruits such as pineapple, banana, plum, wild apple, passion fruit, and Indian gooseberry are often wasted due to poor post-harvest handling and limited processing infrastructure. Converting these underutilized resources into fruit wine provides a sustainable avenue for post-harvest waste management and value creation. With increasing global demand for artisanal and health-oriented beverages, Manipur's fruit wine sector can cater to niche markets emphasizing local identity and natural ingredients. This review highlights the present scenario, technological prospects, and socio-economic implications of fruit wine production in Manipur. Traditional fermentation practices using indigenous yeast cultures, including *hamei*, can be improved through controlled fermentation to ensure product consistency, safety, and quality. Establishing micro and small-scale wineries can generate employment, empower women entrepreneurs, and promote agro-tourism linked to indigenous fruits. Strengthening processing clusters, cold-chain logistics, and regulatory support through initiatives such as PMFME and Startup India will facilitate commercialization. However, challenges such as restrictive alcohol regulations, limited technical expertise, and inadequate infrastructure must be addressed. Strategic interventions—targeted varietal research, standardized SOPs and HACCP-based quality protocols, capacity building, public–private partnerships, and market-oriented branding—are essential. With an integrated approach combining modern oenology and traditional knowledge, Manipur can emerge as a leading fruit wine hub in Northeast India, fostering a circular bioeconomy, reducing waste, and enhancing sustainable livelihoods.

Keywords: Fruit wine, fermentation, *Hamei*, Manipur, pineapple, value addition, entrepreneurship, postharvest technology, quality assurance

Invited talk

Emerging frying techniques for the development of healthy fried snack foods

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The fried foods are highly preferable in India. The Indian snacks market is steadily expanding at a CAGR of 11.2% during 2025-2031. Frying is a cooking of food in oil or fat that involves simultaneous heat and mass transfer process. Consumption of excess fat is one of the reasons for obesity and cardiovascular diseases. However, increasing consumer demand for good quality fried snack foods with low fat, natural aroma and taste for health conscious customers stimulate emerging technique, such as vacuum frying, for the production of the healthy snack food products. Vacuum frying is carried out under pressures (30-80 mbar) well below atmospheric levels, at low temperatures (85-120°C), at three phases, such as frying, pressurization and cooling. Several advantages of vacuum frying technique are observed such as, it (a) reduces fat uptake (50-60%), (b) less volume shrinkage of the product, (c) low oil degradation results in high oil turnover, (d) significantly high retention of colour, carotenoids and other bioactive compounds, (e) frying at low temperature reduces heat damages to nutrients, (f) applicable to wide range of products and (g) produces potato chips with significant reduction (97%) in acryl amide (a carcinogen causes cancer in rats). The CSIR-CFTRI has played a major role for mechanization of processing of healthy fried snack food products by frying and vacuum frying process. In this presentation some of the published results obtained using this technique during processing of some selected fruits (banana, pears), vegetable (okra, potato, eggplant) and nuts (kabuli chana) etc. will be presented and how to get this technology transferred to initiate a startup will also be explained.

Keywords: Vacuum frying, retention of bioactives, healthy snacks, oil absorption

Invited talk

Valorization of Food Processing Industry Waste

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Environmental protection is a global concern, and climate change has started showing its adverse effects on humanity. Food waste is being considered as one of the vital causes of environmental degradation. The food industry produces a huge quantity of waste, which varies considerably in characteristics depending on the raw material. The significant advantage of food industrial waste is its availability in large amounts for valorization at one place in comparison to other types of food waste scattered over a large geographical area. There are many success stories in excellent waste management of biodegradable food waste. The growth of the nutraceutical industry has created the demand for phytochemicals abundantly available in food processing waste. These natural compounds have great potential for exploration to meet future demand for health-promoting products. Green energy is another emerging area of interest for the global community, vital to sustainable growth. Food professionals need to be updated on upcoming global challenges to achieve the United Nations Sustainable Development Goals.

Keywords: Valorization, waste, food processing, green energy, nutraceutical industry

Invited talk

Electrospun Mucilage/PVA-ZnO NPs Nanofiber Mats for Active Food Packaging Applications

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This study aimed to develop and characterize electrospun nanofiber mats composed of mucilage, polyvinyl alcohol (PVA), and zinc oxide nanoparticles (ZnO NPs) for active food packaging applications. Mucilage and ZnO NPs were both derived from the viscous gelatinous pulp and hard imbricate sepals of *Dillenia indica* fruit as a single source. The extracted mucilage exhibited a molecular weight of 2.77×10^6 g/mol and displayed shear-thinning rheological behavior at 1%, 2%, and 3% (w/v) concentrations, with the storage modulus (G′) exceeding the loss modulus (G″), confirming its weak gel-forming nature. The *Dillenia indica* sepal extract used for ZnO NPs biosynthesis which showed high phytochemical potential, containing total phenolic and flavonoid contents of 1.10 mg GAE/g and 253 mg QE/g, respectively, along with antioxidant activity of 3.74 mg GAEAC/g. The biosynthesized ZnO NPs ranged from 40–120 nm in size and comprised 51.57% zinc and 48.53% oxygen, demonstrating notable antibacterial activity against *E. coli* and *S. aureus*. Electrospinning trials revealed that mucilage alone could not yield continuous fibers; however, a uniform and stable nanofiber mat was successfully fabricated by blending 1% mucilage with 8% PVA in a 40:60 ratio. Incorporation of ZnO NPs (0.1%, 0.3%, and 0.5%) significantly enhanced both the antimicrobial performance and mechanical strength of the nanofibers. The optimized formulation (1% mucilage, 8% PVA, 0.3% ZnO NPs) achieved a tensile strength of 17.05 ± 0.50 MPa and a water vapor permeability of 19.23±0.74 (g·mm)/(m²·day·kPa). Furthermore, the integration of anthocyanins imparted intelligent pH-responsive behavior, enabling real-time visual detection of food spoilage through colorimetric changes.

Keywords: Mucilage, Rheology, Electrospinning, Antimicrobial, Food safety

Invited talk

Integrating Sensor Fusion, Machine Learning and Physics-Based Modelling for Predictive Shelf-Life Assessment of Apples in Cold Storage

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Accurate prediction of shelf-life in cold-stored apples remains a complex challenge due to the interplay of physiological, biochemical, and environmental factors. This study develops an integrated computational framework combining dense sensor data acquisition, machine learning (ML) algorithms, and physics-based modeling to predict core temperature dynamics and shelf-life trajectories of Red Delicious apples over six months. The high-resolution dataset includes continuous measurements of temperature, humidity, and critical quality parameters such as total soluble solids (TSS), TA, moisture, and weight loss. Core temperature prediction was achieved using extreme gradient boosting (XGBoost) and long short-term memory (LSTM) networks, with XGBoost outperforming LSTM by attaining an R^2 of 0.88. An entropy-based multi-criteria weighting methodology objectively ascertained the relative importance of multiple quality indices, emphasizing TSS and titratable acidity. Incorporation of a temperature- and humidity-modified Arrhenius equation provided an explicit mechanistic model for TSS degradation kinetics, capturing nonlinear decay trajectories under realistic storage conditions. Critically, hybrid modeling—integrating autoregressive lagged TSS features with ML-predicted core temperature and physics-modeled degradation rates yielded TSS prediction ($R^2 \approx 0.99$), underscoring the temporal autocorrelation and temperature dependencies essential for robust shelf-life estimation. However, inherent limitations include potential noise amplification in numerical differentiation of quality rates and assumptions of homogeneous storage conditions. Validation through time-series cross-validation protocols minimized information leakage and evaluated generalizability. Model interpretability was enhanced with SHapley Additive exPlanations (SHAP), revealing dominant contributions from core temperature lagged features and humidity interactions. This comprehensive approach demonstrates the feasibility of digital twin frameworks that fused data-driven and mechanistic models for precision post-harvest management.

Keywords: Apple cold storage, shelf-life prediction, core temperature, total soluble solids, machine learning, arrhenius kinetics

Invited talk

Raman Spectroscopic Detection of Pesticide Residues on Foods using Chemometric Algorithms : A modern approach

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Monitoring pesticide residues in food products is a key aspect of ensuring food safety and protecting public health. Conventional methods like GC-MS/HPLC and ICP-OES, although accurate, are often expensive, time-consuming, and require complex sample preparation. In this study, we explore the potential of Surface-Enhanced Raman Spectroscopy (SERS) as a simple, rapid, and non-destructive alternative for detecting pesticide residues directly from fruit and vegetable surfaces. Our research focused on three main objectives: (1) to develop a standard operating procedure and database for pesticide detection using SERS; (2) to screen and optimize low-cost SERS-active substrates; and (3) to build a reference spectral library for commonly used pesticides such as Imidacloprid, Difenoconazole, Cu-oxychloride, Azoxystrobin, Carbendazim, Mancozeb, Chlorpyrifos, Fenazaquin, Flubendiamide, and Indoxacarb. Seasonal horticultural produce - apples, strawberries, bell peppers, and tomatoes were collected from Shoolini University farms, orchards, local markets, and farm fields. Samples were washed, peeled, and extracted using suitable solvents (ethyl acetate/acetone). SERS measurements were carried out using a benchtop Raman spectrometer with a 785 nm laser. Multiple scans (n=9) were used to reduce experimental errors. Market samples were mostly below detectable limits, and to confirm the detectability and validate our SERS method, we spiked the samples with known pesticide concentrations and analyzed those using GC-MS/LC-MS. If some pesticides reference spectra are missing in the SERS spectral library, then with the standard solution of the target pesticides (after spiking the sample with known concentrations) and SERS substrate instantly a reference spectral database (detection ranges for each pesticide) can be created with the signal processing software. After this imaging detection process, SERS quantitative and imaging analysis of pesticide molecules have been performed through data pre-processing algorithms and a multivariate statistical regression model. The generated spectral database and optimized protocols could support future development of portable SERS devices for on-site residue analysis.

Keywords: Raman Spectroscopy; SERS; Pesticide Residues; Multivariate Statistics; Non-destructive; On-Site

Invited talk

Leafy Vegetables: Revitalizing Traditional Foods for Nutritional Security and Sustainability

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Since antiquity, vegetables have been an integral part of the human diet, serving as both an affordable source of essential nutrients and as traditional therapeutic herbs. According to WHO recommendations, an adult should consume at least 300 g of vegetables per day. Among vegetable crops, green leafy vegetables such as *palak* (*Beta vulgaris* var. *bengalensis*) and fenugreek (*Trigonella foenum-graecum*) hold a prominent place in traditional diets across many cultures, valued not only for their culinary versatility but also for their dense nutritional and functional compound profile. These leafy greens are rich in vitamins A, C, and K, minerals such as iron and calcium, and bioactive compounds including antioxidants and flavonoids, offering a range of health benefits from enhanced immunity to improved cardiovascular and digestive health. Despite these advantages, the consumption of palak and fenugreek has declined in modern diets due to urbanization, changing lifestyles, and a growing preference for processed foods, raising concerns about dietary quality and nutritional security. Reviving these traditional vegetables aligns with the principles of nutritional security, ensuring access to nutrient-dense foods that promote human health. Furthermore, their cultivation supports agricultural sustainability, as they require relatively low inputs, flourish in diverse climatic conditions, and stupendous initiative option for marginal and women farmers. Integrating palak and methi into contemporary diets not only preserves cultural food heritage but also addresses environmental and health challenges posed by modern food systems. Policy measures, community awareness initiatives, and development of nutritionally improved cultivars can further enhance their accessibility and consumption. Thus, green leafy vegetables can bridge nutritional adequacy and sustainable agriculture, endorsing their role in building resilient, health-promoting food systems for present and future generations.

KEYWORDS: Green Leafy Vegetables, Nutritional Security, Sustainable Development Goals, Traditional Foods, Human Health

Abstracts for Presentations in Oral or Poster Sessions

Thermodynamics of Human Metabolism and its Associated Processes

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The total of all chemical reactions that take place within an organism, including both catabolic (breaking down) and anabolic (building up) processes, is known as metabolism. The principles of thermodynamics regulate the energy transformations that take place throughout these processes. The body's homeostasis, or state of equilibrium, is continuously maintained via metabolism. This entails carefully controlling the flow of energy and striking a balance between anabolism and catabolism. Thermodynamic constraints and the activity of enzymes govern metabolic activity, or rates of flow, which are most generally known as flux. The study of food thermodynamics examines the interactions between heat and energy during digestion and processing. In humans, metabolism is the process by which food is transformed into energy that the body uses for various purposes. It is an illustration of how the first law of thermodynamics works. The second law aids in explaining both the direction and the achievement of equilibrium in metabolic processes. It also indicates whether or not that certain process will take place.

Microfluidic Half-Mode Substrate Integrated Waveguide Sensor for Non-Destructive Real-time Quantification of Alcohol Concentration

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Quality evaluation involves the systematic assessment of product characteristics and is essential to ensuring compliance with predefined standards in meeting consumer expectations. The traditional approach in destructive quality evaluation techniques destroys the sample and thus becomes unsuitable for future use. In contrast, non-destructive quality evaluation enables the assessment of attributes without compromising the sample's integrity, enabling real-time monitoring. Beverages are liquid consumables and may be alcoholic or non-alcoholic in nature. Determining alcohol concentration in undistilled or distilled alcoholic beverages is crucial for quality and cost control, regulatory compliance, consumer safety, and ensuring consistency. Substrate integrated waveguide (SIW) based sensors are precise and compact with low loss and non-contact detection, suitable as real-time quality evaluation as cost-effective, and easily integrable alternative. A novel compact half-mode SIW sensor based on the material-perturbation cavity resonator approach was designed for real-time assessment, simulated, fabricated, and evaluated for its applicability to alcohol concentration measurements up to 50%, which covers the range of most commercially available alcoholic beverages. The measured results show significant shifts in the resonant frequency for determining alcohol concentration. The findings suggest that the developed sensor can be successfully applied to determine alcohol concentration with high precision in a real-time system.

Keywords: Cavity resonator, non-destructive evaluation, substrate-integrated waveguide, sensor.

Insights of Microwave: Analytical and Food Processing Applications

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Dielectric properties form a bridge between material and material characterization. Low-power microwaves are non-destructive in nature, and the dielectric measurements made this approach an emerging approach in material characterization. Compilation of various aspects of microwave, their categorization, generation of microwaves are covered. Open-ended coaxial probe method, wave guide as transmission line method, cavity perturbation method, time domain spectroscopy method, impulse time domain transmission method, free space transmission method, and parallel plate method as measurement techniques are reviewed along with instrumentation including Vector Network Analyzer and Impedance Analyzer. The applications of high-power microwaves in various thermal processing unit operations such as blanching, pasteurization, sterilization, thawing and tempering, drying, and baking processes may be revolutionized by the infusion of microwaves to the conventional thermal approach for efficient food processing operations. A thorough effort to consolidate all aspects of dielectric measurements and encompass diverse applications in food engineering under the canopy of microwaves may thus prove to be the future tool for researchers and industrialists to fulfil the need.

Keywords: Microwaves, Electromagnetic Theory, Magnetron, TWTS, VNA, Food Processing.

Designer lipid: Optimization of enzyme interesterification process and its characterisation

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Designer lipid synthesis through targeted oil modification presents an innovative approach to enhance the nutritional and functional quality of edible oils. In this study, enzymatic interesterification using bond specific lipase (Novozyme 435 - *Candida antarctica*) was employed to restructure fatty acids and triacylglycerols for coconut–chia seed oil blend, aiming to balance the fatty acid profile, enhance resultant oil oxidative stability and functionality. Process optimization was carried out using response surface methodology (RSM) with a central composite design (CCD), considering oil-to-oil ratio, enzyme concentration (%), and reaction time (h) as independent variables with responses such as modified oil yield (%), iodine value (g I_2/100 g), and free fatty acid content (mg KOH/g) of the modified oil. The reaction temperature was kept constant at 45°C. The modified oil was characterised for its physicochemical attributes, oxidative stability, fatty acid composition, and antioxidant potential. The optimised product showed noticeable oxidative stability, evidenced by low p-anisidine (1.41) and peroxide (1.32 meq O_2/kg) values, indicating minimal formation of oxidation products and strong resistance to rancidity. Its enriched antioxidant profile, comprising total phenolics (15.33 mg GAE/100 g), flavonoids (15.08 mg QE/100 g), and moderate tocopherol levels, contributed to enhanced radical scavenging and stabilization of unsaturated fatty acids. The fatty acid profile revealed dominant lauric (32.22%), myristic (14.01%), and palmitic (8.36%) acids, conferring oxidative and thermal stability, while substantial linoleic (6.74%) and linolenic (18.26%) acids enriched the omega-3 content, improving nutritional value. The study showed that enzymatic interesterification proved to be an efficient, green, and tunable method for producing designer lipids with improves nutritional, functional, and oxidative properties, showing strong potential for applications in functional foods, nutraceuticals, and clinical formulations.

Keywords: Chia seed oil; Coconut oil; Designer lipid; Interesterification; Oxidative stability

Enhancing Hot Air-Drying Efficiency and Nutritional Quality of Sweet Lime Peel through Cold Plasma Pretreatment

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Cold plasma (CP) is an emerging nonthermal technology that offers a promising approach to enhance drying efficiency while preserving the nutritional and functional quality of food products. The study evaluated the effect of CP pre-treatment at different exposure times (5, 10 and 15 minutes) on the hot-air drying behavior and quality attributes of sweet lime peel. The CP pre-treatment significantly accelerated the drying rate, reducing the drying time by about 45 minutes. Among the drying models tested, the logarithmic model best represented the experimental data, showing strong agreement with high accuracy ($R2 > 0.990$, $\chi^2 < 0.009$, $RMSE < 0.033$). However, the artificial neural network (ANN) model outperformed the traditional approach by demonstrating superior predictive capability in moisture ratio, with the optimal network configuration identified as a three-layered topology containing 17 neurons in the hidden layer, which yielded the lowest MSE, RMSE, and χ^2 values. Microstructural analysis revealed that CP exposure led to surface etching and microchannel formation due to reactive plasma species, which enhanced moisture diffusion and improved bioactive retention. CP-treated samples showed marked improvement in rehydration ratio (2.96–3.37), total phenolic content (18.74–26.53 mg GAE/g), total flavonoid content (15.23–26.73 mg QE/g), antioxidant activity (32.38–44.88%), and ascorbic acid content (60.12–82.28 mg/100 g). These results indicate that CP pretreatment is an effective and sustainable technique for improving drying performance and nutritional quality in fruit by-products.
Keywords: Cold Plasma, Drying, Extraction, Peel Powder, Sweet Lime Peel

Addressing Public Health Concerns: AI + FTIR Spectroscopy for tracing Carcinogenic Sudan(IV) in Red Chilli Powder

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Sudan(IV) adulteration in red chili powder (RCP) represents an escalating food safety threat, as chronic consumption of contaminated spices can lead to adverse health outcomes in humans. To address this risk, we developed a robust, cost-effective framework combining Fourier-transform infrared (FTIR) spectroscopy with machine learning. The RCP samples from diverse Indian regions were intentionally adulterated with Sudan(IV) dye at concentrations of 0.1%, 0.2%, 0.4%, 0.6%, and 1.0%, generating an FTIR spectral dataset (S_RCPSu). Spectral preprocessing employed a Savitzky–Golay (SkG) filter with varied window points (WP) and polynomial orders, followed by classification via partial least squares discriminant analysis (PLS-DA). Optimal preprocessing was achieved with SkG parameters WP = 13 and polynomial order = 3. Principal component analysis (PCA) loading on PC2 revealed strong positive peaks near 1,579 cm^{-1} (N=N stretching) and around 1,263 cm^{-1} (aromatic C–N/C–C vibrations), which explained the presence of Sudan(IV) in RCP sample. These spectral regions underpinned the PLS-DA model's discrimination, yielding an adulteration detection accuracy of 90.50%. By enabling real-time, detection of Sudan(IV) adulteration in RCP across the food supply chain, this FTIR–machine learning framework directly safeguards consumer health by preventing exposure to carcinogenic dyes. This farmwork enhances rapid decision-making and compliance monitoring, supports regulatory inspections, supply-chain evaluations, and strengthens consumer confidence in spice safety and quality standards. By enabling robust farmwork of FTIR coupled with ML to trace the Sudan(IV) in RCP, this method prevents carcinogenic dye ingestion, preserves nutritional integrity (Vitamins, antioxidants, capsaicinoids) and upholds consumer confidence.
Keywords: FTIR spectroscopy, Machine Learning, Red Chilli Powder, Sudan(IV) adulteration

Octenyl Succinic Anhydride (OSA) Modification of Teff and Barnyard Millet Starches: Functional and Structural Characterization for Food Innovation

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Traditional grains such as teff (*Eragrostis tef*) and barnyard (*Echinochloa esculenta*) millet are gaining renewed attention as sustainable, gluten-free resources; their functional potential can be significantly enhanced through innovative OSA modification. In this study, starches were esterified using octenyl succinic anhydride (OSA, 0.5-1.5%), achieving degrees of substitution (DS) between 0.005 and 0.020. The impact of modification on structural, functional, thermal, and rheological properties was systematically evaluated. OSA esterification occurred primarily in the amorphous regions, confirmed by FTIR analysis, while XRD patterns retained the native A-type crystallinity. Modification reduced amylose content and gelatinization temperatures but enhanced swelling power, solubility, and viscosity, indicating improved hydration and thickening potential. Microscopic observations revealed roughened granule surfaces and partial aggregation, while rheological tests confirmed pseudoplastic flow with reduced viscoelastic moduli. Both starches exhibited improved flowability, enhancing their versatility in diverse formulations. Teff starch showed lower pasting temperature, whereas barnyard starch demonstrated superior gelation and lightness characteristics. These findings highlight the potential of OSA-modified starches from traditional, gluten-free grains as versatile, functional, and safe ingredients for innovative food systems, including emulsified, encapsulated, and allergen-friendly products. The study underscores how value-addition of traditional grains can bridge heritage and innovation, supporting sustainable and health-oriented food development.

Keywords: Teff starch; Barnyard millet; OSA modification; Functional properties; FTIR, XRD

Food Processing and Analytical Advances in Millet Lipidomics: Identification of Bioactive Lipid Species

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Millets are small-seeded cereals increasingly recognized for their nutraceutical value, particularly in managing metabolic disorders such as fatty liver disease and diabetes. Despite their widespread consumption in South Asia and Africa, the lipid composition of millet species remains largely underexplored. In this study, six major Indian millet species-*Eleusine coracana* (finger millet), *Paspalum scrobiculatum* (kodo millet), *Setaria italica* (foxtail millet), *Panicum sumatrense* (little millet), *Echinochloa crusgalli* (barnyard millet), and *Urochloa ramose* (browntop millet)-including 59 varieties, were subjected to non-targeted lipidomics using liquid chromatography-mass spectrometry (LC-MS). Total lipids were extracted following a modified Bligh and Dyer method, and metabolite profiling was performed with MetaboAnalyst for data visualization. A total of 230 lipid and metabolite species were annotated, revealing marked variations in lipid class composition across millet types. Glycerolipids dominated the lipidome, followed by glycerophospholipids. Foxtail millet exhibited the highest lipid content and polyunsaturated/saturated ratio, while little millet showed the greatest health promotion index. Notably, novel fatty acid esters of hydroxy fatty acids (FAHFAs) were identified for the first time in millet samples. Antioxidants such as epigallocatechin and chlorogenic acid were most abundant in barnyard millet, underscoring its potential for functional food applications. These findings highlight the unique lipid signatures of millets and their promising role as sources of bioactive compounds for the development of nutraceuticals or functional food. Future studies focusing on *in vivo* bioactivity will further strengthen the scope of millet-based functional foods targeting metabolic health.

Keywords: Millets, Lipidomics, Untargeted LC-MS, Bioactive lipids, Functional foods, Nutraceuticals

Enhancing Turmeric Quality and Processing Efficiency through Improved Drying Techniques

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Turmeric cultivation faces significant post-harvest challenges due to farmers limited awareness of effective handling techniques and the lack of appropriate storage and processing infrastructure. This study investigates the impact of different curing and drying methods on the quality and recovery of turmeric powder, with the aim of identifying more efficient and economically feasible processing alternatives.
Fresh rhizomes of the *Curcuma longa* variety 'Salem' were subjected to a standardized processing treatment involving peeling, slicing and drying (T3). The processed rhizomes were then dried using two methods: sun drying (D1) and cabinet drying (D3). The treatment was evaluated based on recovery percentage and quality parameters including essential oil, oleoresin and curcumin content.
Cabinet drying (D3) significantly reduced the drying time compared to sun drying (D1). For treatment T3, D3 yielded a dried rhizome slice recovery of 18.73%, essential oil content of 5.98%, oleoresin content of 10.00%, and curcumin content of 4.05%, whereas D1 yielded 19.08%, 5.40%, 9.12% and 3.99%, respectively. Additionally, energy requirements and techno-economic feasibility assessments indicated that cabinet drying is a more efficient and viable approach. The findings suggest that improved processing techniques, particularly cabinet drying, can enhance the quality and economic value of turmeric, offering a practical solution for farmers and small-scale processors.
Keywords: Curcumin, Rhizomes, Curing, Drying.

From Vision to Intelligence: Advances in Image-Based Food Quality Assessment

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Advances in image processing and artificial intelligence (AI) are transforming postharvest quality evaluation by enabling rapid, objective, and scalable automation. Among the emerging optical techniques, biospeckle imaging has proven to be a powerful non-destructive tool capable of capturing dynamic biological activity in fruits. In the present study, biospeckle imaging coupled with Laser Speckle Contrast Analysis (LASCA) was utilized to assess the quality of peaches during storage. The biospeckle patterns generated through laser–tissue interactions were analyzed to characterize microstructural and physiological variations associated with ripening and senescence. A strong correlation was observed between biospeckle activity and conventional quality attributes, including firmness ($R^2 > 0.85$), total soluble solids (TSS), and moisture content. The biospeckle activity consistently decreased with prolonged storage, indicating its reliability as a quantitative indicator of fruit freshness and quality. By enabling real-time, non-invasive, and accurate monitoring, biospeckle imaging overcomes the limitations of conventional destructive physicochemical techniques. The findings highlight its potential integration with AI-based models for automated grading, sorting, and intelligent storage management. This research establishes biospeckle imaging as a promising tool for next-generation postharvest automation aimed at minimizing losses, ensuring consistent quality, and enhancing consumer confidence.
Keywords: Biospeckle Imaging, Laser Speckle Contrast Analysis, Artificial Intelligence, Non-Destructive Testing, Peach Quality, Postharvest Automation

Finger Millet-Based Gluten-Free Rusk: A Healthy Snack

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The increasing prevalence of celiac disease and diabetes has intensified the demand for functional foods that are both gluten-free and possess a low glycemic index (GI). This study focuses on the development and evaluation of rusks formulated using finger millet (Eleusine coracana) as the core ingredient, aimed at providing a nutritious and health-promoting alternative for individuals with these metabolic and autoimmune conditions. Finger millet, is naturally gluten-free and rich in dietary fiber, calcium, and polyphenols. In this finger millet was combined with complementary ingredients such as psyllium husk and sugar to enhance texture, palatability, and nutritional value. The formulated rusks were analyzed for their proximate composition and sensory attributes. Results indicated that the finger millet-based rusks exhibited a significantly higher nutritive value compared to conventional wheat rusks, while maintaining desirable sensory qualities. These findings demonstrate that finger millet-based gluten-free rusks can serve as a suitable, healthful snack option for individuals managing celiac disease and diabetes, aligning with modern dietary trends toward functional and therapeutic foods.

Keywords: Finger millet, gluten-free, health, sensory, nutritional

Nutritional Evaluation, Texture Profile, Packaging Influence and Shelf-Life Assessment of Millet-Based Brownies

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This study focused on the formulation and evaluation of millet-based brownies prepared by partially substituting wheat flour with underutilized millets *viz* ragi and amaranth and using jaggery as a natural sweetener. Sensory evaluation identified ragi brownies as the most acceptable variant, getting an overall liking score of 7.5. Physico-chemical analysis confirmed stable characteristics, with an average moisture content of 12% and a pH of 6.0. Nutritional profiling demonstrated a notable improvement over conventional wheat brownies, showing higher levels of protein, dietary fiber, and minerals. The optimized formulation contained 8% protein, 25% fat, 46% carbohydrates, 16% moisture, 5% ash, and 25 mg/100 g iron. Texture profile analysis revealed a maximum load of 22.15 N and a second-peak force of 20.49 N (~92.5% retention), indicating favorable firmness and cohesiveness consistent with sensory preferences. Shelf-life assessment showed that paper boxes packaging under refrigeration most effectively preserved product quality, while samples in LDPE at room temperature exhibited faster spoilage. The findings establish millet-based brownies as a nutritionally enhanced, texturally appealing, and sustainable bakery alternative, through extended shelf life achievable with proper packaging.

Keywords: Brownie, Millets, Ragi, Amaranth, Jaggery, Nutrition, Texture Profile, Packaging, Shelf Life

Opportunities and alternates for celiac disease and lactose intolerance patients in India

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Due to the increase in the prevalence of celiac disease and lactose intolerance among the Indian population, a unique challenge has come to the knowledge of food researchers and healthcare professionals because wheat and dairy products are the staples of the Indian diet. It is essential to fulfill the dietary demands of these patients with alternates. This study evaluates the opportunities and viable solutions for these patients with the help of different areas working for their betterment such as agriculture, food technology, clinical nutrition and public awareness. It has emerged a great scope for the market growth of gluten free cereal products and non-dairy milk based substitutes. This study also raises concern regarding the affordability and availability of these products for all the population groups of the Indian society. Need of the hour is to focus on the strict labelling requirements of these products in concern to the allergens.

Keywords: Celiac disease, lactose intolerance, gluten free diets, dairy alternates.

Valorization of Green Jackfruit Flour as a Functional Ingredient in Durum Wheat Pasta

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The investigation explores the impact of partially replacing durum wheat semolina (Durum wheat semolina) with green jackfruit flour on pasta's sensorial, nutritional and functional properties. The study aimed to standardize the incorporation level of green jackfruit flour, evaluating its effects on sensory attributes and nutritional quality. Sensorial assessment indicated that 10% green jackfruit flour incorporation yielded the highest acceptability, with scores ranging from 6.5 to 8.2. Nutritional analysis showcased increased fiber and ash content, but slightly reduced protein and fat levels in green jackfruit flour -incorporated pasta. Cooking properties were altered, with longer cooking times and increased cooking losses. Functional properties (Water absorption capacity, water solubility index, and oil absorption capacity) were enhanced on incorporation of green jackfruit flour. Furthermore, the addition of more green jackfruit flour led to a notable increase in total phenolic content and antioxidant activity, with the total phenolic content increased in pasta with 50% green jackfruit flour. Similarly, antioxidant activity rose from 10.87% to 39.6%. These findings suggest green jackfruit flour incorporation into pasta improves nutritional and functional properties, it also affects sensory attributes and cooking performance, necessitating a balanced approach for optimal product development.

Keywords: Durum wheat semolina, Green jackfruit flour, Pasta, antioxidant and total phenolic content.

Spinning Tradition Forward: Optimization of Reverse Centrifugal Expulsion for *Paneer* Production

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Paneer, a traditional Indian dairy product, is conventionally prepared through acid-induced coagulation of milk followed by manual pressing—a process that is labour-intensive, inconsistent, and prone to nutrient losses. To address these limitations, a semi-automatic reverse centrifugal expulsion prototype was developed for efficient whey removal and consistent *paneer* production. The system integrates a processing vessel with a thermally insulated jacket, agitator, acid dosing unit, and centrifugal pressing chamber, enabling controlled mechanical separation with minimal manual intervention. The effects of coagulation temperature (70–80 °C), centrifugal speed (235.3–289.6 RPM), and pressing time (3–5 min) on *paneer* yield and compositional attributes were studied using an I-optimal response surface design. Experimental results showed that coagulation temperature and centrifugal speed significantly affected *paneer* yield, moisture, fat, and total solids ($p < 0.01$), while pressing time had a minor effect. Increasing temperature and speed reduced yield and moisture but enhanced fat and solids retention due to more compact curd formation. Statistical models exhibited strong predictive capability ($R^2 > 0.86$) with non-significant lack of fit, confirming reliability. Optimization using numerical desirability criteria identified the best conditions as 70 °C coagulation temperature, 235.3 RPM speed, and 3 min pressing time, yielding maximum *paneer* output with high reproducibility (desirability = 0.962). The study demonstrates that reverse centrifugal expulsion is a viable, scalable, and hygienic alternative to manual pressing, offering improved yield consistency, process automation, and potential for industrial adoption in modern dairy processing.

Keywords: Reverse centrifugal expulsion; *Paneer* manufacturing; Process optimization; Response surface methodology (RSM); Coagulation temperature; Dairy process automation

Snackester

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Snackester is a modern snacking brand dedicated to delivering healthy, flavourful, and responsibly sourced snacks. The brand focuses on makhana (fox nuts) as its core product, ensuring quality from farm to consumer through ethical sourcing, innovative flavouring, and sustainable packaging. Started with a vision to become India's most trusted and innovative healthy snack brand, connecting farmers and consumers through quality and transparency and a mission to empower farmers with fair pricing, deliver premium-quality snacks to customers, and promote healthy snacking habits across India and beyond. Farmers often receive unfair prices for raw makhana due to middlemen. Consumers lack access to healthy, flavorful, and affordable snack options. The market is saturated with unhealthy, processed snacks lacking nutritional value. Snackester bridges the gap between farmers and consumers through a transparent and sustainable supply chain under Direct Sourcing: Snackester purchases raw makhana directly from farmers, ensuring they receive fair and profitable prices, Value Addition: The raw makhana is cleaned, roasted, and flavored with unique seasonings, Packaging: Products are hygienically packed in eco-friendly pouches for freshness and convenience with a Sales Channels of B2B: Supplying flavored and raw makhana to retailers, wholesalers, and corporate clients, B2C: Selling directly to consumers through online platforms and retail stores and Raw Makhana Sales: Offering premium-quality raw makhana in B2B.
Keywords: Makhana, product development, sales, supply chain, distribution

Extraction of Oil from Selected Oilseeds Using Hydraulic /Cold Press

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India is one of the leading producers and consumers of edible oils, where oil extraction plays a vital role in the food, cosmetic, and pharmaceutical industries. However, traditional extraction methods face several limitations related to oil quality, safety, and environmental impact. The most commonly used techniques are solvent extraction, mechanical expeller pressing, and hydraulic pressing. Solvent extraction provides a higher oil yield but involves the use of organic solvents like hexane, which can leave harmful residues, degrade nutrients, and cause environmental pollution. Mechanical expeller pressing, though solvent-free, generates excessive heat and friction that can destroy sensitive compounds such as vitamins, pigments, and antioxidants, leading to poor flavour and lower nutritional quality. In contrast, hydraulic pressing has emerged as a clean, efficient, and sustainable alternative for oil extraction. It uses high pressure and low temperature to extract oil without the use of chemicals, thereby preserving its natural flavour, aroma, and nutritional properties. The oil obtained through this method is of superior purity, high oxidative stability, and better shelf life. Hydraulic pressing is also simple to operate, energy-efficient, and suitable for small- and medium-scale industries. Although the oil yield is slightly lower than that of solvent extraction, its advantages in product safety, purity, and eco-friendliness make it a preferred choice for producing high-quality oils. Thus, hydraulic pressing offers a sustainable and environment-friendly solution to meet India's growing demand for pure and healthy edible oil production.
Keywords: Hydraulic/ cold pressing, Oil extraction, Optimization, Sustainable processing, Edible oil quality

Innovation in Food Technology: Development and Stabilization of Foods through Pelletisation for Convenience and Sustainability

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Food processing technology advancements have increased due to demand for nutritious, convenient, and shelf-stable foods. Palletisation is a technique widely adopted in pharmaceutical and nutraceutical industries, has recently gained attention in food technology due to its ability to enhance stability, portability, and controlled delivery of nutrients. According to recent national surveys, more than half of Indian women of reproductive age and a significant proportion of children under five suffer from iron deficiency anaemia, resulting in impaired cognitive development, reduced productivity, and increased maternal health risks. To address iron deficiency and provide better convenience, less storage load, and increased distribution sustainability, this study investigates the production and stabilisation of a novel iron-fortified chutney in pellet form. The formulation procedure required converting typical chutney ingredients into a dehydrated, granulated blend, then wet granulation and compression into homogeneous pellets using 10% food-grade starch as a binder. The pellets demonstrated rapid reconstitution in water or saliva, making them suitable as ready-to-eat seasoning boosters or accompaniments to meals. Beyond nutrition, pelletisation offers significant sustainability benefits, including reduced packaging requirements, lower transportation weight, and minimized food waste due to improved stability. Additionally, this strategy satisfies modern customer demands for portable, hygienic, and portion-controlled meal options. The success of the iron-fortified chutney pellets demonstrates the wider potential of pelletisation in converting semi-liquid or perishable traditional foods into stable, value-added formats, increasing their accessibility for a variety of markets, such as institutional feeding programs, low-resource communities, and nutraceutical product lines.
Keywords: iron fortification, functional foods, nutraceutical innovation, traditional food modernization, dehydrated chutney pellets

Influence of Heat Treatment on the Quality Attributes of Honey: Rheology, Enzyme Activity and HMF Accumulation

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Honey is widely regarded as pure and unadulterated only when it remains in a non-crystallized state. Many perceive crystallized honey as adulterated. However, crystallization is a natural process that presents several disadvantages related to its further processing and marketability. This study examined how various thermal treatments affect honey viscosity, crystallization, and enzyme activity to determine the best conditions for delaying or preventing crystallization. Rheological analyses indicated that increased heat exposure led to lower viscosity and delayed crystallization. However, heating can negatively impact honey quality, as demonstrated by a decrease in diastase activity, known as diastase number, alongside a rise in hydroxymethylfurfural (HMF) content. In line with current honey regulations regarding the minimum acceptable diastase number and the maximum allowable HMF content, thermal treatments were conducted on selected honey samples without exceeding these thresholds. The samples were subjected to different temperature-time combinations for evaluation. The results showed that to obtain a non-crystallized honey product lasting 90 days, raw honey must be heated at 60 °C for 45 minutes, and crystallized honey should be treated at 70 °C for 15 minutes while ensuring that HMF levels and diastase activity remain within permissible limits. These results offer important insights into methods for preventing crystallization in honey, helping to enhance its shelf life and marketability while aligning with established quality standards.
Keywords: Thermal treatment, Honey crystallization, Honey quality, Quality standard

EIS as a Tool for Assessing Curd Formation and Gelation Stages in Milk

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This study examines changes in the impedance profile of full-cream milk during fermentation. Fermentation generally involves acid production, which induces the curdling and aggregation of casein micelles, thereby restructuring the milk matrix. These physicochemical changes affect its electrical behaviour, helping to characterize the different stages of fermentation. The aim was to determine whether Electrical Impedance Spectroscopy **(**EIS) can sensitively track these physicochemical transitions. Milk samples were fermented under controlled conditions, and impedance spectra were recorded across a wide frequency range at different time stamps. Nyquist and Bode analyses, supported by R–C equivalent circuit modelling, were used to extract effective components. Results show clear, time-dependent shifts in impedance behaviour, alteration in the low-frequency resistance, and a shift in relaxation frequency. These outcomes demonstrate that EIS can reliably monitor curd formation and provide a non-destructive, real-time tool for controlling gelation and assessing quality in dairy processing.
Keywords: Electrical Impedance Spectroscopy, Fermentation, Milk, Non-Destructive Evaluation, Real-Time Tool, Dairy Products.

Starch-Derived Pickering Emulsions for Advanced Food Technology: Fabrication Methods, Microstructural Organization and Industrial Applications

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Pickering emulsions use solid particles instead of surfactants to stabilize droplets, offering higher stability and reduced reliance on synthetic additives. Starch particles are promising natural stabilizers due to their safety, biodegradability, and functional properties. They spontaneously adsorb at the oil-water interface, preventing coalescence through steric effects, and can form gels with tunable rheological behaviour. Modified starch granules improve emulsion stability during processing and storage, and protect encapsulated bioactive compounds during digestion, making them ideal for food, pharmaceutical, and cosmetic applications. Native starch granules undergo targeted modifications to develop optimal emulsifying functionality within pickering emulsion systems. Effective modification approaches include chemical treatments such as octenyl succinic anhydride (OSA) conjugation, alongside physical interventions encompassing enzymatic or acid-catalysed hydrolysis, mechanical milling, organic solvent precipitation, high-intensity ultrasonication, and pressurized homogenization. Starch-based pickering emulsions display droplet sizes between approximately 1–100 μm, influenced by starch type, concentration, oil-water ratios, pH, ionic strength, processing, and storage conditions. Chemical modifications such as octenyl succinic anhydride (OSA) improve emulsifying efficiency, with specific degrees of modification optimizing droplet size. Increased starch particle concentration reduces droplet size by enhancing interfacial coverage. Microscopy reveals starch particles forming dense layers at the oil-water interface, preventing droplet aggregation, though excess free starch can lower efficiency. Rheologically, these emulsions behave like gels with tunable pseudoplasticity based on composition. Digestibility varies with starch modification and lipid type, as starch layers can hinder enzymatic hydrolysis. Pickering emulsions have versatile food applications, including polymerization for sustainable food packaging films, encapsulation of bioactives like curcumin and resveratrol for targeted delivery, and formulation of additive-free gluten-free rice bread and mayonnaise-like products, enhancing nutrition, stability, and sensory quality. Starch-based pickering emulsions demonstrate substantial potential for revolutionizing diverse food technology applications through enhanced functional properties and improved stability profiles.
Keywords: Starch-based Pickering emulsions, Modified starch particles, Oil-water interface stabilization

Systematic Development and Detailed Characterization of Composite Maize Flat Bread Fortified with Asparagus Bean Flour: A Study on Nutritional Enhancement and Quality Attributes

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Maize flat breads, widely consumed staples, suffer from nutritional inadequacies including low protein and limited essential amino acids. This study developed and comprehensively characterized maize flat bread supplemented with asparagus bean flour (ABF) to create a nutritionally superior composite product through raw material evaluation, flour blend optimization, and storage stability assessment. Proximate analysis revealed ABF contained 22.57% protein compared to 8.84% in maize flour (MF), with ABF showing superior water absorption index (2.71 g/g vs. 1.80 g/g) and foaming capacity (34.67% vs. 13.25%). Amino acid profiling demonstrated ABF was particularly rich in lysine (4.80 g/100g vs. 0.17 g in MF), complementing MF's higher methionine (0.42 g vs. 0.11 g) and cysteine content. Sensory evaluation identified the optimal formulation as 15% ABF and 85% MF, achieving excellent scores: color (8.2), flavor (8.7), and overall acceptability (8.1). The optimized composite flour showed significantly different ($p \leq 0.05$) pasting properties with peak viscosity 1609.00 cP and final viscosity 2326.00 cP. TPA showed an increase in hardness of composite from 30.84g to 31.73g. Farinograph analysis revealed higher water absorption (75% vs. 70.5%) and longer dough development time (5.5 min vs. 4.0 min). The optimized flat bread exhibited significantly enhanced protein, fiber, and ash content with in vitro protein digestibility of 85.11%. Texture analysis showed higher shear value (13.00 N vs. 11.50 N), A considerable difference in L*, A*, B* and Microstructure evaluation was noticed, while total phenolic content was 0.81 mg GAE/g with 28.10% antioxidant activity. 15% percent ABF supplementation enhanced nutrition and functionality without sensory loss. Optimal processing parameters were identified as 225°C with sequential baking times of 120 and 116s. Refrigerated storage with guar gum and BOPP packaging-maintained quality effectively. Future research should explore higher supplementation levels, long-term storage stability, and commercial scale-up feasibility.

Keywords: Asparagus bean flour; Maize flat bread; Composite flour; Nutritional supplementation; Protein enrichment

Valorization of Wheat Bran through Modifications: Functional Enhancement and Applications in Food Products

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Wheat bran, an abundant by-product of the milling industry, is a rich source of dietary fibre, protein, minerals, and bioactive compounds. However, its direct application in food products is limited due to coarse texture, poor solubility, and the presence of anti-nutritional components. To improve its nutritional and technological value, different modification approaches—mechanical, chemical, and biological—have been explored. Wet refining, performed using a Valley Beater, applies controlled mechanical shear to fibrillate and delaminate bran fibre. This treatment significantly enhances water and oil absorption, swelling capacity, and antioxidant activity by reducing particle size and exposing hydrophilic sites. Alkali treatment using sodium hydroxide (NaOH) selectively removes lignin and hemicellulose, improving fibre purity, solubility, and binding properties for food formulations. Biological modification, such as enzymatic hydrolysis or microbial fermentation, further enhances digestibility, phenolic release, and the conversion of insoluble to soluble dietary fibre. Together, these treatments improve the physicochemical and functional properties of wheat bran, making it a promising ingredient for bakery, beverage, and high-fibre traditional food formulations. Valorization of wheat bran through such sustainable modification techniques supports waste reduction and promotes the development of functional and health-oriented foods. Overall, integrating mechanical, alkali, and biological modifications provides a simple, cost-effective route to transform wheat bran into a value-added ingredient for modern food innovation.

Keywords: Wheat bran, Alkali-treatment, Wet-refining, Anti-nutritients, Functional foods.

Physical Modification of Browntop Millet (*Brachiaria ramosa*) Starch Using Pulsed Electric Field, Gamma Irradiation and Ultrasonication

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This study investigates the impact of pulsed electric field (PEF), gamma irradiation (GI), and ultrasonication (US) on the physicochemical, structural, thermal, and rheological properties of browntop millet starch. Starch was modified using PEF at 10 and 20 kV/cm, GI at 6 and 12 kGy, and ultrasonication for 10 and 20 min at 30–50% power rate. Apparent amylose content decreased under PEF and GI, with the lowest level observed in GI-2 (20.85%), whereas US enhanced amylose, reaching 25.48% in US-6 (20 min, 50% power). Functional properties improved across treatments, with maximum water absorption capacity (1.94 g/g) and oil absorption (2.41 g/g) recorded in US-6, indicating enhanced interaction with water and lipids. X-ray diffraction revealed reduced crystallinity, demonstrating structural disruption of starch granules. Differential scanning calorimetry showed a decline in gelatinization enthalpy from native starch (~183.1 J/g) to 151.82 J/g (GI-2) and 95.68 J/g (US-6), confirming loss of crystalline order and enhanced molecular mobility. Pasting behavior significantly changed, with peak viscosity decreasing to 458 cP (GI-2) and 2295 cP (US-6), indicating reduced granular strength. Rheological analysis confirmed shear-thinning behavior in all samples, with pronounced reductions in storage (G′) and loss (G″) moduli in GI and high-power US treatments, signifying weakened gel structure. Powder flow properties improved, with the lowest cohesion index noted in GI-2 (~14.8 g·mm), reflecting enhanced flowability. In summary, PEF, gamma irradiation, and ultrasonication significantly altered the structural, functional, and flow attributes of browntop millet starch, highlighting their potential as efficient modification approaches for diverse food and industrial uses.

Keywords: Browntop millet, Ultrasonication, Gamma-irradiation, Pulse-electric field, Rheological analysis

Development and Characterization of Canola Oil-Based Oleogels Structured with Beeswax and Rice Bran Wax

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Oleogelation represents a novel and innovative approach for transforming liquid edible oils into solid-like fats while preserving their chemical composition. The present study aimed to develop and characterize canola oil-based oleogels structured with natural waxes, namely beeswax (BW) and rice bran wax (RBW), at concentrations of 8%, 10%, and 12% (w/w). The prepared oleogels were evaluated for their physicochemical, textural, and rheological properties to assess their potential as healthier alternatives to conventional solid fats. The acid and peroxide values of all samples were within acceptable limits, confirming chemical stability. Oil binding capacity increased with higher wax concentrations, indicating enhanced network strength and structural integrity. Rheological analysis revealed dominant elastic behaviour (G′ > G″), confirming a strong gel-like structure, which was more pronounced in oleogels with higher wax levels, particularly those structured with beeswax. All samples exhibited shear-thinning behaviour. Rancimat analysis demonstrated that the oxidative stability of canola oil was significantly improved upon oleogelation. Differential scanning calorimetry (DSC) showed distinct melting transitions, while Fourier transform infrared (FTIR) spectra exhibited characteristic peaks without chemical interactions. X-ray diffraction (XRD) patterns indicated a high degree of lateral packing within the crystalline network. Overall, the results demonstrate that beeswax more effectively structures canola oil into stable oleogels compared to rice bran wax, with concentration-dependent improvements in functionality. These findings highlight the potential of beeswax and rice bran wax oleogels as sustainable, trans-fat-free fat replacers in various food formulations.

Keywords: Oleogels, Canola oil, Beeswax, Rice bran wax, Rheology

Real-Time Monitoring of Curd Fermentation Using Electrical Impedance Spectroscopy

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This study investigates the usefulness of electrical impedance spectroscopy (EIS) for real-time monitoring of curd fermentation by comparing impedance behaviour with standard indicators such as pH and titratable acidity. Using a four-electrode arrangement, impedance was recorded across frequencies from 40 kHz to 8 MHz at 35 °C throughout the incubation period. Both pH and acidity followed the expected fermentation trend—pH gradually declined while acidity progressively increased. Correspondingly, impedance values dropped with time, most noticeably at lower frequencies, reflecting the evolving ionic environment and microstructural modifications within the curd. A strong linear association was identified between impedance and acidity, with maximum responsiveness in the 2.24–2.88 MHz band. At 2 MHz, impedance correlated closely with acidity (R^2 = 0.92), demonstrating its capacity for rapid estimation of acid development. During fermentation, pH decreased from 5.2 to 4.54 and acidity rose from 0.74% to 0.93%, changes that were consistently tracked by the electrical response. These outcomes confirm that EIS offers a dependable, non-destructive, and hygienic alternative for monitoring curd fermentation and shows promise for integration into automated dairy processing workflows.

Keywords: Electrical impedance spectroscopy (EIS); pH; Acidity; Frequency response; Lactic fermentation; Non-destructive monitoring; Curd fermentation

Integrating Sustainable Development Goals into Food Fortification Strategies for Addressing Global Micronutrient Deficiencies

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Micronutrient malnutrition, affecting ⅓ to ½ of the global population, is a serious issue that has significant health and economic consequences. It involves deficiencies in essential vitamins and trace minerals, leading to increased mortality rates, poor pregnancy outcomes, impaired development in children, and reduced productivity in adults. The burden of this issue is particularly high in India, causing both human suffering and major economic losses due to unrealized potential and lost productivity. Addressing micronutrient deficiencies is crucial for improving public health and economic stability. Food fortification is an effective, affordable strategy to address micronutrient deficiencies, particularly in vulnerable populations and regions with marginal diets. By adding essential nutrients to common foods like salt, cereals, and dairy, fortification has successfully reduced deficiencies in industrialized countries. While it has improved health outcomes, deficiencies still persist in many low- and middle-income countries (LMICs). Successful programs, such as iodized salt and vitamin D-fortified foods, have shown significant health benefits. To further combat deficiencies, cost-effective fortification programs should target staple foods like flour, rice, and milk, considering local food habits. Incorporating fortification into global health initiatives is crucial for disease prevention and improving overall nutrition.

Keywords: Micronutrient, micronutrient deficiency, fortification

Bacteriophages in Human Health: Emerging Roles in Infection Control and Microbiota Modulation

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Bacterial infections in livestock, poultry, and humans remain one of the leading causes of illness and mortality worldwide. Bacteriophages, viruses that specifically infect bacteria, interact dynamically with both bacterial and mammalian cells, thereby exerting a significant influence on human health. Despite the vast reservoirs of naturally occurring bacteriophages in the human body, their therapeutic potential has long been overshadowed by the widespread use of antibiotics. However, with the growing prevalence of antibiotic-resistant bacteria and the increasing recognition of the critical role of gut microbiota in maintaining health, interest in bacteriophage-based therapies has been revitalised. This review comprehensively summarises current knowledge on bacteriophages, including their classification, mechanisms of action, and comparison with conventional antibiotics. It also highlights key studies on phage therapy and its applications in combating bacterial infections, such as tuberculosis, as well as in improving gut health, particularly in inflammatory bowel disease (IBD). Furthermore, emerging and innovative applications of bacteriophages, such as their use in gene and vaccine delivery, bacterial detection, immunomodulation, and the food industry, are discussed. With the expanding scope of phage therapy and its multifaceted potential, this review underscores the urgent need for continued research to optimise its therapeutic use and address existing limitations, ultimately contributing to the development of safer and more effective strategies for improving human health.

Keywords: Antibiotic resistance; Gene regulation; Immunomodulation; Phage typing; Tuberculosis.

The Emerging of Allergy-Free Foods: Business Opportunities and Challenges in Growing Market

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The growth in the prevalence of food allergies has also led to a sharp increase in the demand of allergy free foods which is both a business opportunity and a challenge. This paper analyzes the rise of the allergen-free food market with special emphasis on the main factors that contributed to the development of the industry including an increasing number of individuals being aware of food allergies and the necessity to find safer food options. Since consumers are after foods that fit certain dietary needs, namely gluten-free, dairy-free, nut-free, etc., companies are investing into developing research and development to satisfy these needs. This has been triggered by regulatory adjustments in the advanced markets like improved labeling and enhanced allergen declarations. Nonetheless, companies have significant difficulties in meeting complicated food safety standards and avoiding cross-contamination in the manufacturing process. Although the process of replacing ingredients and introducing allergen-free products is necessary, the replacement of ingredients sometimes leads to high production costs, which may reflect in the pricing and competition in the market. Irrespective of such challenges, the allergen-free food market is a potential huge business. The companies capable of innovating in creating products, strong safety norms, and demanding transparency in their labeling are in a good place to succeed. Other future opportunities in the market discussed by the paper include the potential of an increase in emerging economies and how the technological progress will help in increasing the production of allergen-free foods.

Keywords: Allergen-free foods, Food allergies, Regulatory challenges, Consumer demand, Market opportunities

In-situ cold plasma treatment for removing food allergens- A short review of effectiveness, mechanisms and implementation strategies

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Cold plasma (CP) is an effective technique for reducing food allergen antigenicity, with studies showing more than 50% reduction in specific allergen proteins. In recent decades, CP has been explored to reduce the immunoglobulin E (IgE) reactivity of major allergens in foods such as peanut, milk, egg, shrimp, soy, wheat, and sesame by generating reactive oxygen and nitrogen species. These reactive species can modify protein structures by oxidizing amino acids, forming new disulfide bonds, altering secondary protein structures, crosslinking proteins, and increasing surface hydrophobicity. Interestingly, all these changes occur at low temperatures, which minimizes the risk of deterioration in nutritional or sensory values. Moreover, as cold plasma technology is safe, it presents a promising method for allergen mitigation in food processing. The in-situ approach, or direct plasma exposure on grains, nuts, or seeds in their natural state, eliminates the need for chemical, enzymatic, or wet pretreatments. In addition, this also significantly reduces the cost of material handling and losses. Therefore, this short review explores recent studies to examine the evidence of allergenicity reduction, the underlying physicochemical mechanisms, and practical strategies for in situ implementation of CP.
Keywords: Cold Plasma, food allergens, protein, antigenicity

Comparative Toxicity and Identification of *Illicium* Species: A Food Safety Perspective on Star Anise Adulteration

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Illicium verum Hook. f. (Chinese star anise) is a widely used culinary spice and medicinal plant, valued for its aromatic and therapeutic properties. However, its morphological resemblance to other *Illicium* species such as *I. anisatum* (Japanese star anise), *I. lanceolatum*, *I. floridanum*, *I. henryi*, and *I. difengpi*, has resulted in frequent cases of adulteration and accidental toxicity. The toxic species contain potent neurotoxic compounds, including anisatin, neoanisatin, and pseudoanisatin, which act as GABA receptor antagonists leading to seizures, tremors, and vomiting. This review aims to compile and compares the toxicity profiles, chemical compositions, and identification methods of major *Illicium* species using data from recent analytical and toxicological studies. Advanced techniques such as vacuum ultraviolet photoionization mass spectrometry (VUV-MS), near- and mid-infrared spectroscopy (NIR/MIR), gas chromatography, and chloroplast genome analysis provide robust discrimination between edible and poisonous species. Reported cases of star anise poisoning, especially in children, underscore the public health risk posed by misidentification and improper labeling of herbal products. The comparative evaluation highlights that integrating morphological, spectroscopic, and molecular tools is crucial for ensuring authenticity and consumer safety. The findings advocate for the development of standardized quality control protocols to prevent adulteration of *Illicium verum* in food and nutraceutical applications.
Keywords: *Illicium sp.*, Anisatin, Adulteration, Neurotoxicity, Food Safety

Nutritional Characterization of Ladakhi Hard Chhurpi: A Potential Candidate for Geographical Indication

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A geographical indication (GI) identifies products linked to a specific origin with distinct qualities or reputations. Chhurpi is a traditional Himalayan cheese, is widely consumed in Ladakh, Arunachal Pradesh, and Darjeeling, though prepared by region-specific methods. In Ladakh, milk is fermented before butter separation and Chhurpi preparation from buttermilk, whereas in Arunachal Pradesh and Darjeeling, fat is first separated and the remaining milk is fermented. This fundamental difference in processing influences nutritional composition and supports the case for GI protection. The present study aimed to characterize the nutritional properties of Hard Chhurpi made from yak milk in Ladakh. Compositional analysis revealed that Ladakhi Chhurpi had a higher protein content (66.38%) and lower fat content. Fatty acid analysis revealed saturated fatty acids comprising ~68% across all samples, MUFA ranging 29-31%, and PUFA (2.84%) were higher in Ladakhi Chhurpi. Total amino acid concentration was more in Ladakhi Chhurpi (46.58 mg/g), with higher levels of lysine (3.81%), methionine (7.34%), tryptophan (5.61%), and proline (6.25%) compared to other regions. A significant increase in hydrolyzed protein content and antioxidant activity was observed after in-vitro digestion of Ladakhi Chhurpi (51.79% and 73.27%) compared to Arunachal (45.89% and 58.70%) and Darjeeling Chhurpi (48.09% and 62.27%). The Ladakhi Hard Chhurpi demonstrated distinct nutritional profile influenced by its distinct preparation method. These findings highlight its potential as a candidate for GI certification, ensuring recognition and protection of this unique Himalayan dairy heritage.

Exploring the Impact of Sorghum-Based Diets on Gut Microbiota Diversity and Health: A Review

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Sorghum known for its hardness and flexibility, exhibit a dynamic nutritional profile being rich in dietary fibre, protein and essential mineral content like phosphorus, magnesium, iron these essential minerals renders sorghum a vital nutritional resource in growth maintenance and metabolic functions. Despite its nutritious profile and broad compliance sorghum remains significantly unexamined in terms of its health-promoting potential. This literature review look into the extensive research on sorghum's based diet on gut microbial diversity and its health promoting potential.Sorghum-based diets have been shown to considerably influence gut microbiota diversity and health in various animal species. Studies on Boschveld indigenous chickens revealed that diets with different sorghum varieties altered bacterial composition, with white sorghum promoting unique bacterial presence like Campybacterales and Streptococcus. In common carp, sorghum inclusion led to increased aerobic and anaerobic bacterial populations, impacting oxidative stress levels negatively. Human trials demonstrated that sorghum consumption improved intestinal microbiota, reduced body fat percentage, and enhanced short-chain fatty acid synthesis, showcasing its prebiotic potential. Additionally, sorghum's nutritional value and phenolic profile suggest its potential to influence rumen microbial abundance and meat quality in livestock, emphasizing the need for further research in this area

Keywords: Sorghum Consumption, Gut Microbiota, Microbial Diversity, human Gut Microbes, Prebiotic Potential.

Analytical Study of Traditional Indian Plant-Based Foods and Their Glycemic Index in Relation to Yogic, Ayurvedic and Modern Preventive Nutrition Principles

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The rising prevalence of metabolic disorders such as diabetes, obesity, and cardiovascular diseases underscores the need for preventive, plant-based nutrition. Traditional Indian dietary systems Yogic and Ayurvedic recommend predominantly plant-based, Sattvic foods that emphasize freshness, balance, and moderation. Modern nutrition science highlights low-glycemic-index (GI) diets for controlling blood glucose and reducing chronic disease risk. This analytical study explores the relationship between traditional Indian plant-based foods, their glycemic index, and preventive health benefits in comparison with modern nutrition principles. By synthesizing data from Ayurvedic texts, Yogic dietary guidelines, and published scientific databases (ICMR, WHO, FAO), this paper identifies foods that are nutritionally rich, low-GI, and aligned with holistic wellness. Findings show that many traditional foods such as millets, legumes, and whole grains possess low-to-moderate GI values, providing metabolic stability and supporting preventive health. The study concludes that integrating Yogic–Ayurvedic dietary wisdom with modern low-GI plant-based nutrition can offer a comprehensive and sustainable preventive diet model.
Keywords: Plant-based diet, Glycemic index, Ayurvedic diet, Yogic nutrition, Preventive health, Traditional foods

Significance of the Edible Banana species of Mizoram: Research Status and Prospects

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The Indian state of Mizoram is positioned at a special geographical location, sharing two international boundaries with Myanmar and Bangladesh. Currently, prospective trade routes and tourism have necessitated urgent technological upgradation towards commercialization of the locally grown produces of this forest-clad state. Mizoram's natural conditions offer a wide diversity of banana and plantain species, that have been ethnically playing a key role in ascertaining health, nutritional and economic security of the local tribal populations. Till date, fourteen banana species belonging to *Musa* L. and *Ensete* Bruce ex Horan. species have been formally identified and reported from the state. Latest improvement in technological know-how have enabled the local small-scale processors to commercialize value added products in packaged or ready-to-serve forms. However, the traditional practices of consuming the edible pseudostem, flowers and inflorescence are yet to be scientifically explored, considering the recent global research and developments occurring in other banana producing zones of India and the world. Local ethno-medicinal knowledge systems also suggest the use of banana fruits for treatment of anaemia, hypertension, diarrhoea, burns, wounds and stomach ulcers, pseudostem juice for kidney problems. Besides these, there are several other traditional usages of the stem layers and leaves such as packaging material for fermented and aquatic foods, water-resistant roofing and biodegradable cutleries among others. Here, a brief reviewed documentation of the current research status and future opportunities for research on the banana resource of Mizoram will be presented.
Keywords: tribal knowledge, organic, product development, technology upscaling, antioxidant

Traditional Food with GI Importance: A Study on Kashmiri Kesar (Saffron)

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Kashmiri Kesar, often called the "pride of Kashmir," is more than just a spice—it is a story of tradition, identity, and deep emotional connection between the land and its people. For generations, the farmers of Kashmir have carefully nurtured these delicate crimson threads, which fill the air with their rich aroma and bring life to countless homes. Known for its purity, vibrant colour, and unique flavour, Kashmiri saffron has always held a special place in India's cultural and economic landscape. In May 2020, it became the first saffron variety in India to receive a Geographical Indication (GI) tag, officially linking its fame to the beautiful valley where it has been cultivated for centuries.This research tells the journey of Kashmiri Kesar—from the fields of Pampore, often called the "saffron town of India," to its growing recognition across the world. It explores how the GI certification has helped restore the lost pride of this precious crop by ensuring authenticity, curbing fake products, and giving rightful value to local farmers. Drawing on various studies, reports, and field insights, the paper looks into how the certification has affected production, marketing, and the overall livelihood of the people involved in saffron farming. However, despite these achievements, the journey is far from easy. Unpredictable weather, shrinking cultivation land, lack of irrigation facilities, and the growing market for imitation saffron continue to create hurdles. Still, the gradual increase in productivity and renewed global attention, bring a sense of hope. The study concludes that while the GI tag has been a powerful tool in preserving and promoting Kashmiri Kesar, what truly sustains it is the dedication of the farmers, the support of effective policies, and the collective effort to keep alive a centuries-old tradition that defines the spirit of Kashmir.

Keywords: Kashmiri Kesar, Geographical Indication (GI) tag, Saffron cultivation, Cultural heritage, Market recognition, Farmers' livelihood, Authenticity and traceability, Sustainability challenges

Decoding Regional Variability in Mysore Pak Using Principal Component Analysis: A Sensory Approach

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Mysore Pak, a royal delicacy from Southern India, is one of the most celebrated traditional sweets, prepared with gram flour, sugar, and ghee. Despite its cultural importance and wide consumer demand, the product lacks scientific standardization, leading to major variations in quality across regions and brands. The present study aimed to systematically characterize soft-textured Mysore Pak using Descriptive Sensory Analysis (DSA) and advanced statistical tools. Sixteen branded samples were procured from different zones of India, primarily from Southern markets along with samples from Delhi, Punjab, and Haryana, and evaluated by a semi-trained sensory panel (n=13) for 23 attributes covering appearance, flavour, texture, and overall acceptability. A comprehensive scoring lexicon was developed, and evaluations were conducted under controlled conditions to ensure reliability. Data were analysed using Principal Component Analysis (PCA) and ANOVA to interpret sensory variability and identify key attributes influencing consumer acceptance. PCA results revealed that positive attributes such as ghee aroma, roasted besan flavour, softness, shiny appearance, golden-yellow colour, and greasy surface texture clustered on the positive axis, while negative traits including stickiness, nutty aftertaste, and graininess loaded on the opposite axis. Clustering on the positive axis indicates attributes that enhance consumer preference and overall acceptability, whereas clustering on the negative axis highlights traits that detract from quality, providing a clear framework to guide product standardization and improvement. Results highlighted significant differences among regions, emphasizing the role of ingredient ratios and preparation styles. This study provides a scientific pathway to standardize Mysore Pak, supporting its commercialization and global market potential.

Keywords: Mysore Pak, Descriptive Sensory Analysis (DSA), Principal Component Analysis (PCA), traditional Indian sweets, Mysore Pak standardization, ghee aroma, texture profiling,

Unveiling the Hidden Potential of Wild Rice: A Traditional Food with Low Glycemic Index

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Traditional foods hold immense potential in enhancing health and nutritional aspects, particularly those derived from less studied genetic resources such as wild rice (Oryza spp.). The present study investigates the nutritional potential of wild rice species with a special focus on their glycemic response compared to cultivated rice genotypes. A diverse set of 27 wild rice accessions representing nine different Oryza species were evaluated for *in vitro* starch digestibility, hydrolysis index (HI), and predicted glycemic index (pGI). Significant variation was observed among the accessions, with wild rice species exhibiting markedly lower HI (38.21) and pGI (60.68) values when compared to cultivated rice varieties (52.63 and 68.51, respectively). Substantial variability was observed among wild rice species, with the equilibrium concentration (Ceq) ranging from 24.94% to 55.68%, kinetic constant (k) from 0.064 to 0.081 min-1, hydrolysis index (HI) from 24.87% to 56.95%, and predicted glycemic index (pGI) from 52.99 to 70.50. In contrast, cultivated rice genotypes exhibited higher digestibility (Ceq 45.44–60.07%) and glycemic response (pGI 66.10–72.23), indicating faster starch hydrolysis and glucose release. Among wild accessions, O. nivara (CR100113B) recorded the lowest HI i.e 24.87% and pGI 52.99, suggesting superior slow-digesting starch characteristics. This suggests a slower rate of glucose release and a potential role of wild rice in the development of low-glycemic or diabetic-friendly diets. Overall, the findings highlight the potential of utilizing wild rice germplasm as a functional food resource for mitigating diet-related metabolic disorders and promoting sustainable nutrition through traditional food systems.

Keywords: functional foods; glycemic index; nutritional diversity; starch digestibility; wild rice

Process Optimization for the Development of Technology and Preparation of Cucumber Petha

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Cucumber is underutilized fruit and due to presence of high moisture content 95-96%, it is vulnerable to spoilage causing micro-organisms. Cucumber in the form of Petha will increase its consumption among all the age groups. The aim of this study was to develop cucumber petha taking variable concentration of sugar and constant temperature drying in hot air oven. Sugar concentrations of 200 Brix, 300 Brix and 400 Brix was prepared, out of which 400 Brix showed the highest overall acceptability (8.53 ± 0.37) on a 9-point hedonic scale in terms of colour, texture, aroma, and flavour. The proximate composition of the optimized sample recorded moisture (15.82 ± 0.50%), ash (0.43 ± 0.03%), fat (0.11 ± 0.02%), and protein (0.37 ± 0.04%), comparable to the control. The antioxidant potential was significant, with DPPH scavenging activity of 54.41 ± 0.52%, total phenolic content of 10 ± 5 mg GAE/g, and total flavonoid content of 0.25 ± 0.08 mg QE/g. Microbial evaluation confirmed minimal growth up to 12 days, classifying it as an intermediate moisture food. During storage, slight reductions occurred in antioxidant activity and moisture, while laminated pouches preserved superior sensory quality compared to LDPE and HDPE. The product remained stable for 30 days at ambient temperature. Economic analysis showed a production cost of ₹216 per kg, confirming commercial feasibility. Overall, cucumber Petha exhibited excellent sensory appeal, nutritional attributes, and shelf stability, establishing its potential as a novel health-oriented confectionery product.

Keywords: Cucumber, antioxidant activity, storage study, sensory parameters.

Impact of Incorporating Beetroot (*Beta vulgaris*) and Rosemary (*Salvia rosmarinus*) Extracts on the Phenolic Profile and Antioxidant Potential of Sandesh

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Sandesh, a traditional milk-based sweet made with heat and acid coagulation, is a famous delicacy in West Bengal. With increased consumer interest in functional foods that provide health benefits, such as antioxidant activity, there is a great opportunity to enhance dairy products using bioactive plant ingredients. This study added ethanolic extracts of beetroot and rosemary to Sandesh separately and in combination at doses of 1%, 2%, and 3%. These herbs and spices, which are known for their antioxidant, anti-inflammatory, antimutagenic, and immune-boosting capabilities, not only improve the sensory qualities of food but also help extend its shelf life. The developed variants showed Radical Scavenging Activity (RSA) ranging between 64–88%, though the activity declined during storage (0–15 days). In addition, the total phenolic content of the fortified samples (2.98–7.98 mg GAE/g) was markedly higher compared to the control Sandesh (1.09 mg GAE/g).
Keywords: Antioxidant activity; Beetroot; Chhana; Herbal *Sandesh.* Natural antioxidants; Phenolic content; Rosemary; Radical Scavenging Activity.

Development and Nutritional Evaluation of Iron-Enriched Traditional Indian Sweetmeat Ball (*Laddoo*) Using Amaranth Flour

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Iron deficiency disorder (IDD) remains one of the most pressing global nutritional challenges, particularly affecting women, children, and adolescents. Iron is indispensable for oxygen transport, enzymatic activity, energy production, and overall cellular function. In India, iron deficiency contributes significantly to the high prevalence of anemia, impairing health, productivity, and socio-economic development. This study aimed to develop an affordable, iron-rich food product. Natural, locally available, and culturally acceptable iron sources, namely amaranth, horse gram, and black raisins, were selected owing to their high iron content and nutritional value. The basic recipe was first standardized and 18 variations were prepared with varying amounts of amaranth, horse gram, black raisins as dominant sources of iron and sweet lime juice as a source of vitamin C. Each variation was subjected to a sensory evaluation using a 9-point hedonic scale based on criteria such as appearance, color, taste, texture, and overall rating. The evaluation scores revealed that amaranth laddoo enriched with 15 g horse gram flour, 30g black raisins and 30ml sweet lime juice was most widely approved variation. Parameters such as moisture, protein, fat, total mineral content, crude fiber, iron, and vitamin C were analysed. Iron content in the best accepted variation was 5.93 mg/100g and vitamin C content was 164.10 mg/100g. Cost analysis demonstrated that the developed product was economically feasible, ensuring accessibility from diverse socio-economic backgrounds. The findings highlight the potential of incorporating underutilized iron-rich ingredients into traditional food products as a sustainable dietary strategy to combat iron deficiency disorders.
Keywords: amaranth, enrichment, iron deficiency disorder, traditional food

Exploring Jackfruit as a promising non Soy Source for Plant -based Meat Alternatives

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The growing global demand for sustainable and ethical food alternatives has led to increased interest in developing plant-based meat analogues. Soy-based analogues, although widely used, present several challenges such as allergenicity, undesirable beany flavor and suboptimal meat-like texture. To address these limitations, the present study proposes the utilization of jackfruit as a novel plant-based ingredient for meat analogues. Jackfruit is rich in antioxidants, vitamins, minerals, and possesses fibrous texture characteristics that make it a promising substitute for soy protein. The objectives of the project include developing jackfruit powder using a tray dryer, evaluating its physicochemical and functional properties, and optimizing its concentration for the preparation of extruded meat analogues. The optimized products will be further analyzed for their physicochemical, functional, sensory, microbial, and shelf-life characteristics under different storage conditions. Preliminary trials indicated acceptable taste and flavor of jackfruit-based analogues but insufficient fibrous texture, highlighting the need for extrusion processing to improve textural quality. The expected outcome of the study is the development of a sustainable, allergen-free, and nutritionally enhanced jackfruit-based meat analogue with desirable sensory characteristics. This innovation could promote value addition to underutilized jackfruit, support farmers' income, reduce environmental degradation, and contribute to the growth of the vegan meat industry, catering to health-conscious consumers and export markets.

Keywords: Jackfruit, Plant-Based Ingredient, Meat Analogues, Extrusion Processing and Sensory Characteristics

Formulation and Characterization of a Plant-Based Beverage from Mango Pulp and Finger Millet Milk

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The present study investigated the effect of formulation on the physico-chemical, functional and organoleptic properties of finger millet milk and beverage flavored with Zardalu mango pulp for its processing suitability. The growing consumer demand for nutritious, lactose-free and plant-based beverages has encouraged the development of innovative functional drinks. Finger millet milk was prepared by soaking, germinating and wet-milling followed by filtration to obtain an aqueous extract. The beverage was formulated in different blending ratios of mango pulp to finger milk (70:30, 60:40, and 50:50). The formulated beverages were analysed for physicochemical, functional and sensory properties. The pH of the formulations ranged from 5.22 ± 0.03 to 5.56 ± 0.02, total soluble solids from 14.2 ± 0.1 to 17.8 ± 0.2 °Brix. The proximate composition of the optimized 60:40 formulation revealed 82.4 ± 0.2% moisture, 2.86 ± 0.05% protein, 1.21 ± 0.03% fat, 12.3 ± 0.2% carbohydrate, 1.02 ± 0.01% ash, and 0.75 ± 0.02% crude fiber. Mineral analysis indicated high calcium (148 mg/100 mL), iron (2.8 mg/100 mL) and magnesium (46 mg/100 mL) contents. The 60:40 formulation showing the least phase separation and sedimentation index reflecting good suspension stability. Sensory evaluation using a nine-point hedonic scale showed that the 60:40 formulation received the highest overall acceptability score (8.2 ± 0.3), attributed to balanced flavour, smooth texture and natural sweetness. This formulation demonstrates potential as a functional, plant-based providing a promising dairy alternative suitable for health-conscious and lactose-intolerant consumers.

Keywords: Millets, Mango, Beverage, Physicochemical, Functional and Minerals

Formulation and Evaluation of Aloe vera Fortified Multigrain Bread: Effect on Glycemic Index

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This study aimed to develop nutritionally enriched multigrain bread fortified with aloe vera gel, a natural source of bioactive compounds including minerals, amino acids, and antioxidants. Six formulations (A0–A5) were prepared using whole wheat, soya, and barley flours with aloe vera gel concentrations ranging from 0 to 35 g. The A4 sample (25 g aloe vera gel) exhibited the highest sensory acceptability among 15 semi-trained panelists. It also showed maximum specific loaf volume (1.076 cm^3/g) and favorable color attributes (L* = 62.49, a* = 8.47, b* = 33.60). Proximate analysis revealed higher nutritional values in A4, with 43.41% carbohydrates, 14.43% proteins, 0.99% fiber, and 5.31% fat. Mineral analysis by MP-AES indicated elevated calcium (680.06 ppm), magnesium (147.14 ppm), and iron (11.77 ppm) contents. The A4 sample also demonstrated a lower glycemic index (57.64) compared to the control sample (89.10), likely due to the presence of soya and barley flour, along with aloe vera gel.
Keywords: Aloe vera gel; Glycemic index; Fortification; Multigrain bread

Synergistic Effect of Multi-Millet Formulation on Polyphenol Stability and Antioxidant Potential: A Mixture Design Approach

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Millets are increasingly recognized as functional foods owing to their rich polyphenols and antioxidant compounds that contribute to health-promoting effects. This study aimed to investigate the synergistic potential of multi-millet formulations in enhancing polyphenol stability and antioxidant activity through optimized blending. A simplex centroid mixture design approach was employed to combine finger millet, pearl millet, and sorghum in varying ratios. Functional responses, including total polyphenol content (TPC), total flavonoid content (TFC), DPPH radical scavenging activity, and FRAP assay, were evaluated across experimental runs. Results revealed that the optimized blend (53% finger millet, 28% pearl millet, 18% sorghum) maximized TPC (639.59 mg/100g), TFC (57.17 mg/100g), and antioxidant responses, confirming finger millet as the primary contributor. Principal component analysis indicated a positive contribution of finger millet (0.345), whereas pearl millet and sorghum exerted negative effects on variance. The synergy index (SI > 1) demonstrated that optimized ratios enhanced functional properties beyond the additive effects of individual millets. These findings confirm the potential of millet-based formulations to deliver improved bioactivity and nutritional integrity through strategic ratio optimization. This study provides a scientific basis for developing multi-millet functional foods with superior health benefits.
Keywords: Multi-millet formulation, Polyphenol stability, Antioxidant potential, Product optimization, Synergy Index

Value addition of muffins by incorporation of orange peel powder

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The rising interest in functional and sustainable foods has encouraged the utilization of fruit and vegetable by-products as functional ingredients in bakery products. The present study focuses on the value addition of muffins through the incorporation of orange peel powder (OPP) to enhance nutritional and functional quality while supporting waste valorization. Orange peel, a major by-product of the citrus processing industry, is rich in dietary fiber, polyphenols, flavonoids, vitamin C, and essential oils, offering antioxidant, antimicrobial, and health-promoting properties. In this study, orange peels were washed, oven-dried at 60°C, ground, and sieved (60 mesh) to prepare OPP. Muffins were formulated by substituting refined wheat flour with OPP at 5%, 10%, and 15% levels. The developed muffins were analyzed for physicochemical parameters (moisture, protein, fat, fiber, ash, and energy value), antioxidant activity (DPPH assay), and sensory acceptability using a nine-point hedonic scale. Shelf-life evaluation was carried out at room temperature for one month. Results are expected to show that OPP incorporation enhances fiber and antioxidant content while maintaining acceptable texture, flavor, and overall sensory quality at optimized levels. The addition of OPP also contributes to improved shelf stability due to its natural antioxidant compounds. This study demonstrates that the incorporation of orange peel powder in muffins not only improves nutritional value but also promotes sustainable food production by upcycling citrus waste, aligning with the UN Sustainable Development Goal 12 for responsible consumption and production.
Keywords: Orange peel powder, functional food, muffins, waste valorization, antioxidant activity, sustainable development.

Millet-Enriched Granola Bar: A Functional Snack to Combat Undernutrition

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Malnutrition, prevalent among children and women, includes undernutrition (wasting, stunting, underweight), micronutrient deficiencies, and diet-related non-communicable diseases. It can be addressed by scientifically reformulating traditional foods using millets and pulses in appropriate proportions. The present study aimed to develop a protein- and mineral-enriched granola bar utilizing millets such as pearl millet, sorghum, finger millet, amaranth puff, and moong dal. Jaggery was used as a natural sweetener instead of refined sugar to enhance the nutritional and functional properties. Formulation optimization was carried out using Response Surface Methodology (RSM) based on protein content, overall acceptability, bowl life, and hardness. The optimized granola bar was evaluated for nutrient composition, mineral content, texture, shelf life, and cost feasibility using standard analytical methods. The optimized product showed 3.26% moisture, 10.85 g protein/100 g, 11.80 g fat/100 g, 69.65 g carbohydrate/100 g, 1.88 g crude fiber/100 g, and 2.65 g ash/100 g. The calcium and iron contents were 88.20 mg and 5.03 mg/100 g, respectively. The developed bar provided 428.20 kcal/100 g, classifying it as an energy-dense snack suitable for combating undernutrition among children and women.

Microbial analysis confirmed that the product remained within safe limits for up to 6 months of storage, and the cost of production was approximately ₹6.00 per 25 g bar. The millet-based granola bar was thus found to be a nutritious, affordable, shelf-stable, and cost-effective alternative to commercial products, suitable for nutritional supplementation and public health programs.
Keywords: Millets, Granola bar, Response Surface Methodology (RSM), nutritional supplementation

Utilization of Millets in Muffins

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Millets are ancient grains recognized as "nutri-cereals" due to their richness in fiber, protein, calcium, iron, and antioxidants. The present study aimed to develop nutrient-rich muffins by partially substituting refined wheat flour with sorghum (jowar) and finger millet (ragi) flour to enhance nutritional quality while maintaining desirable sensory and physical properties. Four formulations (T_0–T4) were prepared with varying proportions of sorghum, ragi, and refined wheat flour. The samples were analyzed for their sensory, physical, and chemical characteristics. Among the treatments, formulation T3 (60% sorghum, 20% ragi, and 20% refined wheat flour) was found most acceptable in terms of texture, taste, and color. The optimized muffins contained moisture (21.84%), fat (24%), fiber (6%), ash (2%), protein (4.98%), and carbohydrates (41.18%). Sensory evaluation based on a 9-point hedonic scale revealed that millet incorporation significantly improved the flavor and nutritional profile without compromising overall acceptability. The study concludes that the inclusion of millets in bakery products can enhance their functional and nutritional value, promote millet utilization, and support healthier food choices for consumers across age groups.
Keywords: Millets, Sorghum, Finger millet, Muffins, Nutritional quality, Sensory evaluation

From Farm to Functional Food: Optimization of an Extruded Snack from Biofortified Finger Millet (*Eleusine coracana*) via Response Surface Methodology

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Biofortified finger millet, rich in micronutrients like Iron and Calcium, is key to combating 'hidden hunger.' However, low consumer acceptance limits its impact. This study aimed to optimize the formulation and processing parameters for a highly accepted extruded snack using this millet. Response Surface Methodology (RSM), specifically a Box-Behnken design, was used. The independent variables were millet content (85–95%), feed moisture (16–20%), screw speed (22–26 rpm), and barrel temperature (160–180°C). Dependent variables included expansion ratio, iron, calcium retention, and overall sensory acceptability. The optimized sample underwent microstructure and molecular interaction (FTIR) analysis. All independent variables significantly affected the snack's physico-chemical and sensory properties ($p < 0.05$). The second-order polynomial models were highly significant, showing strong predictive accuracy with high coefficients of determination ($R2 > 0.90$). Feed moisture was the most influential factor, negatively correlating with both expansion ratio and sensory scores. Numerical optimization determined an optimal solution (e.g., 16% feed moisture, 24.09 rpm screw speed, and 175°C barrel temperature), yielding high desirability. The optimised sample exhibited a highly porous microstructure, resulting in superior crispiness compared to the control samples. The optimized snack had a highly porous microstructure, enhancing crispiness. FTIR confirmed the presence of key functional groups (C-H, OH, N-H, C-N). This work proves RSM is an effective tool for developing a nutrient-dense, highly acceptable extruded finger millet snack, providing a viable pathway for value addition and improved nutritional security.
Keywords: Biofortified Finger Millet, Extrusion, Response Surface Methodology (RSM), Functional Snack, Optimization, Micronutrient.

Development and Consumer Evaluation of Healthier Brownie Variants Incorporating Millet Flours and Natural Sweeteners

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Growing consumer interest in healthier bakery products has stimulated innovation in nutrient-enriched formulations using functional ingredients. This study aimed to develop and standardize healthier brownie variants by incorporating alternative flours and natural sweeteners, and to evaluate their sensory acceptability, economic viability, and consumer willingness to pay. A structured questionnaire administered to 403 participants assessed consumption patterns and preferences, demonstrating high internal reliability (Cronbach's $\alpha = 0.828$). Significant associations ($p < 0.05$) were observed between demographic variables and brownie preferences, with 53.6% favoring cakey textures and 57.3% expressing interest in gluten-free or reduced-sugar options. Formulations utilized pearl millet flour (PMF), kodo millet flour (KMF), date paste, and apple puree as functional substitutes for refined wheat flour, sugar, and fat. PMF exhibited higher water absorption (2.54 g/g) and improved batter stability compared to refined flour (1.68 g/g). Sensory evaluation using a 9-point hedonic scale identified the 50% PMF blend as the most acceptable cakey variant, while fudgy brownies containing 75% date paste and 25% apple puree achieved optimal taste and texture. Economic analysis revealed a marginal cost increase for millet-based brownies (1.32%), while fruit-based variants were substantially higher. Consumer analysis indicated that 80% were willing to pay a premium for healthier alternatives. Overall, millet-based brownies demonstrated an optimal balance of nutritional enhancement, sensory quality, and affordability, underscoring their potential for functional bakery commercialization.

Keywords: Functional bakery products; Millet flour; Natural sweeteners; Sensory evaluation; Consumer perception; Economic analysis; Functional foods

A Comparative Study of Drying Methods on the Quality of a Protein-Rich Papaya and Chia Seed Fruit Bar

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Growing consumer demand for nutritious and functional foods has driven increased interest in plant-based snack development. This study details the formulation and characterization of a papaya-based fruit bar enriched with chia seeds, designed as a balanced, protein-rich, and fiber-packed functional snack. Ripe papaya pulp provided natural sweetness and a wealth of bioactive compounds including carotenoids, phenolics, and vitamin C, enhancing flavor and antioxidant capacity. Chia seeds (Salvia hispanica L.) were added to boost the nutritional profile with omega-3 fatty acids, dietary fiber, and plant proteins.

During development, three drying methods—freeze drying, refractance window drying, and hot air oven drying—were compared to identify optimal time-temperature conditions and maximize retention of heat-sensitive nutrients. The fruit bars were assessed for proximate composition (moisture, protein, fat, carbohydrate, and ash) and physicochemical traits such as pH, water activity, and texture parameters including hardness, cohesiveness, and chewiness. This study underscores the potential of combining tropical fruits with nutrient-dense seeds to create sustainable, functional snacks. These innovations reflect current trends toward natural, protein-fortified, plant-based foods, offering convenient options for health-conscious consumers.

Keywords: Refractance window drying, papaya fruit bar, chia seed, freeze drying, functional snack

Hyperspectral Imaging as an Intelligent Nondestructive Food Quality Assessment Tool

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Ensuring food safety and quality is a worldwide issue that demands swift, dependable, and non-invasive assessment techniques. Traditional analytical methods like chromatography and mass spectrometry, while precise, are destructive, labour-intensive, and not ideal for real-time industrial use. Hyperspectral Imaging (HSI), which combines imaging and spectroscopy, has emerged as a promising optical sensing method that captures both spatial and spectral data across numerous adjacent wavelength bands. This dual capability enables in-depth analysis of the chemical composition, physical structure, and contaminant identification in food matrices. This paper presents the core principles, components, and data-acquisition techniques of HSI, highlighting its benefits over conventional RGB, NIR, and multispectral imaging systems. Additionally, it delves into recent uses of HSI in assessing food quality, such as detecting adulteration, estimating moisture and protein levels, and analyzing microbial contamination. The combination of HSI with machine learning and deep learning algorithms has amplified its potential for automated, real-time quality inspection and classification. However, despite its benefits, industrial adoption is hindered by high system costs, data redundancy, and limited algorithmic generalization. Future developments should aim at compact hardware design, effective spectral data reduction, and interpretable AI models for scalable implementation. In summary, HSI stands as a revolutionary, non-destructive approach for intelligent food monitoring systems, promoting improved safety, authenticity, and sustainability in contemporary food production.

Keywords: Hyperspectral Imaging, Non-Destructive Testing, Food Quality, Machine Vision System, Deep Learning, Artificial Intelligence

Artificial Intelligence-Assisted Quality Analysis and Development of Fruit and Vegetable Juices: A review

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Artificial intelligence (AI) is transforming the fruit and vegetable juice industry by improving product design, process optimization, nutritional profiling, and quality control. Through advanced data analytics and machine learning models such as Artificial Neural Networks (ANNs), Support Vector Machines (SVMs), and Convolutional Neural Networks (CNNs), AI enables precise prediction of nutrient stability, texture, and sensory qualities while minimizing trial and error. CNNs combined with optical and hyperspectral sensors allow real-time detection of spoilage, defects, and adulteration, ensuring consistent product quality and consumer safety. In processing, AI supports optimization of non-thermal preservation technologies like pulsed electric fields and high-pressure processing, which retain more nutrients and natural flavors than conventional thermal methods. These intelligent systems help refine formulations that combine diverse fruit and vegetable ingredients, leading to improved product consistency, reduced waste, and shorter development cycles. Despite these advancements, industry adoption faces challenges, including limited access to standardized datasets, insufficient digital expertise, and high investment costs for small producers. To overcome these barriers, initiatives in data sharing platforms, workforce training, and supportive policy development are essential. Future integration of AI with Internet of Things (IoT) technologies, biosensors, and blockchain systems is expected to enhance real-time monitoring, traceability, and predictive control across production and supply chains. This comprehensive digital transformation promises higher safety, freshness, and reliability of juice products, meeting the evolving expectations of modern health-conscious consumers.

Keywords: biosensors, blockchain systems, pulsed electric fields, high-pressure processing, fruit and vegetable juices.

AI-Driven Optimization for Enhanced 4-aminobutyric acid Production Using Probiotic *Enterococcus durans*

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Gamma-aminobutyric acid (GABA) is a key inhibitory neurotransmitter in the human nervous system and is widely recognized for its health benefits, including stress reduction and relaxation effects. The present study focuses on optimizing GABA production using the probiotic bacterial strain *Enterococcus durans,* isolated from traditional fermented foods. Artificial Intelligence (AI) modeling through a Deep Neural Network (DNN) was employed as the primary optimization framework, with Response Surface Methodology (RSM) used for comparative evaluation. Five process variables, pH (6.5–8.5), incubation time (24–72 h), inoculation level (1–5 %), glutamic acid concentration (25–500 mg), and millet milk concentration (1–5 %), were systematically varied across sixty experimental trials. The DNN achieved strong predictive performance with a validation root-mean-square error (RMSE) of 6.50 mg GABA g^{-1}, identifying optimal conditions for a maximum yield of 18.38 mg GABA g^{-1} at pH 6.5, 72 h incubation, 5 % inoculum, 33.5 mg glutamic acid, and 0.2 % millet milk supplemented with sunflower (0.2 %) and peanut (0.1%) extracts. Further product development included the replacement of synthetic media with soy extract yielded similar GABA levels, confirming the effectiveness of natural, cost-friendly substrates. The results suggest that soy-based probiotic beverages could serve as a promising functional food with added health benefits. To our knowledge, this is the first study applying a DNN-based optimization framework for GABA-enriched product development using soy substrates. The combination of natural ingredients, traditional fermentation, and AI-based optimization offers a scalable model for producing affordable, health-promoting functional beverages suitable for the nutraceutical industry.

Advances in Dairy Quality Assurance through Machine Learning: Current Trends and Applications

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Machine learning (ML) has become central to dairy-quality control, enabling rapid, non-destructive, and near-real-time estimation of parameters such as fat, protein, lactose, and solids. ML techniques are also used for detecting adulterants (water, urea, melamine, starch), predicting spoilage and shelf life, and identifying process anomalies during pasteurization and fermentation. These systems, integrated with spectroscopy, hyperspectral imaging, sensor arrays, and industrial process sensors, significantly improve accuracy and efficiency in maintaining dairy quality standards. Recent literature from major publishers (2018-2025) focuses on various ML algorithms, including regression, kernel methods, ensemble learners, clustering, and anomaly detection, paired with advanced sensing technologies. The review summarizes data sources, preprocessing steps, validation strategies, and performance metrics. Ongoing challenges include the need for standardized open datasets, consistent validation practices, and effective model transferability across different laboratories and settings. ML models like PLSR, PCR, SVM, and Random Forest have demonstrated near-laboratory accuracy for composition prediction, with some models achieving over 92% accuracy. However, barriers such as dataset diversity, validation inconsistency, and limited cross-site testing hinder broader deployment. Future research should focus on developing multi-site spectral libraries, transfer learning methods, multimodal data fusion, explainability, and edge deployment strategies to enhance robustness, regulatory validation, and real-time industrial application.

Keywords: Machine learning, Dairy quality control, Spectroscopy, Adulteration detection, Shelf-life prediction.

Mass modelling of papaya seeds using regression models

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Papaya seed are the potential source of valuable proteins and fats and is a rich source of different bioactive compounds like phenolic acid, flavonoids, vitamin C and possess high antioxidant property. Physical properties of papaya seed are very important for designing the different equipment used for performing various unit operation of the seed. Among the different physical properties, the dimensions, volume, mass and projected area are most important one for designing the grading system for seeds. Grading is one of the most important parameters for quality assessment of seed. However, grading for the small seeds like papaya seed is complicated process as the seeds are relatively smaller in size and have a uniform character, with different mass, thus for papaya seeds, grading on the basis of mass is the most proper technique for grading and will be the beneficial for the designing the grading equipment for papaya seed. Thus the analysis of a correlation between physical properties and mass of papaya seed need to analysed for an effective processing and handling of papaya seed. Mass of papaya seeds were used in the development of regression models. The dimensional characteristics of the seeds were used in regression modelling. The different mass prediction models based on the dimensional properties and projected area were used. The performance was evaluated on the basis of higher correlation coefficients (R2) and lower root mean square error (RMSE) value. Among the different dimension based models S-curve model based on volume outperformed all other models in the predicting the mass of papaya seed and among the different models developed using projected areas, the S-curve model based on projected area perpendicular to thickness outperformed all other model in the predicting the mass of papaya seed.

A Finite Element Insight into Coupled Moisture Diffusion and Lipid Absorption Dynamics in Atmospheric Deep-Fat Frying of Indian Traditional Kofta

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The increasing demand for convenient, nutritionally enhanced, and lower-oil traditional foods has driven the development of optimized ready-to-use (RTU) mixes that provide consistent product quality. In this context, the present study aims to optimize the proportion of banana flour and chickpea flour for the formulation of an RTU kofta dry composite mix using a statistical optimization approach. A two-dimensional axisymmetric finite element method (FEM) model was developed to simulate atmospheric deep-fat frying of kofta at defined thermal conditions using COMSOL Multiphysics 6.0. The simulation captured the expected thermal gradients, showing rapid heating at the surface and progressive temperature rise toward the core. Moisture loss and oil uptake patterns followed typical frying behavior, with pronounced changes at the surface and minimal variations in the internal crumb region. The optimized formulation yielded kofta with reduced surface oil content and sensory attributes comparable to the control. Model validation was performed using experimental observations and a suite of statistical parameters, confirming strong agreement between predicted and measured heat-mass transfer behavior. The study highlights the potential of FEM as a reliable tool for understanding frying dynamics and guiding formulation improvements. Future work may extend model applicability to diverse product geometries, explore oil-reduction strategies, and evaluate alternative frying technologies at pilot or industrial scale.
Keywords: Atmospheric deep fat frying, Composite mix, COMSOL Multiphysics, Heat and mass transfer, Microstructure

Kinetic modelling of PPO inactivation in sugarcane billets subjected to ohmic and thermal blanching

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Sugarcane juice is recognized as a nutritionally rich concoction; however, its accelerated deterioration driven by enzymatic, microbial, and oxidative pathways significantly restricts its commercial exploitation. The objective of this study was to compare the effectiveness of thermal (TB), and ohmic blanching (OB) of sugarcane billets on the polyphenol (PPO) enzyme inactivation kinetics of sugarcane billets. Time–temperature regimes of 70, 80, and 90°C for 0–18 min were applied to each blanching modality. The results showed that out of four mathematical models employed to describe the inactivation kinetics of PPO in sugarcane billets, the weibull model was found best in both the blanching treatments (R2 ≥0.994). The efficiency of OB was found to be evident as the residual activity of PPO was drastically diminished below 10% at 80°C for 15 min whereas in TB it was obtained at 90°C for 15 min. Nevertheless, as the temperature rose to 90°C, OB showed a notable 10% decrease in residual activity in just 9 minutes, while TB took 15 min. The activation energy of PPO inactivation was 37.29 and 38.49 KJ/mole in TB and OB treatment. A diminution in the D, Z and T1/2 values became apparent in both the blanching treatments, with maximum decline in OB as the temperature ascended. The findings demonstrate the potential of ohmic blanching as an effective pre-treatment for enhancing sugarcane juice shelf life by targeting enzymatic browning pathways. Observed residual activity of PPO below 10% indicated ohmic blanching at 90°C for 9 min as the optimal treatment condition.

Keywords: Sugarcane; blanching; ohmic; polyphenol oxidase; enzyme kinetics

Predicting Growth and Instability in rice production in Odisha Using Regression Techniques

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In this communication, we develop and evaluates statistical models to predict the production of rice crop in Odisha using meteorological data. We collected data of those attributes which has been played pivotal role in increasing the production of rice crop and those attributes are Gross area under irrigation in Odisha rice, Fertilizer consumption in Odisha, rainfall and crop wise yield of Rice in Odisha from year 2000 to the year 2023. We will fitted data with multiple linear regression model (MLR) and multiple non-linear regression model (MNLR) and compared with their predictive performance using R2 values. Also, we will plot observed and predicted plots, the higher value of R2 indicates the best fit model which improves yield forecasts.

Keywords: Production of rice crop, Meteorological data, Multiple linear regression model, Multiple non-linear regression model.

Digital Twin - Enabled Smart Food Systems: Enhancing Quality, Safety and Sustainability

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The escalating global demand for secure, efficient, and sustainable food systems, driven by mounting environmental challenges and socio-economic pressures, has accelerated the integration of advanced digital technologies into agri-food value chains. Among these innovations, the digital twin (DT) paradigm has emerged as a transformative enabler of smart food systems, providing real-time, data-driven synchronization between physical processes and their virtual counterparts. This article explores the rapidly evolving landscape of DT-enabled food systems, emphasizing their role in enhancing quality assurance, food safety, and sustainability. Conceptualized as cyber-physical constructs, these virtual replicas integrate heterogeneous data streams such as sensor-derived process variables, multi-omics datasets, and enterprise-level production metrics into dynamic environments capable of simulating and optimizing complex scenarios. Demonstrations in food processing plants illustrate how this approach, when coupled with agent-based simulations and advanced optimization algorithms, markedly improves operational efficiency, resource utilization, and predictive maintenance. In food biotechnology and alternative protein production, digital twin technology leverages AI-driven multi-omics integration to simulate metabolic behaviours and optimize bioprocesses, thereby advancing the nutritional and functional attributes of novel food products. Within food supply chains, these systems enable end-to-end transparency, proactive disruption management, and precision logistics, fostering resilience and sustainability. From intelligent production scheduling in ingredient manufacturing to real-time spoilage prediction and waste minimization in cold-chain logistics, the paradigm demonstrates cross-cutting benefits across the food sector. The discussion highlights adoption hurdles including data interoperability, model fidelity, and infrastructure readiness, while proposing pathways for scalable implementation that advance the transition toward future-proof food systems.

Keywords: Digital Twin, Smart Food Systems, Food Safety, AI-Integration, Sustainable Supply Chains, Quality Assurance

Rapid On-Site Authentication of Milk: Species-Specific Detection Approaches

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India is the world's largest milk producer, and its dairy sector relies extensively on cow and buffalo milk, each serving distinct consumer segments. Preferences for these milks vary across regions and are strongly shaped by religious beliefs, nutritional perceptions, and digestive considerations. Many consumers make deliberate choices between cow and buffalo milk based on perceived health benefits and cultural values, creating two well-defined market categories. However, for dairy processors that market these milks separately, maintaining species purity is a major challenge, as farmers often mix milk from different species during procurement. Ensuring authenticity and preventing such adulteration are therefore essential for preserving consumer confidence. The growing consumer awareness of milk quality and authenticity has intensified the need for reliable, rapid species identification methods within the Indian dairy supply chain. Conventional analytical techniques, such as Polymerase chain reaction (PCR/qPCR), Capillary electrophoresis, and Fourier-Transform mid-infrared (FT-MIR) spectroscopy, rely on species-specific protein and molecular markers like β-casein variants and Immunoglobulin G (IgG). Although these laboratory-based assays provide high accuracy, they demand sophisticated instrumentation and technical expertise, limiting their feasibility at milk collection centers. To address this limitation, research is advancing toward the development of rapid, field-deployable detection kits that can differentiate cow and buffalo milk within few minutes. Techniques such as lateral flow immunoassays and biosensor-based systems are being optimized for on-site application. These portable detection tools hold strong potential to enhance quality assurance, detect adulteration, and reinforce consumer trust in India's dairy value chain.

Keywords: Milk Authentication, Species-specific Milk, β-Casein Variants, IgG Proteins, PCR & qPCR Methods, Capillary Electrophoresis, FT-MIR Spectroscopy, Rapid Detection Kits

Physics-informed inverse modelling framework for particle scale coefficient approximation of pea protein isolate

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Precise measurement of the particle interaction coefficients is a crucial task to enable the rapid prediction of flow dynamics, particle contact dynamics, and energy dissipation in a multi-powder food particulate system. However, experimental measurement of these coefficients (such as the coefficient of static friction, the coefficient of rolling friction, and the restitution coefficient) at the particle scale, considering both particle-particle and particle-wall interactions, is quite complex. To overcome this challenge, an inverse modeling framework integrating the discrete element method (DEM) and multilayer perceptron neural network (MLPNN) was developed for the parametric approximation of pea protein isolate powders. Furthermore, data mapping (such as angle of repose, shear angle, and mass ratio) was implemented using a drawdown test at a specified range of coefficients within the DEM model. Based on the mapped data, the MLPNN model was iteratively trained until it achieved less than 1% error for accurately predicting outcomes to define the particle-scale coefficients. The model was further validated using experimental data to accurately replicate the true set of coefficient parameters. Results indicate that the inverse model can precisely capture the coefficients, with errors in deviation between experimental and simulated parameters less than 1%. The proposed inverse integrated model can precisely calibrate interaction coefficients under distinct conditions and is helpful to establish multi-scale properties in food component simulations, supporting digital twin integration for real-time powder processing systems.

Keywords: Discrete element method; machine learning; particle coefficient; Particle scale modelling; Value approximation.

Modelling and Analysis of Drying Kinetics of Radish Microgreens Using a Fluidised Bed Dryer

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Microgreens are young, tender seedlings harvested shortly after germination when the first true leaves emerge. Owing to their high nutritional value and visual appeal, they have gained substantial consumer interest; however, their high moisture content renders them highly perishable with limited shelf life. Efficient drying methods are therefore essential to extend their stability while retaining quality. In this study, the drying kinetics of radish microgreens were investigated using a fluidised bed dryer at three temperatures (40°C, 45°C, and 50°C). Five thin-layer models—Newton, Lewis, Page, Henderson and Pabis, and Two-term—were applied to the experimental data to describe the drying behaviour, and their performance was statistically evaluated using R^2, χ^2, and RMSE criteria. Results indicated that the moisture ratio (MR) and drying rate (DR) decreased rapidly at the initial stages of drying and gradually approached equilibrium toward the end. Among the tested models, the Page model best represented the experimental drying kinetics at 45°C with $R^2 = 0.987$ and RMSE = 0.01479. To enhance predictive capability beyond empirical models, an Artificial Neural Network (ANN) was also developed to estimate MR as a function of time and temperature. The ANN model (one hidden layer with 15 neurons) achieved a high predictive accuracy with $R^2 = 0.9982$ and RMSE = 0.00984, demonstrating superior performance over conventional models. Overall, the integration of empirical and ANN modelling provides a comprehensive understanding of the drying kinetics of radish microgreens in a fluidised bed system. The findings can guide process optimisation to achieve higher drying efficiency while preserving nutritional and sensory quality.

Keywords: Microgreens, Shelf life, Fluidised bed dryer, Drying kinetics, Artificial neural network

Smart Vibration Sensing and Machine Learning for Non-Destructive Estimation of Tender Coconut Water Volume

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Accurate and rapid estimation of tender coconut water volume is essential for ensuring product quality, fair pricing, and efficient postharvest handling. In this study, a non-destructive and low-cost technique was developed using mechanical vibration sensing coupled with machine learning algorithms to estimate internal water volume without breaking the shell. The experimental setup consisted of an ATmega328P microcontroller integrated with piezoelectric sensors that recorded vibrational responses generated by controlled tapping at different shell orientations. Extracted features such as vibrational attenuation, resonance amplitude, and energy decay were correlated with actual measured water volumes ranging from 0 to 210 mL. Two predictive models—Support Vector Regression (SVR) and Random Forest (RF)—were employed to evaluate the accuracy of water volume estimation. Among these, the RF model exhibited superior predictive performance with an R^2 of 0.97 and mean squared error (MSE) of 47.3, while SVR achieved an R^2 of 0.92 and MSE of 130.4. The robustness and ensemble nature of the RF algorithm provided higher generalization across varied knocking positions. The developed approach demonstrates the feasibility of using vibration response analysis for contact-free volume estimation and can be integrated into automated grading systems or IoT-enabled quality monitoring frameworks. This advancement presents a practical solution for sustainable and data-driven management in the coconut processing industry.

Keywords: Tender coconut water, Mechanical vibration, Non-destructive testing, Support Vector Regression, Random Forest, Machine learning, Postharvest quality.

Internet of Things (IoT)-based Storage Parameter Studies for Tomatoes

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Tomatoes are highly perishable commodities that deteriorate quickly due to microbial activity, enzymatic reactions, and environmental fluctuations. In developing regions, post-harvest losses reach 20–50 percent, mainly from poor storage management and inadequate control of temperature and humidity. To mitigate these losses, an Internet of Things (IoT)-based storage studies system was conducted to enable real-time tracking, automated alerts, and intelligent monitoring of critical environmental parameters. Initial trials employed a one-cubic-foot ($1' \times 1' \times 1'$) chamber, while the current phase expands to an eight-cubic-foot ($2' \times 2' \times 2'$) chamber to simulate practical storage conditions. Tomato respiration, ripening, and shelf-life were also investigated under anaerobic environments. The system integrates DHT22 sensors for temperature and humidity measurement and an MQ135 gas sensor for detecting spoilage-related gases. Data acquisition is managed by an Arduino microcontroller with an ESP8266 Wi-Fi module, which transmits data to the ThingSpeak cloud for visualization, alerts, and ripening-stage estimation. Despite calibration and setup challenges, the system provides a scalable, cost-effective approach to tomato storage management, enhancing quality control, reducing losses, and supporting global efforts to minimize food waste.

Keywords: Internet of Things (IoT), Tomato, DHT22, MQ135, Arduino, ThingSpeak, anaerobic conditions,

Internet of Things (IoT)-Based Smart Chamber for Respiration Rate Assessment of Fresh Capsicum

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A Smart Internet of Things (IoT)-based airtight chamber was developed for real-time monitoring and assessment of the respiration rate of fresh capsicum under ambient environmental conditions. The system integrates Arduino Nano 33 IoT and ESP32 microcontroller boards with a DHT22 temperature–humidity sensor, an O2 sensor (SEN0322), and a CO2 sensor (SEN0220) to continuously measure variations in gaseous composition, temperature, and relative humidity inside the chamber. The acquired data are transmitted to the ThingSpeak cloud platform for real-time visualization, analysis, and storage. The respiration rate of capsicum was determined using mass balance equations derived from the rate of O_2 depletion and CO_2 evolution within the closed system. The calculated respiratory quotient (RQ) ranged from 0.9 to 1.0, indicating balanced gas exchange. Proper sensor calibration and stabilization procedures ensured high measurement accuracy and system reliability. The developed IoT-based chamber exhibited stable performance and precision in quantifying the respiration dynamics of fresh capsicum. This smart system provides a scientific basis for optimizing postharvest handling and designing suitable Modified Atmosphere Packaging (MAP) systems. Furthermore, the IoT-based system offers scalability and real-time data accessibility, supporting enhanced postharvest management and reduction of quality and storage losses across the fresh produce supply chain.

Keywords: Internet of Things (IoT), respiration rate, respiratory quotient (RQ), capsicum, smart chamber, postharvest management.

Design and Validation of a Smart Biosensor Algorithm for Real-Time Detection of Chicken Meat Spoilage

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Chicken spoilage is a critical issue in the food industry, leading to significant economic losses and food safety concerns. Conventional detection techniques such as microbial culture, GC-MS, and sensory evaluation are time-consuming, destructive, and require skilled personnel. This study aimed to develop a predictive algorithm for rapid, non-invasive detection of chicken spoilage by correlating microbial load with volatile organic compound (VOC) emissions using Arduino-based gas sensors. A biosensor box was designed incorporating MQ-135 (H_2S sensor), MQ-137 (NH_3 sensor), and DHT11 (temperature and humidity sensor) connected to an Arduino Nano microcontroller and LCD display for real-time monitoring. Chicken samples—raw, marinated, frozen, and ready-to-cook—were analyzed over 72 hours for microbial load (TPC), gas emissions, and sensory attributes. Results indicated a strong positive correlation between increasing NH_3 and H_2S concentrations and microbial counts during spoilage progression. Statistical regression confirmed that VOC concentrations could reliably predict spoilage levels, forming the basis for the algorithm's predictive model. The developed system demonstrated high accuracy and reproducibility, providing a cost-effective, portable, and rapid method for real-time spoilage detection. This approach holds promising applications in poultry supply chains, retail storage, and smart packaging systems, contributing to food safety assurance and waste reduction.

Keywords: Chicken spoilage detection, Volatile organic compounds (VOCs), Biosensor system, Arduino-based predictive model, Microbial load correlation

Photonic Crystal Fiber Based Biosensor for Adulteration Detection in Liquid Based Food Products: A Review

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This review paper provides an in-depth overview of photonic crystal fibre (PCF)-based SPR biosensors used to detect adulteration in liquid-based food goods. The introduction of plasmonic nanostructures in PCF-based SPR is a great approach to design a compact and highly sensitive biosensor. The article explores the impact of nanoparticle parametric variations on the sensor performances. Currently, nanoparticle based SPR biosensors show great potential to detect a very small variation in refractive index. The study provides the fundamental principles of PCF sensors, design, fabrication, simulation, and application of nanoparticles in PCF biosensors.

Keywords: Plasmonic Nanoparticles, Photonic Crystal Fiber, Refractive Index, Surface Plasmon Resonance.

Smart MXene Nanosensors: A Promising Approach for Safe and Sustainable Food Monitoring

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Ensuring the safety and quality of fruits and vegetables is a major global concern due to the increasing use of pesticides, preservatives, and industrial pollutants. Conventional detection methods are often time-consuming, costly, and require sophisticated instrumentation. In this context, MXenes a novel class of two-dimensional transition metal carbides and nitrides have emerged as next-generation sensing materials owing to their excellent electrical conductivity, hydrophilicity, large surface area, and tunable surface functionalities. The proposed research aims to design and develop MXene-based nanocomposite sensors for the rapid and sensitive detection of toxic chemicals in food matrices. By integrating MXenes with suitable polymers or metal oxides, the selectivity, stability, and sensitivity of the sensing platform can be significantly enhanced. These smart nanosensors are envisioned to enable real-time, non-destructive, and environmentally sustainable monitoring of contaminants such as pesticides and heavy metals in agricultural produce. The expected outcomes will contribute to the advancement of smart, portable sensing technologies for ensuring food safety, quality assurance, and consumer health in modern agri-food systems.

Keywords: MXene nanocomposites, food safety, toxic chemical detection, nanosensors, sustainable monitoring, transducers

Influence of Pressurized Ohmic Heating (OHPC) on the Cooking Behaviour and Rheology Properties of Rice- A Mechanistic Insight

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Rice is the most widely consumed cereal and a staple food globally. Brown rice is typically cooked using conventional methods. These methods influence grain quality attributes, including texture and color, but are energy-intensive due to multi-step heat transfer through conduction and convection. Prolonged cooking times not only reduce energy efficiency but also contribute to nutrient loss. In contrast, emerging volumetric heating techniques, such as ohmic heating, provide significant advantages by reducing cooking time and improving energy efficiency. The objective of this work is to study cooking behaviour (electrical conductivity, energy consumption, and temperature profile) of rice in a developed ohmic heating pressure cooker (OHPC) and evaluate cooking quality by texture profile analysis and dynamic rheological testing. A developed OHPC setup was operated at different EFS (20, 30, and 40 V/cm) under 0.05 % salted water of rice-water mixture. Cooking temperature and pressure were 115°C and 0.9 kg/cm2, respectively, and a K-type thermocouple was used to measure temperature. A texture analyser and rheometer were used for coking quality evaluation of rice. The time required to reach 100 °C for salt-water mixture was 22, 6.5, 4, and 11 minutes for 20, 30, 40, and 0 V/cm, respectively, and their energy consumption was 0.021, 0.031, 0.042, and 0.0732 kWh, respectively. This shows that energy consumption in conventional cooking is 136 % higher than the OHPC cooking method. The heating rate was significantly improved with EFS, which led to a decrease in cooking time. The consistency coefficient (K*) and loss tangent (tan ı) from a dynamic frequency sweep were used to compare with the hardness and stickiness tested by TPA.
Keywords: Rice cooking, ohmic heating, Rheology, Texture

Influence of moisture content on engineering properties of kodo millet with and without husk

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Growing demand for gluten free, low glycemic index and climate resilient crops leads to increase in production of millets which were known as underutilized but nutrients –rich cereals. Among millets Kodo millet is high drought resistance, rich in nutrients and bioactive compounds. Physical properties of grains play role in quality assessment, processing and equipment design. A study was conducted to determine the physical properties of two commonly grown varieties of kodo millet grains with and without husk in the moisture content range 15.45-25.8% db along with regression equation and coefficient of determination. Comparison between the two varieties (ALT-1 and TNS-86) with and without husk was also conducted. The mean values of physical properties such as length, width, thickness, sphericity, surface area, volume, true density, porosity, 1000 grains mass, static angle of repose and dynamic angle of repose increased with increase in moisture content. No significant impact of addition of moisture on sphericity of grains with husk was observed and bulk density decreased with increase in moisture. The grains with husk have high mean values of geometric properties than grains without husk. However, bulk density, true density and static angle of repose was higher in case of grains without husk than grains with husk. Between the millet variety, grains of ALT-1 variety have slightly high mean values of physical properties than TNS-86 variety.
Keywords: Kodo millet, husk, gluten free, cereal, engineering property

Correlating Microstructural and Textural Changes with Sensory Quality of Tapioca Chips Prepared by Frying, Air-Frying and Baking

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This study investigates the effect of different processing methods, particularly frying, air-frying, and baking on the development of healthier snack foods. The focus lies in examining the sensory, structural, and physical attributes of chips formulated from a blend of flours. Traditional frying is well known for producing desirable flavor and texture; however, it results in excessive oil absorption, making the product less suitable for health-conscious consumers. In contrast, baked or air-fried products contain less fat but often fail to fully replicate the sensory qualities of fried chips, limiting their popularity. To address this, the study aims to establish correlations between microstructure, texture, and oil content while preserving sensory appeal. Field emission scanning electron microscopy (FESEM) revealed that fried chips exhibited a dense microstructure with pore development, leading to higher hardness, brittleness, and stiffness. Air-fried chips, on the other hand, demonstrated reduced oil absorption and improved nutritional quality, including higher protein and fiber content. The results highlight the critical role of the processing medium in determining internal structure, oil distribution, and textural performance. Among the methods compared, air-frying emerged as the most suitable alternative, producing chips with reduced oil content while maintaining flavor and texture characteristics close to those of conventionally fried products.
Keywords: Healthy snack, lower oil absorption, crispy, air-fried chips

Green Extraction Technologies *for Clitoria ternatea Flowers:* A Su*stainable* Approach to Maximizing Phytochemical Yield

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Clitoria ternatea L., commonly known as butterfly pea, is a valuable botanical source of anthocyanins, flavonoids, and polyphenols with recognized antioxidant and nutraceutical properties. The increasing demand for natural colorants and bioactive extracts has prompted a shift from conventional solvent-based extractions to greener and more sustainable techniques. This review compiles and analyzes research published between 2020 and 2025, focusing on eco-efficient extraction approaches for *C. ternatea* flowers. Comparative evaluations reveal the superior performance of ultrasound-assisted extraction (UAE), low-vacuum plasma (LVP), microwave-assisted extraction (MAE), and natural deep eutectic solvent (NADES) systems in enhancing total phenolic content (TPC) and total anthocyanin content (TAC) while reducing solvent and energy requirements. Among these, response surface methodology (RSM)-optimized UAE and plasma-assisted methods achieved up to 57% higher yields than conventional reflux or Soxhlet extractions. Ethanol–water mixtures and choline chloride-based NADES proved particularly effective in preserving pigment stability and bioactivity. Mechanistic analyses indicate that non-thermal physical processes, such as ultrasonic cavitation and plasma-induced microetching, improve cell wall disruption and mass transfer efficiency. These sustainable extraction strategies highlight *C. ternatea* as a promising model for developing scalable, eco-friendly bioprocesses applicable in food, cosmetic, and packaging industries.
Keywords: *Clitoria ternatea*, green extraction, ultrasound-assisted extraction, plasma-assisted extraction, anthocyanins, sustainable bioprocessing

Electrical Properties of Jaggery as a Function of Moisture Content: Implications for Quality Control and Shelf-Life Augmentation

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Jaggery, an uncentrifuged sugar product rich in essential minerals and bioactive compounds, represents a healthier alternative to refined sugar; however, its hygroscopic behaviour significantly compromises product quality and shelf life through moisture absorption and subsequent microbial degradation. The internal moisture content is the critical quality attribute governing its stability, yet the conventional hot air oven method for moisture determination is time-consuming and unsuitable for real-time industrial monitoring. This study addresses the need for a rapid, non-destructive quality assessment technique by examining the relationship between the physicochemical properties of solid jaggery and its electrical characteristics as a function of varying moisture levels. Plain and iron-fortified jaggery samples were analysed using a custom-designed setup to measure electrical conductivity (σ), resistivity (ρ), resistance (R), and conductance (G) across a moisture range of 4.5%–7.58%. The results revealed a complex but consistent relationship between moisture and electrical properties, providing a basis for indirect moisture estimation. Electrical resistance and resistivity generally increased with higher moisture content, attributed to the insulating effect of entrapped air pores. In contrast, conductivity and conductance decreased until 6.67% moisture, beyond which conductivity exhibited an unexpected rise. Additionally, the study established a direct correlation between current flow and temperature elevation in the jaggery matrix, highlighting the influence of ionic resistance and moisture-filled pores on heat dissipation an important aspect for ohmic heating applications. These findings lay a crucial foundation for developing an electrical resistivity based, real-time moisture measurement system, facilitating improved process control and enhanced shelf-life management of solid jaggery.

Keywords: Jaggery, Electrical conductivity, Resistivity, Non-destructive testing, Ohmic heating

Techno-Economic Evaluation of Rice Straw Conversion into Sustainable Packaging: A Viable Solution to Stubble Burning

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Open-field burning of rice straw in paddy-producing countries poses a significant environmental challenge, contributing substantially to greenhouse gas emissions and particulate pollution. The present study focuses on a sustainable alternative by converting rice straw into cellulose nano fiber (CNF)-based packaging materials with improved strength and barrier properties. Rice straw was delignified using an optimized organosolv pulping and DED (D: chlorine dioxide bleaching; E: sodium hydroxide extraction) bleaching process, followed by mechanical refining by Valley beater to produce CNFs. The resulting paper was surface sized with alkyl ketene dimer (AKD) wax to enhance hydrophobicity and water resistance. The CNF sheets exhibited a 2.6-fold increase in tensile index and a 3.8-fold increase in burst index compared to less refined pulp. At the same time, the water vapour transmission rate (WVTR) and Cobb values decreased significantly after AKD surface treatment. These improvements confirm the development of cellulose nanopaper with superior mechanical strength, reduced permeability, and enhanced oil- and grease-resistance, suitable for food packaging applications. A techno-economic analysis confirmed that producing rice straw-derived cellulose nano paper is technically feasible and financially viable for small-scale operations. The total production cost was estimated at ₹234.48/kg with a selling price of ₹260/kg, yielding an annual profit of ₹11.48 million and a payback period of 2.61 years for a total investment of ₹30 million. Sensitivity analysis identified solvent recovery and raw material costs as key economic drivers. Overall, this study demonstrates that rice straw-derived CNF nanopaper is an economically viable and sustainable packaging solution that supports circular bioeconomy development and reduces environmental pollution.

Keywords: Rice straw, Cellulose nanofibers, Sustainable packaging, Techno-economic analysis, Circular bioeconomy

Phytonanosynthesised Nanoparticles Impact Virulence and Biofilm Forming Properties of *Listeria monocytogenes*

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Listeria monocytogenes is present in the environment and persists in food processing areas for long periods in harsh environments, resulting in the development of biofilms on abiotic surfaces. The presence of *Listeria* in facilities frequently causes contamination of food products and leads to potential threats to human health. Our study aimed to counter *Listeria monocytogenes* growth using phyto-synthesised magnesium oxide nanoparticles (G-MgO NPs). The nanoparticles were characterised, and their antimicrobial activity and minimum inhibitory concentration were determined against *Listeria monocytogenes* cells. The application of G-MgO NPs at MIC and sub-MIC was used to analyse the antivirulence property using a haemolysis assay and phospholipase activity. The biofilm-forming ability of *Listeria* with nanoparticles was determined using a crystal violet assay, motility, and EPS production.

The nanoparticles were green synthesised, and FE-SEM evaluated the size of 37 nm with spherical shapes. The minimum inhibitory concentration (MIC) of G-MgO NPs ranged from 3 mg/mL to 6 mg/mL for Listeria monocytogenes strains in BHI medium. The group treated with the synthesised nanoparticles showed a 50% reduction in haemolysis virulence in *Listeria* strains compared to the untreated control group. Phospholipase C lecithinase activity was not observed in the egg yolk agar medium treated with G-MgO NPs. The *Listeria* strains showed significantly less biofilm development at MIC after 48 h compared to the control group. Exopolysaccharide products were reduced by 19 %, and motility showed a 50% reduction at 25ºC for 48 hours. Further, gene expression analysis showed that MIC concentrations of nanoparticles significantly downregulated the expression of virulence (*prfA, hly*, *plcA*, and *plcB*) and quorum sensing genes (*agrA*, *agrC*, and *agrD*). This study presents a low-cost nanoparticle synthesis method and its ability to counter *Listeria* virulence and biofilm-forming ability.

Keywords: Green Synthesis, Magnesium oxide nanoparticles, *Listeria monocytogenes*, Antivirulent, Antibiofilm, Ant quorum

Nanomaterial-Based Colorimetric Sensor for Fructose Detection in Food Products

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Fructose (C6H12O6), a natural monosaccharide commonly present in many food products like, fruits, honey, and sweetened beverages, etc. Detection of fructose level in food supply chain would be helpful in the quality, product design, regulatory compliance, nutritional labelling. This research reports a low cost, selective and colorimetric rapid fructose sensor using gold nanoparticles (AuNPs). AuNPs were synthesized via chemical reduction method and conducted different characterization studies like UV-Vis absorption ($\lambda max \approx 520$ nm), DLS (average size ≈ 72.3 nm), zeta potential (−40.5 mV), XRD (max. intensity observed at $2\theta=32^{\circ}$), TEM, and FTIR analysis for properties optimization. The binding mechanism explained that AuNPs were functionalized with 3-aminophenylboronic acid (3-APBA) through amine linkage, leaving boronic acid groups that selectively bind with fructose cis-diol at the C-2 and C-3 positions. This interaction induced nanoparticle aggregation, confirmed by red shift of UV-Vis absorption peak from 520 to 656 nm without any incubation time, while no shift observed in the presence of interference compounds like glucose, maltose and sucrose. The fructose studied in the 0.1 to 10 mg/mL range taken for calibration graph resulted the LOD=1.59 mg/mL. The sensor reagent taken for estimation of fructose in commercial honey, juice samples and results were validated with high-performance liquid chromatography (HPLC). The good recovery rate of 81%, 110% and 137% with fructose content of 0.8807 mg/mL, 2.4084 mg/mL, and 0.8267 mg/mL in honey, Juice 1, Juice 2 respectively confirming the sensor has good selectivity. Therefore, the developed sensor may find potential applications in food industries, commercial onsite testing and R&D sectors as a rapid detection kit.

Keywords: Gold NPs, Fructose, 3-APBA, colorimetric sensor, Selectivity, rapid detection

Isolation, characterization, and utilization of Tardi (Dioscorea bellophylla) starch in the development of antimicrobial films incorporated with silver nanoparticle

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Nanoparticles incorporated starch-based films have emerged as a promising and versatile class of coating materials with a wide range of applications across various food industries. In addition, the incorporation of nanoparticles imparts inherent antimicrobial properties to the films, rendering them effective in combating pathogens and maintaining hygiene in critical environments. Thus, this study aimed to develop varying proportions (0.5%, 1%, 1.5%, and 2.0%) of silver nanoparticles (AgNPs) incorporated Tardi (*D. bellophylla*) starch-based films using casting method and to evaluate their physicochemical, mechanical, morphological, and thermal properties. Results showed that the presence of AgNPs in the Tardi starch films significantly affected the film properties. Scanning electron micrographs (SEM) analyses and structural changes are shown by FTIR, which results in a slight shift of peaks due to AgNPs. In case of colour parameters, the controlled formulation films were colourless, whereas the nanoparticles incorporated films showed off white tint. The transparency of films was significantly ($p \leq 0.05$) decreased with the addition of AgNPs. Water vapour permeability and solubility decreased, and tensile strength increased as AgNPs concentration increased. Further, the films showed significant antimicrobial activity against selected gram-positive bacteria. The study thus reflects that this enhanced quality of film may find the application as coating material for fruit, vegetable in enhancing the shelf life.

Keywords: Tardi starch, silver nanoparticle, films, AgNPs concentration, food coating, antimicrobial properties.

Towards Safer Wheat-Based Foods: Exploring Genetic Variation in Precursors of Acrylamide Formation in Wheat

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Acrylamide is a heat-induced contaminant in carbohydrate-rich foods, formed during high-temperature processing and known for its neurotoxic, genotoxic, and potential carcinogenic effects. It is primarily formed through the Maillard reaction between free asparagine (the principal precursor) and reducing sugars during thermal processing. Asparagine plays a crucial role in nitrogen metabolism and acts as a major nitrogen transport and storage molecule in plants; however, its excessive accumulation in grains poses a risk for acrylamide formation during food processing. The present study evaluated genetic variation in free asparagine, free amino acids, total soluble protein, and sugars such as total soluble sugars, reducing sugars, bound and free fructose, sucrose, glucose, and starch among Indian wheat genotypes, including landraces, durum, barley, and triticale. Significant variability was observed for precursor compounds, suggesting inherent genetic differences influencing acrylamide-forming potential. In a subsequent experiment, selected genotypes were grown under controlled nutrient conditions to study gene expression and enzyme activity related to asparagine formation during grain development. The outcomes are expected to aid in identifying wheat genotypes with reduced precursor accumulation and improved processing safety.

Keywords: Acrylamide, Asparagine, Maillard reaction, Genetic variation, Food safety.

Oriental Fermented Foods and Their Indian Counterparts: A Review

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Fermented foods have quietly shaped everyday diets across Asia, especially in India, for decades. They are not just about preserving ingredients or enhancing flavour, but they also carry stories of place, habit, and survival. “Oriental fermented foods” typically evoke miso, natto, kimchi, tempeh, or fish sauces, each rooted in history and regional logic. Yet, similar traditions flourish in India's Northeast, where culinary borders blur with Southeast Asia. Fermentation relies on local abundance, whether it be soybeans, fish, or bamboo shoots, and the methods differ from valley to valley. Axone (Nagaland) and Kinema (Sikkim) are both soybean ferments but with significantly different aromas and textures. In Manipur, Ngari and Tungtap, which are fermented fish pastes, lend depth to local curries, while bamboo shoot ferments like Khorisa and Mesu add a tangy sharpness that defines regional cooking. To outsiders these may smell strong, but they’re nutrient-dense staples imbued with meaning. Fermentation breaks down proteins and boosts vitamins, and some emerging research suggests that it may even improve gut health through naturally occurring probiotics in it. Remarkably, this process requires no formal technology; these foods simply happen to be guided by time, ambient temperature, and inherited intuition. Lactic acid bacteria, yeasts, and countless unnamed microbes do their quiet work. The same principle appears nationwide; for example, idli and dosa batters ferment overnight on kitchen counters, and rice brews like apong and chhang bubble in homes. As global curiosity grows around “functional foods”, these humble traditions deserve a closer look not just as quaint relics but as living examples of sustainable, low-tech innovation. Studying them will help us understand not only how food nourishes the body but also how culture preserves knowledge.

Keywords: Oriental fermented foods, traditional Indian foods, soybean fermentation, bamboo shoot fermentation, probiotics, microbial diversity, sustainable food practices, functional foods.

Kombucha: A Fermented Beverage with Probiotic Potential and Bioactive Properties

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Due to its distinctive sensory qualities and numerous health claims, kombucha—an ancient, slightly acidic, and fizzy fermented beverage—has seen a global comeback. Sweetened tea (Camellia sinensis) is fermented aerobically to create this functional beverage using a gelatinous matrix called a Symbiotic Culture of Bacteria and Yeast (SCOBY), or "tea fungus." Acetobacteraceae (e.g., Komagataeibacter xylinus) and several yeast species (e.g., Saccharomyces and Zygosaccharomyces) dominate the dynamic microbial consortium known as SCOBY, which collaborates to change the substrate. The low pH (around 3.5) and antibacterial action are caused by a variety of organic acids, particularly gluconic acid and acetic acid, which are important metabolic products. Additionally, the finished drink is enhanced with useful substances including ethanol, amino acids, B vitamins, and higher levels of bioavailable polyphenols and flavonoids, all of which contribute to strong antioxidant activity. Kombucha has been used in traditional and folk medicine to treat a variety of conditions, including rheumatism and digestive problems. Hepatoprotective, antidiabetic, hypocholesterolemic, and antibacterial activities have been demonstrated in recent scientific investigations, mostly in vitro and animal experiments, supporting several of these alleged therapeutic effects. Despite its intriguing functional potential, caution is required because to the absence of established production techniques, the considerable variability in microbial composition across batches, and the risk for contamination in home-brewed products. In addition to identifying crucial gaps in human clinical research that need to be filled for regulatory standardization and definitive health substantiation, this thorough review synthesizes the current scientific literature, clarifying the intricate microbial dynamics, the resulting bioactive composition, and the most recent evidence supporting kombucha's role as a functional food.

Keywords: kombucha, tea fungus, medicine, antimicrobial

Comparative Evaluation of Shelf Life and Physicochemical Stability of Kimchi Prepared from Indian and Napa Cabbage during Refrigerated Storage

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This study evaluated the shelf life and physicochemical stability of kimchi prepared from Indian and Napa cabbage varieties during refrigerated storage. Kimchi was prepared through spontaneous lactic acid fermentation for 24 hours at ambient conditions and subsequently stored under refrigeration (4 ± 1°C) in three types of packaging materials, glass jars, plastic containers, and earthen pots. Throughout storage, changes in pH, total soluble solids (TSS), moisture content, and color parameters were monitored at regular intervals to assess product quality and stability. The initial pH value of 5.0 gradually decreased to 4.0, indicating progressive lactic acid fermentation and acidification. TSS was recorded at 5°Brix for treated samples and 4°Brix for the control, while moisture content averaged 91%, showing minor fluctuations during storage. Color and sensory evaluations, conducted in triplicate, confirmed that the kimchi samples retained desirable visual appeal, texture, and characteristic flavour up to 45 days of refrigerated storage. Among packaging materials, glass jars demonstrated the best retention of quality attributes, followed by plastic containers and earthen pots. Overall, the study highlights the potential of Indian cabbage as a viable alternative to Napa cabbage for kimchi production and emphasizes the importance of packaging material selection in maintaining product quality and extending shelf life. These findings contribute to the optimization of fermentation-based vegetable preservation and offer insights for developing commercially viable, value-added fermented foods suited to Indian conditions.

Keywords: Kimchi, TSS, Lactic acid Fermentation, Napa Cabbage, Fermented Food

Study on the Extraction and Characterization of Okra Peduncle Polysaccharide Using Ultrasound-Assisted Technique

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The rapid increase in the demand for sustainable and biodegradable biopolymers has significantly increased the exploitation of underutilized plant sources and their use as renewable sources of functional polysaccharides. The current study focusses on the extraction of the polysaccharide from okra Peduncle and its characterization, an agricultural byproduct that is mostly discarded during the different processing operations. The water-soluble okra peduncle polysaccharides (OPP) obtained through the ultrasonic-assisted extraction (UAE) yielded 8.7 ± 0.4 % (w/w) light beige, odorless powder comprising of strong hydrophilic nature and bearing water holding capacity (WHC) of 3.8 ± 0.2 g H_2O g^{-1}. The antioxidant assays performed demonstrated a concentration dependent radical scavenging efficacy with an IC_{50} values of 1.42 mg/mL for DPPH, 1.26 mg/mL for ABTS and 1.63 mg/Ml for •OH, confirming the moderate electron donating and hydrogen transfer capability of OPP. Collectively, from these results it can be revealed that okra Peduncle as a novel antioxidant functional polysaccharide, supporting their potential use as value-added biopolymer.

Keywords: Sustainable, Polysaccharides, Antioxidants, Ultrasound-Assisted-extraction

Gut Health and Oriental fermented food – A scientific look into Eastern traditional marvels

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Oriental fermented foods like kimchi, miso, natto, Suan Cai, Dou Chi, and fermented rice products—represent a long-standing intersection of culinary practice and medicinal philosophy across East Asia. Contemporary gut-health research is beginning to validate many of these traditional insights. Several mechanistic pathways have now been documented, including probiotic action, enhancement of intestinal barrier integrity, and short-chain fatty acid (SCFA) production. Recent evidence shows that fermented foods modulate tight-junction proteins (occludin, claudin, ZO-1), reducing epithelial permeability and lowering pro-inflammatory cytokines such as TNF-α and IL-6, while increasing IL-10 and TGF-β. Suan Cai, rich in *Lactobacillus plantarum*, supports mucosal integrity, whereas Dou Chi, containing *Bacillus subtilis*, significantly increases microbial diversity. Additionally, fermented rice products such as Jiu Niang stimulate populations of *Bifidobacterium* and *Faecalibacterium*, both key taxa associated with improved gut barrier and reduced inflammatory tone. Clinical metabolic pathways are also reflected in SCFA profiles. Acetate supports lipid metabolism, propionate improves insulin sensitivity, and butyrate enhances colonocyte health and reduces colon-cancer risk. These findings align closely with traditional Chinese medicine views of fermented foods as agents that "strengthen the spleen," "resolve dampness," and improve digestion. Large-scale microbiome data, including analyses of 242 healthy adults, underscore the high baseline diversity of the human gut microbiome and highlight how fermented foods may further enrich beneficial taxa such as *Bacteroides* and *Firmicutes*. This poster topic integrates traditional perspectives with emerging molecular evidence, demonstrating how Oriental fermented foods influence gut microbial ecology, immune signalling, and metabolic regulation. Taken together, these findings present compelling scientific support for the longstanding Eastern practices that position fermented foods as daily functional foods for health optimization.

Keywords: Traditional fermented food, Gut Microbiota Modulation, Short-Chain Fatty Acids (SCFAs), Fermentation Metabolites.

Development and evaluation of fiber-enriched pasta using mechanically separated pea pod fractions

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Pasta is a globally appreciated food product, valued for its ease of preparation and sensory appeal. However, traditional pasta made from refined wheat flour is low in dietary fiber, which limits its nutritional benefits. Hence, enhancing pasta with natural fiber sources can offer both nutritional and functional benefits. The use of agro-industrial by-products like pea pods present an eco-friendly and cost-effective approach to fortify food while addressing sustainability. The present study was aimed to develop fiber-enriched pasta by gradual replacement of semolina (0-30%) with pea pod fiber which was mechanically separated from pea pods. Pea pod fibre incorporation significantly influenced the cooking properties. The water absorption index as well as gruel solid loss increased with increasing pea pod fiber level reaching maximum to 1.83 and 1.91% at 30% level, respectively. The cooking time was inversely proportional to pea pod fiber level. Color analysis revealed a noticeable shift in visual attributes with increased fiber. Protein content showed a gradual decline from 15.47% in the control to 13.84% in pasta with 30%, whereas ash content, indicative of mineral content, increased with fiber level. The TDF content of pasta samples increased significantly with the incorporation of pea pod fiber. The organoleptic evaluation of pasta samples indicated that the pea pod fibre could be incorporated in the formulation up to 15% level only having an overall acceptability score of 7.25. Therefore, it may be concluded that mechanically separated pea pod fiber fractions can be effectively to produce fibre rich enriched pasta with acceptable cooking characteristics, offering a sustainable and functional alternative for health-conscious consumers.

Designing Stable Butteroil-based Nanoemulsion for Functional Foods: Enhanced Stability and Controlled Release Study

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Nanoemulsion has emerged as a promising strategy to enhance the solubility, thermal stability, and bioaccessibility of lipophilic bioactive compounds in food systems. This study investigates the formulation of oil-in-water (O/W) nanoemulsions using butteroil (BO) as a hydrophobic carrier and whey protein concentrate (WPC-80) and maltodextrin (MD) as wall matrix. All the formulations were developed using the microfluidization technique by varying pressures (10,000–20,000 psi) and cycles (2–4 passes). The formulations were prepared with core-to-wall ratios of 1:1, 1:2, and 1:3, having a WPC-MD ratio of 1:1, 1:2 and 2:1. Among the tested formulations, 1:2 ratio of whey protein (WP) and maltodextrin (MD) conferred enhanced steric stabilization, attributed to the formation of a dense interfacial layer resulting in a higher encapsulation efficiency (89.34 ± 0.89 %). The most efficient nanoemulsion was achieved using a WP:MD:BO ratio of 1:2:1, processed at 20,000 psi across three cycles. This formulation exhibited the smallest particle size (206.33 ± 11.50 nm), narrow size distribution, and the lowest creaming index. Moreover, it remained structurally and functionally stable under various stress conditions, including acidic and alkaline pH, elevated salt concentrations, and thermal treatment. The optimized emulsion also demonstrated favourable release kinetics of the encapsulated agent. Therefore, the result supports the potential of WP-MD-BO matrix as a food-grade, biopolymer-based carrier system for the effective delivery of lipophilic bioactive compounds in functional foods.

Keywords: Butteroil; Functional Food; Microfluidization; Nano-emulsion

Innovation in Wheat Bran Modification: A Techno-Economic Analysis for the Development of Fiber-rich Food Products

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This study presents a comprehensive techno-economic analysis (TEA) evaluating the commercial viability of a novel wet refining process to valorize underutilized wheat bran into high-value functional food products. The analysis is based on a pilot-scale plant with a capacity of 10 kg/hr of raw wheat bran, designed to produce two distinct consumer goods: a savoury Ready-to-Use (RTU) powder and high-fiber cookies. The wet refining process found to significantly enhance the nutritional profile of the bran, increasing its total dietary fiber content from 41.63% to 70.22%. The financial model was developed for a 10-year operational lifetime, incorporating conservative, market-aligned assumptions. This includes wholesale-realized product prices of Rs. 220/kg for the RTU powder and Rs. 180/kg for the cookies, a phased market ramp-up achieving a steady-state utilization of 80%, and a detailed operational cost structure. The results indicate a total initial capital outlay of Rs. 1.68 Crore, inclusive of working capital. The base-case financial projections show the project is highly viable, with a payback period of approximately 3.19 years, an Internal Rate of Return (IRR) of 40.2%, and a Net Present Value (NPV) of Rs. 2.67 Crore at a 12% discount rate. A multi-variable sensitivity analysis confirms the project's financial resilience, demonstrating profitability even under pessimistic market conditions. The study concludes that the proposed venture is technically sound and financially robust, presenting a compelling investment opportunity. The critical path forward involves securing regulatory approval from the Food Safety and Standards Authority of India (FSSAI) for the modified bran as a novel food ingredient.

Keywords: Techno-Economic Analysis (TEA), Wheat Bran Valorization, Wet Refining, Functional Foods, Dietary Fiber.

Development of Functional Biscuit for the Prophylactic Management of Neurodegenerative diseases

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Neurodegenerative diseases (NDDs), including Alzheimer's disease, Parkinson's disease, and Huntington's disease, represent a major global health burden due to their progressive nature, limited treatment options, and rising prevalence among aging populations. Growing scientific evidence highlights the potential of functional foods rich in bioactive phytochemicals to modulate neurobiological pathways, offering preventive and therapeutic support. This study aimed to develop a functional biscuit formulation incorporating neuroprotective medicinal plants—*Mucuna pruriens* and *Zanthoxylum armatum*—along with nutritionally supportive ingredients to promote cognitive health and mitigate risk factors associated with NDDs. *Mucuna pruriens*, a natural source of L-Dopa and antioxidant compounds, and *Zanthoxylum armatum*, known for its flavonoids and anti-inflammatory properties, were extracted and incorporated into a nutrient-enriched biscuit matrix using roasted gram flour, casein protein, stevia, and natural emulsifiers. Extracts were prepared via hydroethanolic extraction and analyzed through HPLC to quantify L-Dopa and other phytochemicals. Proximate analysis, total phenolic content, antioxidant activity (DPPH assay), and mineral profiling were performed to evaluate nutritional and functional attributes. Hydroethanolic extracts of *Mucuna pruriens* quantified through HPLC confirmed the presence of L-Dopa at 0.858 mg/mL. The formulated biscuits exhibited high antioxidant potential, significant presence of neuroactive phytochemicals, and favorable nutritional properties, suggesting their utility as a functional dietary intervention for neuroprotection. The findings suggest that integrating traditional medicinal botanicals into modern food systems may provide safe, cost-effective dietary strategies to support neurological health. Further sensory studies and clinical evaluations are recommended to validate long-term efficacy and consumer acceptability.

Keywords: Neurodegenerative diseases, Mucuna pruriens, Zanthoxylum armatum, L-Dopa, HPLC, Cognitive health.

Development of Herbal Tea for the Prophylactic Management of Menopause

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Menopause represents a significant transitional phase in a woman's life, often accompanied by vasomotor, psychological, urogenital, and metabolic disturbances that negatively impact quality of life. Although hormone replacement therapy (HRT) remains effective, its long-term use is associated with adverse effects such as increased cardiovascular and cancer risk, highlighting the need for natural, safe, and holistic alternatives. This study aimed to develop a functional herbal tea incorporating phytotherapeutic ingredients traditionally used for alleviating menopausal symptoms, including *Saraca asoca*, *Glycyrrhiza glabra*, *Matricaria chamomilla*, and *Camellia sinensis*. Plant materials were extracted using ethanol-assisted maceration, followed by rotary evaporation. Qualitative and quantitative phytochemical evaluations were performed, including High-Performance Liquid Chromatography (HPLC) to confirm the presence of bioactive compounds (flavonoids, phenolics, saponins, tannins, catechin, epicatechin, gallic acid, glycyrrhizic acid , glabridin, and apigenin). Proximate analysis assessed moisture, ash, protein, fat, carbohydrate, and fiber content to ensure nutritional relevance. Antioxidant activity was evaluated via DPPH radical scavenging assay, and total phenolic content (TPC) and tannin levels were quantified. The developed formulation demonstrated high phenolic content (notably flavonoids), strong antioxidant activity, and favorable proximate nutritional values. HPLC profiling confirmed the presence of key phytoestrogenic constituents beneficial for menopausal symptom relief. Observational sensory evaluation indicated consumer acceptability in terms of flavor, aroma, and color.

Keywords: Menopause, Functional tea, Saraca asoca, Glycyrrhiza glabra, Matricaria chamomilla, Phytoestrogens, HPLC, Antioxidant activity.

Evaluation of nutritional, thermal, pasting, microbial and microstructural characteristics of functional pasta

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The aim of present research work was to characterise garlic powder (1.5%) incorporated pasta on the basis of nutritional, thermal, pasting, microbial and microstructural characteristics with control pasta (100% durum semolina). The functional pasta made with 98.5% semolina and 1.5% garlic powder formulations exhibited 14.71 mg/100g allicin content, 86.78 mgGA/100g TPC, 71.50 mgCatechin/100g TFC, and 13.62% antioxidant activity, which was higher than control pasta. Garlic powder incorporated in pasta reduced the total plate count by 25.53% because garlic powder has antibacterial properties. The sensory parameters, mainly the flavour and overall acceptability, were found to be better in garlic incorporated pasta. Scanning electron microscopy, Fourier-transform infrared spectroscopy, and X-ray diffractograms analysis showed the microstructural differences in gluten networks, chemical bounding in at different wavenumbers and degree of crystallinity respectively. The addition of garlic flour obtained an overall decrease in the thermal characteristics of the pasta. Results of pasting properties indicated the structural stability of starch granules, making them more resistant to retrogradation and/or gelatinization.
Keywords: Pasta, Garlic powder, antioxidant activity, microbial properties, microstructural characteristics

Exploration of ACE-Inhibitory Peptides Generated in low sodium Cheddar Cheese and Their Molecular Interactions

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This study investigated the generation of angiotensin-converting enzyme (ACE) inhibitory peptides in Cheddar cheese prepared with substitution of sodium chloride by potassium chloride @1:1 and 1:3. Control cheese (2.5% NaCl) and sodium-substituted variants were ripened at 4 °C for 9 months to evaluate changes in ACE-inhibitory potential. Samples exhibiting the highest inhibition levels were analyzed for peptide profiling using RP-HPLC and LC-MS/MS. Identified peptides were further assessed for their bioactivity through computational screening, toxicity prediction, and molecular docking analyses. Among all treatments, cheese with @1:3 NaCl/KCl exhibited a greater number of bioactive peptides with higher ACE-inhibitory potential. Docking simulations revealed that the peptide QEPVLGPVRGPFPI showed the strongest binding affinity with the ACE enzyme, forming multiple hydrogen bonds with active site residues (Tyr62, Asn66, Arg124, Ala356, and Ser517), corresponding to a binding energy of −10.2 kcal/mol. The higher substitution of sodium with potassium enhanced proteolytic activity, leading to the release of peptides with greater biofunctional properties. Overall, the findings demonstrate that sodium reduction through potassium substitution can promote the formation of health-promoting peptides in cheese without compromising ripening quality. This approach provides a potential pathway for developing functional dairy products beneficial in managing hypertension.
Keywords: Cheddar cheese, sodium reduction, potassium substitution, ACE inhibition, molecular docking, bioactive peptides

Kombucha: A Functional Fermented Tea with Probiotic and Therapeutic Potential

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Kombucha is a traditional fermented tea drink that is developed using the symbiotic culture of bacteria and yeast (SCOBY). The origin of Kombucha is Asia most likely from East Asia. It has become widely known as functional drink in the world in the recent years because of its special combination of organic acids, polyphenols, vitamins, amino acids, and probiotics. This review focus on biochemical composition, microbial ecology, and health-promoting properties of kombucha with particular emphasis on the use of the product as a therapeutic beverage. Kombucha is a rich phenolic and probiotics that is why it has antioxidant, antimicrobial, anti-inflammatory, antidiabetic, and cardioprotective properties which are the primary reasons for kombucha's health benefits. The physicochemical characteristics and bioactivity of it can change significantly depending on the variation of tea substrates, fermentation duration, and microbial diversity. Bioactive-enriched kombucha preparations enriched with medical herbs, fruits, and prebiotics have also been shown to have improved functional performance, which includes increased antioxidant functionality, gut microbiome modulation and regulation of metabolism. In vitro and in vivo studies show encouraging results, clinical validations are limited and the production procedures should be optimized to guarantee safety, consistency, and therapeutic efficacy. This review highlights the increasing rate of using Kombucha as a non-alcoholic, probiotic- enrich functional drink and therefore there is a need to conduct more research on its molecular process and its long-term impacts on the human body. As there is an upward trend in the rate of consumerism of non-alcoholic drinks with high content of probiotics as functional drinks, kombucha is a viable green opportunity in terms of innovation in the global market of health beneficial beverages.

Keywords: Kombucha, SCOBY, Fermented tea, Bioactive compounds, Probiotics, Functional beverage

Role of Pigmented Rice as a Nutraceuticals

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Rice *Oryza sativa* L., is a staple food more than half of world population intake rice as a major cereal and it is a good source of protein, carbohydrates, vitamin, minerals. Rice also available in different colours varieties are red, black and purple due to natural plant pigment present in rice pericarp layer so they are called pigmented rice. Pigmented rice mostly cultivated in Asian continents like China, Japan, Thailand and India other country also produce black rice are Bangladesh, Indonesia, Philippines. Pigmented rice utilized as a nutraceutical for consumption of all age group and more nutritious as compare to white rice due to presence of various bioactive compounds such as anthocyanins, phenolic compounds, flavonoids and proanthocyanidins have several health benefits associated with nutraceuticals and functionals ingredients like anti-cancer, anti-inflammatory, antioxidative effect. Recent development in processing of pigmented rice have allowed greater retention of their contents. Pigmented rice has also been converted to different products for food preservation and to derive functional foods. Significantly bioactive compounds present in pigmented rice and their potential for nutraceuticals and medicinal ingredients. Food product made by red and black rice are sugar free, fat free such as pasta, cake, kheer, beverages, children food, biscuit, alcoholic beverages wine, mead etc., these products utilized in daily diet for improve antioxidant activity and reduce harmful health disease so that high benefits to the nutraceuticals and functional food products.

Keywords: Nutraceuticals, Functional foods, Antioxidants, Anthocyanins, Anti-cancer

Physico-chemical and Antioxidant evaluation of oven-dried *Azolla pinnata* powder

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Azolla is a well-known aquatic fern belonging to the family Azollaceae. It is widely used as animal feed, a biofertilizer and green manure because it can be easily cultivated without competing with agricultural land and provides high biomass. It has a high nutritional profile, especially its protein content, including all essential amino acids, making it a potential dietary ingredient and nutraceutical. In the present study, dried *Azolla pinnata* powder was used to analyze the physicochemical, nutritional, flow and antioxidant characteristics. The fresh Azolla was cleaned and dried in a hot-air oven at 45°C, then ground and analyzed. The moisture content of oven-dried Azolla was 7.3%. The proximate composition of oven-dried samples, namely crude protein, crude fat, crude fibre, total ash and carbohydrate as the remaining fraction on a dry weight basis, was 30.2, 3.7, 12.2, 15.2 and 38.5%, respectively. The physical parameters, such as bulk density and tap density, were 0.25 g/mL and 0.32 g/mL, respectively. From these values, the Hausner ratio (1.25) and Carr's index (20.4 percent), represent the passable flow behavior of the Azolla powder. The Azolla powder showed the lightness of 42.7, a* of -5.20 and b* value of 18.6, suggesting pigment retention without excess browning. The antioxidant properties of Azolla, as determined by DPPH and FRAP (IC50) assays, were 48.79 mg/mL and 2.3 µg/mL, respectively. The water- and oil-absorbing capacities of dried *Azolla pinnata* powder were 6.14 g/g and 3.35 g/g, respectively. Overall, the combination of high nutritional value and antioxidant potential highlights the potential of Azolla for use in functional foods, feed supplements and herbal formulations.

Keywords: *Azolla pinnata*; Antioxidant Activity; Functional Food; Physicochemical Properties

Comparative Evaluation of Conventional and Modern Extraction Methods for Bioactive Compounds from Mulberry Leaves with Antidiabetic Potential

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Type 2 diabetes mellitus (T2DM) has emerged as the top health concern of the twenty-first century and the most prevalent form of diabetes globally. The root cause of T2DM is characterized by insulin resistance in somatic cells leading to persistent hyperglycemia. Mulberry leaf (ML) and mulberry leaf extract (MLE) have numerous biological properties, such as regulating sugar and lipid metabolism, reducing blood glucose, and increasing insulin secretion. Mulberry leaves (ML) are rich in bioactive components, such as 1-deoxynojirimycin (1-DNJ 5.47%), resveratrol (0.39%) etc. 1-DNJ is one of the primary alkaloids in ML, and it is an inhibitor of α-glucosidase, which results in the inhibition of the elevation of postprandial blood glucose, fasting blood glucose (FBG), glycosylated haemoglobin (HbA1c), and fasting plasma insulin (FPI). There are different extraction Techniques available including Conventional Extraction Techniques such as Maceration, Digestion, Soxhlet Extraction etc whereas in Modern Extraction Techniques ultrasonication extraction, ASE, MAE etc. Modern Extraction Techniques are more efficient than conventional extraction Techniques as it promises the benefits like reduced required time, less solvent demand, better yield and better preservation of biological activity and less energy demand. This finding will suggest the suitable extraction techniques for Mulberry Leaf has significant potential to reverse T2DM by enhancing Insulin Sensitivity.

Keywords: Mulberry Leaf Extract, (T2DM) Type 2 Diabetes Mellitus, Insulin Resistance, DNJ (deoxy nojirimycin) Insulin Sensitivity, Accelerated Solvent Extraction, MAE

Valorization of Eggshell Waste as a Natural Calcium Source for Food Enrichment and Nutritional Supplementation

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This study looks on the enrichment and use of eggshell waste as an affordable calcium supply. FTIR peaks typical of calcite and the lack of organic residues demonstrated that calcium carbonate ($CaCO_3$) is the primary constituent of the processed eggshell powder, according to physicochemical investigations. A rough, porous morphology with calcium, carbon, and oxygen as the main constituents, as well as trace minerals that support its structural qualities, was discovered by SEM examination. The eggshell powder is thermally stable up to 250°C, according to thermal investigation using DSC; throughout this range, moisture evaporation and slow organic degradation take place. Due to the powder's inorganic character, the DPPH assay revealed very little antioxidant activity. Eggshell powder greatly increased the calcium content of cookies without negatively impacting dough workability or the baked cookies' sensory attributes, which were still satisfactory in terms of flavor, texture, and appearance. According to these results, eggshell waste can be efficiently converted into a cost-effective, natural calcium supplement for food enrichment, encouraging sustained waste value creation and enhanced nutritional value.
Keywords: Eggshell waste, Calcium carbonate, Food enrichment, Nutritional supplementation, Waste valorization, Physicochemical analysis, FTIR spectroscopy

Circular Economy Approach to Nutraceutical Recovery from under-utilized *Ficus carica* fruits: Polyphenols and Dietary Fibres

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Fig (Ficus carica) fruit, categorized as under-utilized, belonging to the mulberry family, edible, sweet fruit with unique flavour and texture, varying in colour from green to deep purple. Being an abundant source of bioactive compounds (dietary fibres, polyphenols, anthocyanins, flavonoids), contribute to antioxidant, anti-aging, anti-inflammatory, and gut health-promoting properties. The mandate for the present investigation was to utilize the best drying treatment and sustainable extraction techniques for the recovery of bioactive compounds from Fig fruits. Ultrasonic-assisted extraction (20 °C, 30 min and 20 KHz) demonstrated the notable improvements in extraction yield of polyphenols 40-46 % particularly total polyphenols 13.95 mg GAE/ g DW compared to the conventional extraction method. UAE exhibited higher levels of total phenolics (13.813 ± 0.151 mg GAE/ g DW), total flavonoids (3.925 ± 0.033 mg CE/ g DW), anti-oxidant activity (1.190 ± 0.345 IC50 mg/mL). The residual part thereafter extraction was washed, dried and found higher in insoluble fibre content (69%). The FTIR characterization predicted the polyphenolic compounds and dietary fibre concentrate in the extract and residual matrix respectively. Freeze-dried ultrasonic-assisted extraction was found best combination to extract the bioactive compounds, aligning circular economy approach, making the method valuable for the functional food and nutraceutical delivery.
Keywords: Ficus carica,, phenolic compounds, dietary fibres, circular economy, nutraceutical

Development and Analysis of Lycopene Fortified Cereal Flakes

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The present study investigates the incorporation of lycopene extract from tomatoes into the formulation of cereal flakes. A blend of wheat, rice and corn flour was fortified with lycopene extracted from the Alankar tomato cultivar using various solvent systems. Fresh tomatoes were sliced and homogenized to form a uniform pulp, from which lycopene is extracted using different combinations of ethanol, ethyl acetate and acetone. The mixture is then shaken in an orbital shaker at 40 °C for 5 h followed by concentration in a rotary evaporator at 60 °C to obtain a lycopene-rich extract. Lycopene content is determined by measuring absorbance at 503 nm using a UV–Visible spectrophotometer. The efficiency of lycopene extraction was highest with ethyl acetate alone (0.264 mg/g), followed by the acetone:ethyl acetate (1:1) solvent system (0.190 mg/g), whereas the ethanol:ethyl acetate (1:1) combination resulted in the lowest yield (0.034 mg/g). Extract obtained by ethyl acetate extraction was incorporated in the cereal flakes at three different concentrations *viz*. 3g/100g (T1), 4g/100g (T2) and 5g/100g (T3). T1 showed a lycopene content of 0.050 mg/g, whereas the T3 revealed highest lycopene level of 0. 169 mg/g of cereal flakes. Proximate analyses of the cereal flakes revealed that the sample has 4.76%moisture content, 1.43% ash, 3.21% fat, 8.56% protein and 82.04% carbohydrate. Sensory evaluation using a 9-point hedonic scale indicated high consumer acceptance with scores for color (8.2), flavor (7.9), texture (8.1), and overall acceptability (8.3). Thus, it can be concluded that lycopene fortified cereal flakes are nutritionally rich, visually appealing and scalable breakfast option.

Keywords: Tomatoes, Lycopene, Ethyl acetate, Antioxidants, Cereal lakes

Development of Microencapsulated Natural Sweetener From Star Anise and Liquorice

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Growing awareness of the health risks linked to excess sugar consumption has increased interest in natural sweeteners that combine functionality with a desirable taste. This study reports the development of a microencapsulated natural sweetener using *Illicium verum* (star anise) and *Glycyrrhiza glabra* (liquorice), which are both rich in bioactive anethole and glycyrrhizin. The extracts were blended with inulin as a prebiotic carrier and Tween 80 as an emulsifier to form a uniform mixture, which was then spray dried for microencapsulation. This process was designed to enhance the stability, solubility, and retention of bioactive compounds, while preserving sweetness and flavour quality. The physicochemical and functional characteristics of the resulting powder was analysed. The sweetener achieved a yield of 87.29 ± 1.23 %, encapsulation efficiency of 83.64 ± 2.34 %, moisture 8.34 ± 0.96 %, water activity 0.47 ± 0.01, solubility 72.36 ± 1.79 %, and bulk density 0.31 ± 0.01 g/cm³, indicating excellent flowability and storage stability. A semi-trained sensory panel (n≈10) evaluated its performance in peda, cookies, and cake, confirming a clean, pleasant sweetness comparable to sucrose, without bitterness or aftertaste. Optimal acceptability was observed at 0.5–1.25 g per 100 g of the product, depending on the food matrix. These findings demonstrate that combining plant-derived bioactive compounds with microencapsulation technology can produce stable, functional, and natural sweeteners suitable for both traditional and processed foods. The developed formulation offers a promising route toward health-conscious and sustainable sweetening solutions that align with modern dietary and industrial demands.

Keywords: Microencapsulation, Bioactive Sweetener, Star Anise, Liquorice, Functional Foods

Impact of Blue Light Photoperiod on the Nutritional and Functional Profile of *Moringa Microgreens*

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Moringa oleifera, a traditional food plant renowned for its nutritional and medicinal attributes, is gaining global attention as an innovative solution for nutrient-dense diets and functional food applications. This study explores the impact of blue light photoperiods on the nutritional, mineral, and bioactive profiles of moringa microgreens, addressing the intersection of food innovation and traditional health-promoting crops. Cultivated under controlled blue light regimes (0, 8, 16, 24 hours), moringa microgreens exhibited significant increases in ash, protein, and fat content, with maximal values at 24 hours, alongside reduced carbohydrate and fibre levels. Prolonged photoperiods yielded denser dry matter and enriched concentrations of key minerals, such as calcium (256.45 mg/100g), potassium (1972.60 mg/100g), zinc (35.86 mg/100g), and iron (44.41 mg/100g), supporting their role in mitigating dietary deficiencies. Bioactive content, including total phenolic (13.28 mg GAE/g), flavonoid (19.84 mg QE/g DW), and antioxidant capacity, was notably enhanced, emphasising potential health benefits. Chlorophyll content also increased significantly, reflecting improved pigment accumulation. Collectively, these findings highlight blue-light photoperiod as a potential strategy to enhance the nutritional and health-promoting value of moringa microgreens, supporting their application in future functional foods and neutraceuticals that support the global effort to develop sustainable, nutrient-dense foods to promote wellness and address dietary deficiencies.

Health Benefits and Nutritional Aspects of Functional Food

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Functional foods are natural or processed foods that offer health benefits to consumers. They are distinct from traditional nutritional foods since they not only contribute to nutrition but also to disease prevention and immunity support. These benefits include inhibition of oxidative stress, modulation of metabolic balance, and maintenance of gut microbial diversity. Studies demonstrated that regular consumption of these foods is associated with decreased risks of cardiovascular disease, type-2 diabetes, obesity, certain cancers, and cognitive deterioration in ageing. The presence of nutrients and bioactive compounds have been shown to have positive health impacts in the prevention and management of chronic diseases. In the creation of functional foods, lactic fermentation products play a significant role and they are traditionally classified into three categories- probiotics, prebiotics and synbiotics. A fourth category, biogenics, was added more recently in modern classifications. Along with probiotics and other bioactive metabolites, antioxidants in fermented food enhance the functional benefits of food by slowing down cellular deterioration and promoting general health. Functional foods are beneficial foods with great nutritional composition and health importance viz., cholesterol reduction, heart health and cancer risk reduction. By introducing these functional foods in our lifestyle health aspects and nutrients of body can be maintained. The objective of the present review is to highlight the importance of functional foods, health benefits and their contribution to disease prevention and overall well-being.

Keywords: Antioxidants, Functional foods, Health benefits, Nutritional composition,

A Comparative Study on the Extraction Efficiency and Pigment Profile of Carotenoids in Red, Green and Yellow Bell Peppers

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The fruit of *Capsicum* species, commonly known as bell pepper, represents one of the most important sources of natural carotenoids used in foods, nutraceuticals and pharmaceuticals. Belonging to the *Solanaceae* family and originating from Central and South America, bell peppers occur in different colours—green, yellow, orange and red—corresponding to distinct stages of ripening and carotenoid accumulation. Carotenoids are lipophilic tetraterpenoids responsible for the characteristic pigmentation and health-promoting properties of the fruits. During ripening, chloroplasts rich in chlorophylls are transformed into chromoplasts with diverse carotenoid profiles. Green peppers contain mainly chloroplast carotenoids such as lutein, violaxanthin, neoxanthin and β-carotene, whereas yellow and orange peppers are rich in lutein, violaxanthin, antheraxanthin, zeaxanthin and β-cryptoxanthin. Red peppers exhibit the most complex and concentrated carotenoid composition, dominated by unique xanthophylls and red ketocarotenoids—capsanthin, capsorubin and capsanthin-5,6-epoxide. These pigments not only define fruit coloration but also act as potent antioxidants with anti-inflammatory and anti-carcinogenic properties, contributing to reduced risks of chronic diseases including cancer, cardiovascular disorders and age-related eye diseases. Considering their nutritional and functional relevance, the extraction of carotenoids from red, green and yellow bell peppers has gained increasing scientific and industrial attention. This review discusses the biochemical composition, transformation of pigments during ripening, and comparative carotenoid profiles across pepper varieties, emphasizing efficient extraction methods for maximizing yield and preserving bioactivity.

Keywords: *Capsicum annuum*, carotenoids, extraction, antioxidant activity, capsanthin, ripening stages

Colored rice – Unlocking nutritional, anti-nutritional, phytochemical, health-benefits, processing technologies and application in food systems

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Rice is a global staple, second only to wheat, feeding billions. Colored rice varieties—black, red, and blue—have gained attention for their superior nutritional profiles and rich bioactive phytochemicals. These pigmented varieties contain higher proteins, dietary fiber, and essential minerals than white rice. Their vibrant colors arise primarily from anthocyanins such as cyanidin-3-glucoside and peonidin-3-glucoside, proanthocyanidins comprising flavan-3-ol oligomers, predominantly in red rice, and flavonoids including phlorizin and quercetin concentrated in rice bran, all contributing to potent antioxidant activity. However, colored rice also contains anti-nutritional factors like phytic acid and tannins, which limit mineral absorption and reduce protein digestibility. Processing methods such as germination, fermentation, extrusion, infrared heating, and microwave treatment reduce these compounds, enhancing bioavailability and sensory qualities. Advanced analytical techniques (HPLC, LC-MS, GC-MS, DPPH, FRAP) are used to profile phytochemicals and antioxidant potentials. Health benefits from colored rice include anti-inflammatory, antidiabetic, anticancer, and cardiovascular protection through antioxidative and fiber-related mechanisms. In the food industry, colored rice enriches gluten-free baked goods, functional snacks, beverages, and desserts, combining nutrition and sensory appeal. Future innovations hold promise for expanding colored rice uses toward sustainable, biodegradable packaging materials, intelligent food freshness indicators, and novel functional foods tailored by genetic and metabolomic enhancements. These approaches align with sustainability and circular economy principles, valorizing agricultural by-products and reducing environmental footprints. Colored rice thus represents a transformative food resource supporting nutrition, health, and ecological stewardship—a promising asset for the future of human well-being.

Keywords: Colored rice, Nutritional composition, Phytochemicals, Antioxidant activity, Functional foods

Mung bean (*Vigna radiata L.*) - Unveiling nutritional, antinutritional, phytochemical, health benefits, processing technologies, and, application in food systems

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Mung bean (*Vigna radiata L.*), commonly known as green gram, is an important legume crop ranking fourth among India's pulse crops in terms of production. It is rich in proteins, carbohydrates. The nutritious value of mung bean and their capacity to withstand conditions in arid and semiarid regions make them a crucial crop for food security. Mung beans are also an excellent source of bioactive compounds, including polyphenols, phenolic acids, flavonoids, and tannins, which contribute to their antioxidant, antimicrobial, and health-promoting properties. Extraction of these bioactive compounds has been optimized using both conventional (Soxhlet, maceration, hydrodistillation) and modern techniques such as ultrasound-assisted, microwave-assisted, enzyme-assisted, and supercritical fluid extraction. Processing methods like soaking and germination significantly affect the levels of phenolic compounds, enhancing or reducing bioactive contents depending on duration and temperature. However, mung beans also contain antinutritional factors such as saponins, phytic acid, tannins, and trypsin inhibitors. In terms of applications, mung bean flour can be utilized as a functional additive due to its high fiber content and lower fat content. Additionally, mung bean protein isolate exhibits promising nutraceutical applications, demonstrating hepatoprotective effects against inflammation and hepatic lipid accumulation. An analysis of mung bean protein (MBP) has also shown a significant reduction in triglycerides, non-HDL cholesterol, and plasma total cholesterol, along with increased fecal sterol excretion.

Bell pepper: Unraveling bioactive properties of Polyphenols, its extraction and application in food sector

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Bell peppers (*Capsicum annuum* L.) are widely consumed vegetables known for their rich nutritional and bioactive composition. Bell peppers are the fruit of a flowering plant in the botanical family Solanaceae. The plant produces berries of many colours including red, green, and yellow, often with pungent taste. Bell peppers have high levels of water and carbohydrates with a low protein and fat content, which makes them a low-calorie food. Bell peppers are excellent sources of essential vitamins, particularly vitamins C, A, E, B6, and folic acid, and also provide dietary fiber, beta-carotene, and lycopene. In addition to traditional nutrients, they are rich in phytochemicals such as flavonoids, carotenoids, phenolic acids, tannins , capsinoids, and pectic polysaccharides. This study highlights the antioxidant potential and health benefits associated with bell peppers, focusing on their phenolic and flavonoid content. Bell pepper possess antioxidant, anti-inflammatory, antitumoral, antimicrobial, antidiabetic, and immunomodulatory properties. These bioactive properties contribute to the reduction of oxidative stress, thereby lowering the risk of chronic non-communicable diseases including cardiovascular disease, cancer, diabetes, osteoporosis, and neurodegenerative disorders. The green bell pepper contains the highest levels of phenolic compounds . Highest amount of Vitamin C is found in yellow bell pepper. Green bell pepper contain lowest amount of vitamin C. The red bell pepper contain the highest levels of total carotenoids and α-tocopherol. Bell peppers are rich in various polyphenols like quercetin, luteolin, kaempferol, myricetin, catechin, epicatechin, hesperidin, caffeic acid, ellagic acid, chlorogenic acid, vanillic acid, ferulic acid. This research underscores the nutritional and nutraceutical importance of bell peppers and supports their role as functional food ingredients for improving human health and preventing degenerative diseases.
Keywords: Polyphenols, Bell pepper, anti oxidizing, anti inflammatory

Influence of Processing and Extraction Techniques on the Bioactive Composition and Antioxidant Potential of Vigna mungo

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Black gram (Vigna mungo L.), a small black legume belonging to the *Fabaceae* family, is a vital pulse crop primarily cultivated in India and widely used in Asian cuisine. It serves as an excellent nutritional source, rich in carbohydrates, proteins, and essential minerals such as iron, calcium, magnesium, and phosphorus. In addition to its macronutrients, black gram contains significant amounts of B-complex vitamins and bioactive phytochemicals, including alkaloids, flavonoids, saponins, tannins, phenolic compounds, and isoflavones like genistein and daidzein. Phenolic compounds such as gallic, caffeic, and ferulic acids act as natural antioxidants that neutralize free radicals, protect biomolecules, and enhance glucose metabolism. Flavonoids including quercetin, luteolin, and kaempferol further reinforce these benefits through anti-inflammatory, antibacterial, and metabolic regulatory mechanisms. Similarly, tannins and saponins contribute to black gram's defensive and therapeutic potential by supporting cardiovascular health and demonstrating antimicrobial and cholesterol-lowering effects Extraction of these bioactive compounds employs several advanced techniques, from traditional Soxhlet extraction to green technologies such as extraction process Ultrasound-Assisted , Microwave-Assisted, Pressurized Liquid , Enzyme-Assisted , and Supercritical Fluid . Processing methods such as soaking and germination also influence the bioactive content. Soaking at 25°C helps retain phenolic stability, while controlled germination enhances phenolic diversity before enzymatic degradation occurs. Overall, black gram stands out as a functional food with remarkable nutritional and therapeutic potential. Its rich composition of bioactive compounds highlights its significance for research, nutraceutical development, pharmacological activities and health-oriented dietary interventions.

Clitoria ternatea as a Source of Natural Antioxidants and Smart Biodegradable Materials: Bridging Functional Food and Sustainable Packaging Innovation

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Clitoria ternatea L. (butterfly pea) has emerged as a multifunctional botanical uniting the domains of functional nutrition and sustainable materials. This review highlights its diverse phytochemical profile, antioxidant mechanisms, and applied potential in nutraceutical and biodegradable packaging innovations. Rich in anthocyanins and flavonoids, *C. ternatea* exhibits strong radical-scavenging and enzyme-regulatory functions, underpinning reported antidiabetic, hepatoprotective, and neuroprotective effects. Advances in green extraction techniques, such as ultrasound-assisted and low-vacuum plasma methods, have significantly enhanced anthocyanin yield, purity, and stability while minimizing solvent use and environmental impact. These improvements strengthen process sustainability and industrial scalability for bioactive recovery. In functional food applications, incorporation of *C. ternatea* extracts into rice, kombucha, and bakery formulations has improved antioxidant capacity, reduced starch digestibility, and maintained sensory qualities. Such benefits support its role in developing natural, low-glycaemic, antioxidant-enriched products aligned with consumer preferences for health-oriented foods. Simultaneously, integrating *C. ternatea* bioactives into cellulose, gelatin, and chitosan matrices has led to smart, pH-responsive films exhibiting antioxidant and freshness-indicating properties, capable of extending the shelf-life of perishable products. This dual functionality establishes *C. ternatea* as a strategic resource for next-generation nutraceuticals and intelligent biodegradable packaging systems. Further studies on stability, bioavailability, and process-scale optimization are essential to translate laboratory outcomes into commercial reality, contributing to the advancement of circular and sustainable food systems.

Keywords: *Clitoria ternatea*, butterfly pea, anthocyanins, functional foods, antioxidant films, smart packaging, green extraction.

Dietary Fiber–Microbiota–Metabolite Axis: Integrative Insights into SCFA-Mediated Metabolic Regulation via PI3K/AKT and AMPK Pathways

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Dietary fiber (DF) functions as a key modulator of host metabolism through its interaction with the gut microbiota. Microbial fermentation of DF produces short-chain fatty acids (SCFAs)—primarily acetate, propionate, and butyrate—that serve as signaling molecules influencing glucose, lipid, and energy homeostasis. Although the nutritional benefits of fiber are well established, the molecular mechanisms by which SCFAs regulate the PI3K/AKT and AMPK signalling pathways remain incompletely understood. Integrating these mechanistic insights is crucial for developing fiber-based nutritional strategies to combat obesity, metabolic syndrome, and type 2 diabetes. This review synthesizes recent advances (2018–2025) elucidating the dietary fiber–microbiota–metabolite axis and its role in metabolic regulation through PI3K/AKT and AMPK activation. A systematic literature review of studies indexed in Scopus, PubMed, and ScienceDirect was performed using the keywords "dietary fiber," "gut microbiota," "short-chain fatty acids," "PI3K/AKT," "AMPK," and "metabolic regulation." Evidence from human, animal, and in vitro models highlights that fiber fermentation enhances microbial diversity and SCFA yield, particularly butyrate, which stimulates PI3K/AKT phosphorylation and AMPK activation, thereby improving insulin sensitivity, lipid oxidation, and mitochondrial function. Distinct fiber sources—such as fermented soy, Tartary buckwheat, seaweed, and mango peel—show strong potential to modulate the gut–liver metabolic axis via these molecular routes. SCFAs also influence gut hormones (GLP-1, PYY) and bile acid metabolism, linking microbial activity to hepatic and neural energy regulation. Despite these advances, inter-individual variability, fiber structure specificity, and dose–response relationships remain insufficiently defined. Future research integrating multi-omics approaches is needed to map metabolite–microbiota–host interactions and enable precision nutrition using functional, sustainable fiber sources.
Keywords: Dietary fiber, gut microbiota, short-chain fatty acids, PI3K/AKT, AMPK, metabolic health

Formulation and Quality Evaluation of Foxtail Millet and Proso Millet Dairy-Free *Kulfi*

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Growing awareness of dietary limitations and the demand for healthier food options have led to a notable increase in the popularity of plant-based, lactose-free desserts. This increase indicates a move toward more inclusive, health-conscious eating habits, particularly among people who avoid dairy due to milk allergies, lactose intolerances, or lifestyle preferences. Though widely consumed, traditional dairy products frequently don't meet the needs of people with lactose intolerance, milk allergies, veganism, or health-conscious lifestyles. Using millet milk as a practical and sustainable substitute, the current study concentrated on creating a healthy, dairy-free *kulfi*. A control made from skimmed milk was used to compare the two *kulfi* varieties that were created using 100% foxtail millet milk and 100% proso millet milk. Both millet-based *kulfis* were found to be highly acceptable by consumers based on sensory evaluation on a 100-point scale. Proso millet *kulfi* had the highest score (91.33), followed by foxtail millet *kulfi* (84.43). According to nutritional analysis, the millet *kulfis* had a much lower fat content (proso: 13.25%, foxtail: 13.50%) and a significantly greater protein content (proso: 6.39%, foxtail: 6.24%) than the control (protein: 3.39%, fat: 14.26%). Because they had more protein and carbohydrates, they also had larger energy values. Millet milk *kulfis* showed slower melting rates (proso: 0.29 ml/min, foxtail: 0.21 ml/min) than the control (0.77 ml/min), implying improved heat stability and structural integrity. Millet *kulfis* had an elevated antioxidant potential (proso: 2.06 mg GAE/g; foxtail: 1.97 mg GAE/g) than the control (1.58 mg GAE/g), that enhanced their functional benefits. Millet *kulfis* had elevated mineral enrichment—more calcium, magnesium, phosphorus, and zinc—making them a functional and nutrient-dense alternative to traditional *kulfi*. Millet *kulfi* samples had much lower microbial counts than traditional *kulfi* over a 30-day storage period, indicating improved microbiological stability. Overall, the study showed that millets can be used to make plant based, nutrient-dense, consumer-acceptable and better shelf-stable traditional products like *kulfi*.

Assessment of Antidiabetic Properties of Bitter Gourd (*Momordica charantia L.*) Using In Vitro Models

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Diabetes mellitus remains a leading global health concern, driving research toward plant-derived bioactives as safer therapeutic alternatives. *Momordica charantia* L. (bitter gourd), a widely used medicinal plant, exhibits diverse biochemical mechanisms that contribute to glucose regulation. This review consolidates insights into the *in vitro* methodologies employed to evaluate its antidiabetic potential, emphasizing enzyme inhibitory and glucose uptake assays. Bioactive compounds, including insulin-like peptides, charantin, and polypeptide-P, have demonstrated potent inhibitory effects on key carbohydrate-hydrolyzing enzymes - α-amylase, α-glucosidase, and dipeptidyl peptidase-IV (DPP-IV) - comparable to standard synthetic inhibitors. Studies with yeast cells also show that bitter gourd mimics insulin activity, indicating it works through multiple pathways. The review also discusses how extraction solvent polarity influences bioactivity outcomes and assay sensitivity. By integrating recent findings with the comparative assessment of solvent extracts, it highlights the potential of bitter gourd as a natural antidiabetic agent and the value of standardized in vitro screening for preclinical evaluation. Future research should focus on synergistic herbal formulations, and mechanistic validation using molecular docking and in vivo correlation. Overall, this work connects traditional use with scientific evidence, reinforcing *Momordica charantia*'s promise in managing diabetes.

Keywords: Diabetes mellitus, *Momordica charantia*, enzyme inhibition, glucose uptake, bioactive compounds

Taste-Masking Strategies for Bitter Gourd (*Momordica charantia*): A Review of Emerging Techniques for Functional Food Development

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Bitter gourd (*Momordica charantia*) is widely recognized for its antidiabetic, antioxidant, and health-promoting bioactive compounds such as charantin, polypeptide-P, and momordicosides. However, its intense bitterness poses a major barrier to consumer acceptance and industrial application in functional foods. This review provides a comparative evaluation of different taste-masking techniques developed to overcome this limitation, including β-cyclodextrin inclusion complexation, alginate bead encapsulation, hot melt extrusion, coating with natural polymers, and flavor modification approaches. β-Cyclodextrin (β-CD) forms host–guest complexes that entrap bitter molecules, while alginate beads prepared by ionotropic gelation act as a physical barrier providing controlled release. Hot melt extrusion offers a solvent-free and scalable approach for embedding bitter compounds within polymer matrices, whereas coating and flavoring methods enhance sensory masking using natural food-grade materials. The review further discusses key process parameters, characterization techniques, and sensory threshold evaluation methods (such as serial dilution) used to assess masking efficiency. Overall, integrating molecular, matrix, and sensory-based masking techniques presents a sustainable, consumer-acceptable strategy for transforming traditionally bitter phytoconstituents of M. charantia into functional food and nutraceutical products.

Keywords: Bitter gourd (*Momordica charantia*), Taste masking, Functional foods, Bioactive compounds, Sensory evaluation

Development and Characterization of Nutrient-Enriched Ice Cream Cones Formulated using Pearl Millet Flour and Moringa Leaf Powder

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In the frozen dessert industry, ice cream cones are one of the most popular bakery-based accompaniments because of their sweet, and crunchy texture. However, traditional cones made primarily with all-purpose flour, provide limited nutritional benefits, as they are characterized by high calorie content and low levels of protein, dietary fiber, and essential micronutrients. The demand for developing healthy ice cream cones that enhance the nutritional quality of frozen desserts is gaining momentum as consumer preference for functional and nutraceutical foods is increasing. The current study focuses on development and characterization of ice cream cones that contain 90% pearl millet (*Pennisetum glaucum*) flour fortified with 10% moringa (*Moringa oleifera*) leaf powder as functional ingredients. The flour blend aimed to enhance the nutritional and nutraceutical potential of the product while maintaining desirable sensory and structural characteristics. Comparative analysis revealed that pearl millet–moringa cone exhibited higher values of ash (2.22%), crude fiber (3.71%), iron (4.22 mg/100g), zinc (1.4 mg/100g), magnesium (151.9 mg/100g), and potassium (394.51 mg/100g) as compared to control cone. Moringa leaf powder added natural antioxidants and bioactive substances that enhance the cone's nutraceutical value. As a result, the developed cone showed exceptional nutritional density, functional characteristics, as well as potential health benefits, establishing it as a novel and value-added bakery product that fits in with consumer demands for sustainable, nutrient-enriched, and functional foods.

Keywords: Ice cream cones, Pearl millet, Moringa leaf powder, Functional foods, Nutraceutical potential

Comparative Studies on the Green Extraction of Dietary Fibre Concentrate from Barnyard Millet Husk

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Millets are the traditional, highly nutritious, annual, warm season cereal crops. However, in cultivating millets, several by-products (husk, bran, straws etc.) are also generated. The valorization of millet by-products can be a novel approach to enhance their efficacy by recovering bioactive compounds. Barnyard millet husk is an unexploited by-product of millet and contains significant amount of dietary fiber, bioactive compounds, and minerals. Dietary fiber has several beneficial effects, such as lowering risk of intestinal disorders, obesity, regulates blood pressure, thus reducing risk of heart diseases. Conventional methods entail use of hazardous chemicals, high temperature, and longer time, which may result in degradation of extracted polysaccharides. However, there are very few studies on dietary fiber extraction from millet by-products using green extraction method. Valorization of millet by-products (barnyard husk) for the extraction of dietary fiber. In present study, comparative analysis of different green techniques (enzymatic extraction, ultrasound-assisted extraction, microwave-assisted extraction, ultrasound-assisted enzyme extraction, and microwave-assisted enzyme extraction) for extraction of dietary fiber concentrate from barnyard millet husk was investigated. The ultrasound assisted enzymatic extraction resulted the highest extraction yield (67.5%, w/w) of total dietary fiber from barnyard millet husk. The dietary fiber from millet husk was further assessed for physico-chemical and microstructural characterization. The results showed that ultrasound assisted enzymatic extraction led to the substantial increase in functional properties which are desirable properties for better end use of dietary fiber as functional ingredient in food industry.

Keywords: Millet, Ultrasound, functional ingredient, Dietary fiber

Development and characterization of instant powder using underutilized *Morus alba* leaves

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Mulberry leaves are underutilized reservoir of various potential bioactive compounds and their consumption has been proven to have some preventive medicinal properties. It includes anti-oxidative, anti-hyperglycaemic, and anti-hyperlipidaemic properties, which serve a preventive action against cardiovascular diseases and cancer. Considering their high potential, this study aims to develop an instant powder from mulberry leaf extract by agglomeration process. Agglomeration process improves powder flow and reconstitution by clustering and improving surface properties of powder particles. Furthermore, bioactive compound was extracted by isothermal shaking in distilled water. The extract was combined with maltodextrin (12 %), and the combined mixture was spray dried. Then dried powder was further agglomerated in fluidized bed dryer at distinct process parameters, such as inlet air temperature, lecithin concentration, and time duration. Corresponding parameters were optimized using Box-Behnken design. The outcome indicates that the optimized powder had solubility and dispersibility of 86.52 % and 83.6 %, respectively. Additionally, Carr's index (16.5%) and Hausner number (1.15) were found to be improved and showing free flowing nature of the powder. Furthermore, total phenol content, total flavonoid content, and tannin content were found to be 2.03 mg/100g, 2.48 mg/100g, and 2.53 TAE mg/10g, respectively. SEM analysis also confirmed agglomerate formation. The results of *in-vitro* anti-diabetic and anti-gout assays showed a negative correlation between the concentration of instant powder and standard drugs, with enzyme activity of α-amylase, β-glucosidase, and xanthine oxidase. The results of this study indicate the potential of the developed powder as a nutraceutical ingredient.

Keywords: instant power, *Morus alba*, spray drying, agglomeration

Valorization of Chia Seed Meal: Functional Proteins, Bioactive Peptides and Health Applications

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Chia seeds, which are a member of the mint family known as Lamiaceae, specifically originated from the plant species *Salvia hispanica*. Historically valued by ancient Meso-american civilizations such as the Aztecs and Mayans, chia was considered one of the principal staple foods, ranking alongside maize and beans. Chia seeds are valued for their abundant omega-3 fatty acids, dietary fiber, along with essential nutrients. Chia seeds meal (CSM), a byproduct of oil extraction, is an underutilized source of high-quality proteins and bioactive peptides with considerable functional properties and health benefits. The amino acid composition of chia protein is well-balanced, with high levels of glutamic acid, aspartic acid, arginine, and branched-chain amino acids (leucine, isoleucine, valine)—all essential for human nutrition and metabolic functions. Unlike many plant proteins, chia proteins exhibit relatively good digestibility and functional properties such as emulsifying, foaming, and water-holding capacities, which are desirable in food formulations. Additionally, through enzymatic hydrolysis, chia seed proteins can be broken down into bioactive peptides—short amino acid sequences that exert specific biological effects beyond basic nutrition. These peptides have demonstrated a wide range of bioactivities, including antioxidant, antihypertensive, anti-inflammatory, and antidiabetic effects in various studies. Additionally, the incorporation of chia protein isolates and hydrolysates into functional foods and nutraceuticals offers sustainable paths for valorizing chia byproducts within a circular bioeconomy framework. Despite promising findings, challenges remain regarding large-scale production, peptide stability, bioavailability, and clinical validation of health benefits. This study incorporates existing knowledge regarding the composition, extraction, structural attributes, and bio-functional aspects of proteins and peptides obtained from chia seeds meal.

Keywords: *Salvia hispanica* L., by-products, chia seeds meal, proteins, bioactive peptides, valorization.

Optimizing novel processing technology, drying techniques and packaging materials during storage for maximum retention of momordicin from bitter gourd pomace

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The objective of the present study is to optimize the novel processing technology, drying techniques and packaging materials during storage for maximum retention of momordicin from bitter gourd waste (pomace). In this study, novel non-thermal technologies such as cold plasma and ultrasonication were compared with conventional thermal technology i.e. steam blanching. The effects of these technologies as pre-treatments were examined on bitter gourd pomace. For optimizing drying techniques three different dryers (tray dryer, microwave dryer and solar dryer) were used. Whereas, for optimizing packaging materials during storage powder was stored in metallized laminate polymer (MLP), cast polypropylene (CPP) and polypropylene (PP) under ambient conditions and momordicin content was recorded at an interval of one month. In the present study, among pre-treatments cold plasma emerged as the most effective method for enhancing the momordicin content (1.200 mg/ml) followed by ultrasonication and steam blanching. Whereas, among drying techniques tray drying proved to be superior for maximizing momordicin content (1.223 mg/ml) followed by microwave drying and sun drying. Overall, in the first month of storage, polypropylene (PP) packed powder treated with tray drying and cold plasma (1.747 mg/ml) shows superior momordicin retention. Collectively, these findings are valuable for advancing food processing technologies and developing functional foods.

An approach to disrupt and characterize stable bee pollen structure using ultrasonication for food application

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Bee pollen, an API-product is a potential source of various therapeutic activities such as antioxidant, anti-inflammatory, anti-bacterial etc. However, nutrient availability is restricted due to rigid exine and intine layers. In order to overcome the hindrances caused, the implementation of ultrasonication processing to bee pollen brings about notable positive changes in morphology, proximate, antioxidant, and functional properties of disrupted bee pollen. Scanning electron microscopy (SEM) micrographs reveal proficient segregation of the bee pollen cell wall into fragments, facilitating the efficient release of nutrients from the pollen grains. Proximate analysis reflects a substantial increase in fat and protein content by 31.6% and 49.3%, respectively. Antioxidant and TPC values exhibit a noteworthy concentration increase of nearly 13.9 and 83.94% along with significant improvement in techno-functional properties such as solubility (81.8%), OHC (98.5%), FA (61.4%), EA (61.2%). Processing treatment reflects that 4 hours of ultrasonication is sufficient to break the cell wall effectively and subsequently release the nutrients. Therefore, the application of ultrasonication emerges as the optimal technique for disrupting and maximising the utilisation of bee pollen superfood, which is currently under-exploited. The use of cell wall breaks bee pollen in various food and pharmaceutical products makes this under-utilised food source a high-performance food ingredient for better functionality and applicability.

Keywords: Bee pollen, Stable structure, Ultrasonication, Functional food ingredient.

Valorization of roselle calyx bioactive compounds through ultrasound assisted extraction using response surface methodology

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Extensive post-harvest wastage of roselle calyces represents a missed opportunity for harnessing their high-value bioactive compounds, underscoring the need for innovative velarization strategies. Roselle (*Hibiscus sabdariffa* L.) calyx velarization into polyphenols-rich extract offers a sustainable approach to utilize agro-waste while enhancing the production of natural antioxidants through response surface methodology. The optimized values of UAE obtained roselle calyx extract were (EY= 48%, TPC=37.89 mg GAE/g, TFC=29.86 mg QE/g, TAC=9.79 mg CGE/g, and AA=88.09%). It is clearly observed that UAE method was more efficient in extraction of bioactive compound from roselle calyx's extract. The roselle calyx extract were characterized by FTIR, UV-Visible spectroscopy and color properties. Enhanced functional properties enabled roselle calyces to achieve desirable colour characteristics, making it suitable for incorporation into beverages, jam jellies, and other processed foods. Functional improvements supported better quality performance during formulation, contributing to the overall quality and consumer appeal of the final products. By leveraging these advancements, roselle calyces offers a sustainable and nutritionally valuable alternative artificial colour, supporting the development of innovative integrity, and stability. Overall, the study demonstrates that optimizing roselle calyx valorization through UAE not only maximizes the recovery of bioactive compounds but also promotes sustainable utilization of agro-waste, paving the way for the development of natural, functional ingredients in food and nutraceutical applications.
Keywords: Roselle calyx; valorisation; polyphenols; ultrasound-assisted extraction

Ultrasound-Assisted Enzymatic Extraction of *Moringa oleifera* Seed Oil: Process Optimization and Determination of Nutritional Landscape

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The study optimized a green extraction method, ultrasound-assisted enzymatic extraction (UAEE), to extract oil from *Moringa oleifera* seeds using the cellulase enzyme. GC-MS, FTIR, and SEM were used to profile the fatty acids, functional groups, and surface morphology. Gas Chromatography-Mass Spectrometry (GC-MS) analysis identified a diverse range of bioactive compounds, including monounsaturated fatty acids (MUFAs) such as oleic acid, cis-vaccenic acid, and trans-13-octadecenoic acid, which exhibit significant pharmacological activities like antioxidant, anti-inflammatory, and antibacterial effects. SEM revealed the structural disruption of seed cells caused by ultrasound and cellulase treatment, highlighting the enhanced oil release capability of UAEE. A central-composite design was used to optimize the extraction, analyzing the effects of ultrasonic amplitude (20-60 %), incubation time (1–2 hours), and particle size (0.3-2.36 mm) on total oil yield (35.81 %), determining the optimal points (20% ultrasonic amplitude, 1 hour incubation time and 0.3 mm particle size). The optimized extract was further investigated for total phenolic content and antioxidant activities. Physicochemical properties (acid value, saponification value, iodine value) were also evaluated for optimized extract. The study utilized an economical approach to extract maximum oil yield from *Moringa oleifera* seed for effectively their potential applications in the food industry, simultaneously establishing promising pharmacological activity through available literature.
Keywords: *Moringa oleifera* seed; ultrasonication; oil extract; enzymatic extraction; response surface methodology; GC-MS

Moringa Oleifera as Multifunctional Plant: Benefits and Application

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Moringa oleifera, a 'miracle tree,' is known for its usage as a water purifier, in the cosmetic industry, and as a biofuel. It is an underutilized plant and is usually called *Sainjna* in Hindi and *Sahajan* in Bengali and Marathi. The drumstick tree has pharmacological properties such as anti-asthmatic, anti-cancer, anti-diabetic, anti-epileptic, anti-infertility, anti-inflammatory, antioxidant, anti-pyretic, anti-ulcer, antiurolithiatic, cholesterol-lowering, diuretic, hepatoprotective, and wound-healing. It is nutritionally superior, as it contains alkaloids, dietary fiber, flavonoids, glycosides, protein, minerals (iron, magnesium, calcium, and phosphorus), and vitamins (folate, niacin, pyridoxine, riboflavin, and vitamins A and C). It also supports cardiovascular health, blood glucose regulation, and immune function. The various parts, like fruits, seeds, leaves, flowers, bark, and roots, are efficacious as medicinal plants, and their incorporation into bakery products, curries, extruded products, and soups is a tremendous source of nutritional security. It is indeed a wonder plant with enormous potential yet to be fully explored in food applications.

Keywords: Moringa, Health benefits, Food application, miracle plant

Exploring the Nutritional and Functional Potential of Genus *Bauhinia* (Kachnar): A Promising Food Source For The Future

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The genus *Bauhinia* and its species has been known since ages by tribal people and medicinal practitioners in tropical and subtropical regions for the treatment of various diseases. This genus is widely distributed across tropical and subtropical regions, are traditionally valued for their medicinal properties. Belonging to the family Fabaceae, Bauhinia is a rich source of bioactive compounds including flavonoids, tannins, terpenoids, saponins, and phenolic acids. Different plant parts including leaves, bark, flowers, seeds, and roots are employed in ethnomedicine, each contributing distinct therapeutic benefits. Various studies have highlighted its pharmacological potential, demonstrating antioxidant, antimicrobial, anti-inflammatory, antidiabetic, and hepatoprotective activities. With increasing interest in plant-based natural food products, *Bauhinia* stands out as a promising natural source for further phytochemical and pharmacological exploration.

Effect of extraction pH on yield, proximate composition, nutritional properties, structural and functional characteristics of *Acacia nilotica* seed proteins

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Acacia nilotica Linn. is an underutilized leguminous plant, known for its rich phytochemical compounds and wide array of biological activities, yet its potential as a functional ingredient in food remains underexplored. The seed contains protein content ranging from 23.37 to 30%. This study systematically evaluated the effect of extraction pH from 9 to 12 on proximate composition, nutritional properties, *in-vitro* protein digestibility, molecular weight, structural and functional characteristics of *A. nilotica* seed proteins. The highest protein content and essential amino acids were obtained at an extraction pH of 11. However, the highest yield, and protein recovery yield were found at pH 12. The secondary structure determined by circular dichroism spectroscopy revealed a decrease in alpha helix and beta sheets and an enhancement in beta coils and random coils with the progression in extraction pH. The morphology determined by scanning electron microscopy further confirmed fragmentation or denaturation of protein with an increase in extraction pH. The X-ray diffraction revealed an amorphous structure at all the extraction pH. The highest denaturation temperature and functional properties, namely protein solubility, water/oil holding capacity, foaming, and emulsion properties, were observed at pH 11. The result suggested that the extraction pH 12 can be utilised for the maximum protein recovery and yield, while pH 11 can be utilized for the maximum protein content. Overall, *A. nilotica* seed proteins can be regarded as a suitable alternative plant protein of plant protein and should be further explored for potential food and nutraceutical applications.
Keywords: Underutilized, legumes, *A. nilotica* seeds, protein, yield, functional properties.

Xanthan gum Assisted 3D Printing of Heat Desiccated Milk Solids for Dysphagia-Friendly Foods

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This study investigated the role of xanthan gum (XG) in modulating the 3D printability, rheological behaviour, structural features, and attributes of formulations prepared from heat-desiccated milk solids (HDMS) added with cane sugar. XG was incorporated at 0.5, 1.0, and 1.5% (w/w) in HDMS with total solids (TS) of 55 and 60% and cane sugar concentrations of 20 and 30%. All the formulations exhibited shear-thinning, viscoelastic gel-like behaviour, with XG addition notably enhancing yield stress, storage modulus, and shear recovery. Among them, formulation with 60% TS HDMS, 20% sugar and 1.0% XG demonstrated superior printing precision, shape fidelity, and extrusion control, owing to its elastic structuring and flowability. Tribological analysis showed that XG reduced friction coefficients, implying enhanced oral lubrication. Particle size distribution, SEM, and CLSM confirmed denser, more uniform protein–polysaccharide networks at higher XG levels, while FTIR, NMR, and DSC revealed enhanced protein–hydrocolloid interactions, reduced water mobility, and XG-induced plasticization effects. Correlating with network densification, texture profile analysis further indicated that XG incorporation increased hardness, cohesiveness, and chewiness attributes. Several XG-containing formulations were classified under IDDSI levels 5–7, underscoring their potential application in dysphagia-friendly diets. These findings highlight the multifunctional role of XG in tailoring rheology, lubrication, and microstructure of dairy-based 3D printing inks. By establishing an optimal composition window, this work provides a practical framework for the dairy industry to design customizable, structurally stable, and nutritious 3D-printed products.
Keywords: 3D food printing, dairy products, dysphagic diet, rheology, tribology, xanthan gum

Application of locust bean gum in development of honey fillings: Optimization and characterization

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This study aimed to develop and optimize a novel bakery filling using honey, watermelon rind paste (WMRP), and locust bean gum (LBG) and compare its properties with commercial chocolate fillings. A Box-Behnken design was employed to optimize the preparation process, considering three key independent variables: WMRP (10–30% w/w of honey weight), LBG (1–1.5% w/w of honey weight), and vacuum drying time (5–10 h). The effects of these variables were systematically evaluated in terms of baking stability index, syneresis, total phenolic content (TPC), firmness, and water activity. The optimal formulation was identified as 27.14% WMRP, 1.4% LBG, and a drying time of 7.6 h. Incorporating WMRP significantly enhanced TPC, total flavonoid content (TFC), and antioxidant capacity, while LBG played a critical role in improving baking stability and viscoelastic properties. The optimized honey fillings exhibited similar thermal properties to commercial chocolate fillings but demonstrated superior antioxidant activity, including higher TPC, TFC, and radical scavenging activity. Although commercial chocolate fillings displayed slightly better viscoelastic properties, they had lower structural stability compared to the honey fillings. The optimized honey filling provides a promising alternative to commercial options, offering superior nutritional value, enhanced rheological stability, and comparable thermal characteristics. This innovation highlights the potential for developing bakery fillings with improved health benefits and functional properties.

Keywords: Honey, WMRP, LBG, Bakery products, Commercial products

Fabrication and characterization of fenugreek seed gum and alginate composite hydrogel films for sustainable food packaging application

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In response to the environmental concerns associated with petroleum-based packaging, eco-friendly food packaging materials have attracted considerable interest. By-products from the oilseed crop processing industries can be effectively valorized to recover valuable compounds, including biodegradable polymers like galactomannans. Among these, fenugreek seed gum (FSG) exhibits excellent gelling, thickening, and film-forming capabilities, which can be effectively utilized for food packaging application. In the present work, hydrogel films were fabricated using fenugreek seed gum (0.5% - 2%) and sodium alginate (1%), along with glycerol. The rheological analysis of these composite film-forming solutions revealed progressive increase in viscosity with incorporation of gum. Further, the antimicrobial potential was observed against *Staphylococcus aureus* and *Escherichia coli* using the agar diffusion assay, as evidenced by well-defined inhibition zones. Subsequently, the films were developed through calcium chloride-induced cross-linking via immersion technique, and assessed for various physicochemical parameters, including mechanical strength, light transmittance, hydrophobicity, and oxygen transmission rate. Their practical application was further assessed, with outcomes compared against fruits packaged in commercial polypropylene material and an unpackaged control. The composite films effectively minimized surface dehydration, preserved textural integrity, and suppressed microbial growth. Thus, the present investigation demonstrated homogeneous distribution and strong interpolymeric interaction between fenugreek gum and alginate, confirming their suitability as eco-friendly and sustainable materials for packaging applications.

Keywords: Fenugreek gum, alginate, $CaCl_2$, cross-linking, hydrogel, packaging films

Rice starch-based edible coatings and films as innovative approach for food quality preservation

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From the lush paddies of the world, rice emerges not only as a global dietary staple but also as a reservoir of nutrients, minerals, and bioactive compounds. Rice starch, extracted from both conventional white and colored varieties such as black, red, and blue rice, has gained recognition as a sustainable material for edible coatings and biodegradable films. Pigmented rice starches are enriched with anthocyanins—cyanidin-3-glucoside, peonidin-3-glucoside, and cyanidin-3-rutinoside—along with B vitamins, iron, zinc, and dietary fiber, which enhance both the nutritional and functional attributes of the films. The presence of these natural pigments further increases the antioxidant potential of the coatings. The distinctive amylose– amylopectin ratio in rice starch contributes to adjustable gel strength and flexibility, enabling the formation of smooth, semi-permeable barriers that effectively restrict moisture, oxygen, and microbial transfer. Its compatibility with natural plasticizers and biopolymers makes it ideal for developing smart, eco-friendly packaging. However, colored rice starch films may encounter challenges related to thermal stability, mechanical strength, and film uniformity. These limitations, revealed through rheological, morphological, and spectrophotometric analyses, can be mitigated through chemical cross-linking, enzymatic modification, or composite formulations with fatty acid esters to improve film integrity and performance. Overall, colored rice starch-based coatings demonstrate enhanced antioxidant retention, reduced weight loss, and delayed ripening of foods, establishing them as promising, biodegradable materials that ensure product freshness, nutritional preservation, and sustainability in modern food packaging.

Keywords: Colored rice, film-forming properties, functional packaging, health benefits.

Basil Seed-Derived Hydrocolloids as Emerging Stabilizers for Pickering Emulsion: Structure, Functionality and Food Applications

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Seed gum (BSG) is an emerging plant-based hydrocolloid that play a vital role in the food industry because of its various functional properties such as thickening, gelling, fat replacing, emulsion, and foam stabilizing. It is a polysaccharide-rich biopolymer exhibiting properties like viscoelasticity, high water-binding capacity and biocompatibility. In addition to stabilizing emulsions BSG act as a fat alternative by water retention and forming gel-like networks which mimics the texture and rheological properties of fat in low fat food application. In this review BSG hydrocolloids are studied for their structure, interfacial activity and various functions in Pickering emulsion including droplet stabilization, rheological properties and its interaction with other biopolymers. This review also highlights its potential application in food industry including low fat emulsions, functional beverages, improved texture and encapsulation of bioactive compounds. The review also explores its future research direction focusing on its fat replacement potential, mechanisms of particle formation and long-term stability of emulsions in varying environmental conditions.

Keywords: Seed gum, Hydrocolloids, Pickering Emulsion, Plant-Based

Development of Sodium-Alginate and Carrageenan-Based Biodegradable Films Incorporated with Nanoclay (MMT K10) for Shelf-Life Extension of Apricot Fruits

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The excessive use of plastic packaging poses serious environmental concerns, driving the need for biodegradable alternatives. This study focuses on developing and characterizing biodegradable films prepared from sodium alginate and carrageenan incorporated with nano clay (Montmorillonite K10). Films were formulated with different nano clay concentrations—0.0%, 0.2%, 0.5%, and 1% (w/w) and coded as SACK0-0 (control), SACK1-0.2, SACK2-0.5 and SACK3-1. The films were evaluated for mechanical, physical, and morphological properties. Incorporation of nano clay improved thickness, moisture content, and water vapor permeability, with a notable increase in tensile strength (87.09 ± 3.23 MPa) compared to the control (36.69 ± 0.23 MPa). SEM analysis confirmed uniform and crack-free film surfaces. The optimized SACK3-1 and control films were applied to apricot fruits to assess their shelf-life. Coated samples were analyzed for colour, firmness, total soluble solids (TSS), and weight loss. Results showed that apricots coated with SACK3-1 retained freshness for 6 days, while uncoated and control-coated fruits spoiled by day 4. Thus, SACK3-1 extended the shelf life by about 3 days. The findings demonstrate that sodium-alginate–carrageenan–nano clay films hold strong potential as eco-friendly packaging materials for extending fruit shelf life and reducing plastic waste.

Keywords: Sodium alginate, Carrageenan, Nano Clay, Biodegradable film, Apricot, Shelf life

Enhancing the Shelf Life and Quality of Fresh-Cut Melon Using Starch–Alginate–Aloe Vera Based Coatings

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Fresh-cut fruits deteriorate faster than intact ones due to surface browning, texture loss and off-flavor development. The application of edible coatings can effectively minimize these changes by acting as a modified atmosphere, extending shelf life and offering an eco-friendly alternative to synthetic packaging. This study evaluated the quality and shelf life of fresh-cut melon pieces coated with starch/alginate-based edible coatings containing olive oil (1% v/v) as a lipid component, with starch (3–5% w/v) and alginate (1–2% w/v) concentrations varied accordingly. Glycerol (3% v/v) and Tween 80 (1% v/v) were used as plasticizer and emulsifier, respectively. Additionally, aloe vera gel (AVG, 30% v/v) was incorporated into the coating formulations to develop herbal edible coatings with added antioxidant and antimicrobial properties. The herbal coatings, particularly the HA2 sample (Alginate 2% + AVG 30%), showed the lowest weight loss (2.81 ± 0.30%) and effectively maintained texture, color, and microbial stability (<5 log CFU/g) up to 14 days of refrigerated storage. Coated samples also retained acceptable sensory qualities throughout the storage period. The results demonstrated that aloe vera-incorporated starch/alginate coatings can serve as an effective, natural and sustainable strategy for extending the shelf life of fresh-cut melon.

Keywords: Edible coating, Starch, Alginate, Aloe vera, Melon, Shelf life

Valorization of *Syzygium cumini* Seed Waste through Starch Extraction, Characterization and Nanoreduction

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Starch, an abundant polysaccharide, plays a crucial role in various industries, including food, pharmaceuticals, and textiles. This study investigates the extraction, characterization, and nano-reduction of starch from *Syzygium cumini* (Jamun) seeds, an underutilized starch source. Starch extraction was performed using six different steeping additives: distilled water, NaOH, acetic acid, ascorbic acid, citric acid, and lactic acid, with citric acid yielding the highest recovery (35.6%). The extracted starch was characterized using scanning electron microscopy (SEM), Fourier-transform infrared spectroscopy (FTIR), and pasting property analysis to assess its physicochemical attributes. Starch granules exhibited a size distribution of 2.8 to 32 µm, with water and oil absorption capacities of 160% and 124%, respectively. Furthermore, acid hydrolysis, ultrasonication, and a combined sonication-acid treatment successfully facilitated the nano-reduction of starch. The resulting nanoparticles exhibited enhanced surface properties and structural modifications, expanding their potential applications. The findings indicate that *S. cumini* seed starch possesses unique physicochemical characteristics, making it a promising candidate for commercial applications in food processing, biodegradable materials, and nanotechnology.
Keywords: Syzygium cumini seed, starch extraction, nanoreduction, physicochemical properties, biodegradable materials, waste valorization

Enhancing Kombucha as a Functional Beverage: A Review of the Combined Effects of Fruit Fortification and Tea Varieties

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Kombucha is an ancient Chinese fermented beverage which is developed from the infusions of different types of substrates fermented with a symbiotic culture of yeast and bacteria (SCOBY). It has been consumed for centuries for its health benefits, which led to many research studies experimenting with new alternatives to make it taste better and be even healthier due to the increasing health-conscious concern and increase in demand. This paper reviews how the synergistic effect of tea *Camellia sinensis* with different kinds of fruits affects the quality and nutritional value of kombucha. During the fermentation process, the culture turns sweet tea into a beverage rich in bioactive compounds like vitamins (B&C), organic acids, caffeine, polyphenols, sugars, D-saccharic acid-1,4-lactone (DSL), CO2, minerals, proteins, fats, ethanol (2%) and probiotics that contributes to the beneficial effects on the stomach and immune system. Fruits bring their own healthy nutrients, such as antioxidants, to the drink. This paper highlights the utilizations of various fruits like blueberries, strawberry tree (ST) fruit snake fruit, Brazilian fruits, cherry, strawberry, plum, persimmon, apricot, orange, pomegranate and grapes in kombucha. It was reported in previous literature that this synergistic effect of tea and fruit substrates has shown to produce high levels of bioactive compounds that fight cell damage, controlling oxidative stress, provides gastroprotective property, lowering cholesterol and so on. Combining tea with fruit juices or pulps is an excellent way to create a beverage that is not only refreshing and delicious but also packed with antioxidants and polyphenolic compounds that support good health.
Keywords: Kombucha, SCOBY, organic acids, Antioxidants, probiotics, *Camellia sinensis*, polyphenols, synergistic effect.

Phenotypic and genetic assessment of probiotic *Lactobacillus delbrueckii* DC3 isolated from traditional Indian fermented food

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This study reports the isolation and characterization of *Lactobacillus delbrueckii* subsp. *indicus* DC-3 from the traditional Indian fermented milk product, dahi. The strain was identified through whole-genome sequencing, and its safety was thoroughly assessed using both genetic and phenotypic analyses, including the detection of virulence factors, mobile and insertion elements, plasmids, and antibiotic resistance genes. Additionally, the probiotic potential of the strain was evaluated in vitro by examining its biofilm formation ability, antibacterial activity, and exopolysaccharide (EPS) production. Genomic analysis revealed that the strain possesses a single circular chromosome (3,145,837 bp) with a GC content of 56.73%, a high number of accessory and unique genes, and an open pan-genome, with no presence of plasmids, insertion sequences, mobile elements, virulence determinants, or transferable antibiotic resistance genes. Functionally, the strain demonstrated strong survival under simulated gastrointestinal conditions, maintaining 83% viability in gastric juice (3 h) and 71% in intestinal juice (6 h). It exhibited 42.5% autoaggregation, mucin adhesion capability, 8.7% adhesion to xylene, and 8.3% adhesion to Caco-2 cells. Safety evaluation confirmed its γ-hemolytic nature, typical antibiotic sensitivity pattern, and negative results for mucin and gelatin degradation. The strain produced 10.5 g/L of D-lactic acid and hydrogen peroxide, effectively inhibiting and co-aggregating with *Escherichia coli* MTCC 1687, *Proteus mirabilis* MTCC 425, and *Candida albicans* ATCC 14053. Moreover, it synthesized 90 mg/L of EPS after 48 hours and demonstrated biofilm-forming capacity. Overall, these findings indicate that *L. delbrueckii* subsp. *indicus* DC-3 is genetically distinct from previously reported strains and represents a safe and promising probiotic candidate for potential application in fermented foods.

Keywords: *Lactobacillus delbrueckii* subsp. *indicus* DC-3, Probiotic potential, Safety evaluation, Fermented milk, Dahi, Hydrogen peroxide

Development and Evaluation of Protein-Rich Probiotic Soy base Shrikhand as a Functional Non-Dairy Dessert

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The present study was undertaken to develop and assess protein-rich soyashrikhand as a functional non-dairy probiotic dessert. Soymilk was prepared and analysed for its proximate composition, as acidity (0.17%), total soluble solids (9.79°Brix), moisture (83.06%), crude protein (6.66%), crude fat (2.09%), ash (0.87%), carbohydrates (7.30%), calcium (21.66 mg/100 g), iron (0.75 mg/100 g), and antioxidant activity (42.20% inhibition). Soyashrikhand was developed by fermenting soymilk using different Lactobacillus strains such as *L. acidophilus* (15), *L. plantarum* (20), *L. rhamnosus* (296), and a mixed culture. The formulation containing *L. acidophilus* showed the highest sensory acceptability (overall score: 8.20/9). The final product showed improved nutritional characteristics as crude protein (10.85%), carbohydrates (34.68%), calcium (95.95 mg/100 g), and antioxidant activity (54.43% inhibition). In vitro probiotic tolerance studies reveals that *L. acidophilus* showed significant survivability under acidic (pH 2) and bile conditions. Storage studies at 4 ± 1 °C for 15 days indicated a gradual increase in acidity from 0.71% to 1.01% and a minor decline in TSS from 49°Brix to 47.4°Brix and viability count from 8.20 log CFU/ml to 8.08 log CFU/ml, and no coliform detected. Overall, soyashrikhand fortified with *Lactobacillus acidophilus* showed excellent probiotic viability, sensory appeal, and nutritional value, highlighting its potential as a cost-effective, lactose-free functional food alternative.

Keywords: Soyashrikhand, *Lactobacillus acidophilus*, Probiotic, Functional food, Soy protein, Sensory evaluation.

Emerging Prebiotic Strategies for Gut Health: From Natural Polysaccharides to Engineered Synbiotics

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Prebiotics are selectively fermentable substrates that provide health benefits mainly through modulating the gut microbiota and producing short-chain fatty acids (SCFAs), including acetate, propionate, and butyrate. From 2015 to 2025, research has gone beyond traditional prebiotics like inulin and fructooligosaccharides to include plant-derived polysaccharides, microbial exopolysaccharides, and structurally engineered or conjugated molecules. These developments highlight the importance of prebiotic structure, degree of polymerization, and chemical modifications in influencing microbial fermentation and SCFA profiles. Emerging evidence underscores the interactions between primary degraders and cross-feeding networks in SCFA production, affecting gut barrier function, immune response, metabolic regulation, and overall health. Notably, new delivery systems and synbiotics improve probiotic survival and enable sustained SCFA release, expanding potential treatments for colitis, metabolic issues, cancer, and neuroinflammation. This review combines mechanistic insights into prebiotic–microbiota–SCFA interactions, compares different prebiotic types and their effects, and points to future directions involving precise prebiotic design, sustainable sourcing, and clinical validation. Overall, advances from the past decade reinforce SCFAs as key mediators of prebiotic benefits and highlight the potential of tailored prebiotic strategies as tools for targeted health modulation.

Keywords: Prebiotics; Short-chain fatty acids (SCFAs); Gut microbiota; Fermentation; Cross-feeding; Exopolysaccharides; Synbiotics; Structural modification; Gut barrier; Immune modulation; Metabolic regulation; Neuroprotection

Prebiotic, Probiotic and Synbiotic

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The pivotal role of the gut microbiome in human health has propelled interest in targeted dietary interventions, primarily prebiotics, probiotics and synbiotics. This presentation will explore the mechanisms and clinical evidence for these three strategies. Probiotics are live microorganisms that confer a health benefit by competitive exclusion of pathogens, reinforcement of the gut barrier, and immunomodulation. Prebiotics, non-digestible food ingredients like fructo-oligosaccharide (FOS) and galactooligosaccharides(GOS), selectively stimulate the growth and activity of beneficial indigenous bacteria. Synbiotics, synergistic combinations of pre- and probiotics, are designed to improve the survival and implantation of live microbial supplements, thereby delivering enhanced benefits. We will critically appraise the clinical landscape, reviewing meta- analyses that support the use of specific probiotic strains in managing antibiotic- associated diarrhea and irritable bowel syndrome(IBS). The evidence for prebiotics in modulating immune function and metabolic health will be discussed. A key focus will be the emerging, superior efficacy of rationally designed synbiotics in clinical areas such as hepatic encephalopathy, metabolic syndrome, and postoperative recovery,where they often outperform monotherapies. Despite promising evidence, challenges remain in strain selection, product standardization, and personalization. This synthesis aims to bridge foundational science with clinical practice, providing a clear perspective on the future of microbiome- targeted therapies for improving human health.

Keywords: Prebiotic, probiotic, synbiotic, human health, nutrition, clinical symptoms

Enhancing Storage and Frying Oxidative Stability of Ghee Using Antioxidants Extracted from Tulsi Leaves

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Tulsi leaves have high antioxidant properties due to their rich content of phenolic and flavonoid compounds, which effectively scavenge free radicals and prevent oxidation. This study investigates the incorporation of Tulsi extract into ghee and evaluates its oxidative stability during storage and frying. The methanolic extraction yield of tulsi leaves was 4.21 ± 0.62 percent (w/w) and it contains total phenolic content (TPC) of 138 mg GAE/g, total flavonoid content (TFC) of 63.8 mg CAE/g and antioxidant activity IC_{50} value of 4.2 µg/ml. Addition of tulsi leaves extract in different proportions of 0.2, 0.4, 0.6, 0.8 and 1.0% considerably decreased the oxidative deterioration during the course of 21 days of storage at 80 °C. Over time, the free fatty acid (% FFA) values rose, but at 1.0% extract concentration it showed the minimum change 0.086% as compare to the fresh oil 0.031%. The storage stability in terms of % FFA of 1.0% TLE extract added ghee sample was superior than the synthetic antioxidant BHA (0.098%) added sample even after 21 days of storage. The peroxide values (PV) of the ghee samples added with TLE of 0.2-1.0% ranged between 42 meq O_2/kg and 9 meq O2/kg respectively, demonstrating effective retardation of primary oxidation. Similarly, p-anisidine values (AV) were markedly reduced, from 22.72 ± 0.63 at 0.2 % extract to 6.04 ± 0.67 at 1.0 % extract, confirming suppression of secondary oxidation products. Under frying conditions at 180°C for varying time interval of 0, 18, 36, 54, 72 and 90 min, Tulsi extract continued to exhibit strong antioxidant protection. At 1.0 % concentration, % FFA (0.451 ± 0.062), PV (24 ± 0.32 meq O_2/kg), and AV (10.42 ± 0.59) were all significantly lower than control and comparable or superior to BHA even after 90 min of frying. Overall, Tulsi leaf extract effectively stabilized the ghee for oxidative deterioration during both storage and frying, indicating its potential as a natural alternative over synthetic antioxidants in lipid-based food systems.

Keywords: Tulsi leaves, Ocimum sanctum, ghee, antioxidant activity, oxidative stability, natural antioxidant, storage, frying.

Effect of drying conditions on physical and functional properties of guar gum

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Guar gum drying process is a critical stage in the manufacturing of powder typically performed using different dryers to ensure product stability and long shelf life. In this study the effects of six different drying conditions on the physical and functional properties of guar gum were investigated. The present study revealed that microwave drying provided the most suitable physical and functional properties for dried guar gums as compared to oven dried samples. Microwave dried sample showed the highest porosity, emulsion capacity and foaming properties. However, attributes of guar gum powders prepared by different drying conditions showed that 360W microwave dried samples had relatively good c characteristics as compared to other dried guar gum samples S dried lower L* value and (1.87)d (1.73) slight. microwave oven drying confirmed comparatively higher solubility (67.48 %) and foaming capacity (34.12 %). Thus, the observation concluded that microwave drying showed better quality characteristics in terms of physical and functional properties as compared to oven dried samples.

Characterization of Edible Films Prepared from Donkey Milk Proteins

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The growing demand for sustainable food packaging materials has stimulated interest in milk-derived proteins as natural film-forming agents. According to Acumen Research and consulting report, 2022 the Global Edible Films and Coatings Market accounted for US$ 2,686 Mn in 2021 and is estimated to reach US$ 5,186 Mn by 2030, with a significant CAGR of 7.8% from 2022 to 2030. Donkey milk is quite comparable to human breast milk and is regarded as a food with significant value addition due to presence of proteins, fat, vitamins. This study investigates the potential of isolated proteins i.e casein and whey proteins from donkey milk for edible film development. The public is becoming more interested in donkey milk since they are high in essential milk components. Milk powder, baby formula, cheese, ice cream and other fermented milk products are examples of dairy products manufactured from donkey milk. Donkey milk casein proteins were extracted, characterized and incorporated into film-forming solutions with different plasticisers including enzyme based plasticisers to evaluate their functional, structural and mechanical properties. The resulting films were analyzed for thickness, tensile strength & elongation at break. The donkey casein proteins based film had tensile strength 5.62±1.49 MPa. Elongation break varied 5.62±1.49%. Overall, donkey milk caseins proteins demonstrated promising film-forming capabilities and using their potential application in packaging systems. These findings contribute to expanding the underexplored use of donkey milk proteins in environmentally friendly food packaging solutions.
Keywords: Donkey milk, edible film, milk protein, plasticizer, packaging materials

Comparative Evaluation of Hybrid and Cabinet Drying on Physicochemical and Functional Quality of Tender Jackfruit (*Artocarpus heterophyllus Lam*.) for the preparation of Curry

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This study evaluates the drying behavior and quality characteristics of tender jackfruit subjected to hybrid and cabinet drying methods. The main objective was to enhance shelf-life and product quality while minimizing post-harvest losses. Various pre-treatments, potassium metabisulfite (KMS), citric acid, and potassium sorbate were applied at concentrations of 0.1–0.3%. Among them, 0.3% KMS proved most effective in preserving color, texture, and microbial safety. Hybrid drying at 60°C significantly outperformed cabinet drying in terms of moisture removal rate, nutrient retention, and sensory acceptability. Proximate analysis revealed that hybrid-dried jackfruit retained higher levels of protein (2.54%), fiber (3.26%), and carbohydrates (82.13%) with lower residual moisture (10.2%) compared to cabinet drying. Storage studies showed that aluminum-laminated polyethylene pouches better preserved product quality over 90 days. Sensory evaluation rated the hybrid-dried jackfruit curry favorably in taste and texture. Drying kinetics were analyzed using mathematical models, with the Page model showing the best fit ($R^2 = 0.90$) for hybrid drying, indicating efficient moisture diffusion and retention of quality attributes. These findings highlight the potential of hybrid drying combined with effective pre-treatment as a sustainable and economically viable approach for tender jackfruit processing and commercialization.
Keywords: Tender Jackfruit, Hybrid Drying, Moisture removal kinetics, Pre-treatment optimization, Physicochemical properties

Formulation and quality assessment of instant dhokla mix with incorporation of foxtail millet and horse gram

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To develop and quality evaluation of instant dhokla mixes incorporation with foxtail millet and horse gram. Cereal-legume-based instant fermented food (Dhokla) is one of the most popular, indigenous fermented foods of India. The value added instant dhokla mix was developed by using ingredient viz. foxtail millet, horse gram. the ratio of foxtail millet:horse gram in the formulation was A(1:1), B(2:1), C(1:2), D(2:0), E(0:2) Five variations were performed and were organoleptically evaluated in comparison with basic variation. The most acceptable variation of developed mix analyzed for nutritional quality. The findings revealed that among all variations of dhokla mix the variation (C) was organoleptically acceptable. The Value added instant dhokla mix found to contain more protein (19.29g), fat (4.90g), total minerals (3.87g), fiber (1.21g), iron (7.52mg), calcium (128.20mg) and phosphorus (313.33mg) per 100g which was increased by 3.67g, 2.0g, 1.57g, 0.89g, 4.0mg, 83.18mg and 74.67mg respectively over the basic mix. Storage study indicated that developed instant dhokla mix can be stored up to six months. Moisture absorption and peroxide value was low in laminated aluminum pouch (P1) than polythene pouch (P2) stored mix. Microbial study showed that both the stored samples had safe microbial population and hence were fit for consumption.

Keywords: Value addition, Dhokla, Instant mix, Foxtail millet, Horse gram

Quality Evaluation of Jute Leaves Dried by Open Sun Drying (OSD) and Solar Tunnel Dryer (STD) methods

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This research work investigates the quality analysis of dried jute leaves (Corchorus olitorius) using two drying methods: open sun drying (OSD) and solar tunnel dryer (STD). Jute leave is a good source of minerals, proteins, vitamins and macronutrients that are necessary for the human nutrition. Since jute leaves are a seasonal plant and prone to microbial degradation and are easily spoiling due to high moisture contain, drying is the effective technique to prolong their shelf life and preserve them. The initial moisture content of fresh jute leaves was . The final moisture content of jute leaves achieved after drying with OSD, STD was in 2 days and in 6 hrs. The findings showed that, in comparison to OSD, drying in a STD maintained better nutritional quality and significantly reduced drying time, making STD a more effective and hygienic technique for preserving jute leaves. Besides improving product quality, it helps sustainably preserve seasonal green veggies after harvest.

Keywords: Jute leaves, STD, Quality analysis

Morphological, physicochemical and functional characterization of *Arenga obtusifolia* pith flour starch

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Palms (family *Arecaceae*) are notable yet overlooked starch sources. Starch extracted from *Arenga obtusifolia* palm pith flour was studied morphological, chemical, physicochemical and functional properties. Scanning electron microscopy revealed the sizes, shapes and morphological features of the smooth-surfaced starch granules. Mixed A+B (CA type) type polymorphism as typical to other *Arenga* species was depicted by the X-ray diffraction pattern. Differential scanning calorimetry revealed the gelatinization pattern of the starch with transition initial, peak and conclusion temperatures of 68.1°C, 77.2°C and 81.6°C, respectively. Enthalpy of transition measured 9.00 J/g. Bonding patterns were elucidated by infrared spectroscopy. Pasting and other functional properties, namely swelling power, solubility and freeze-thaw stability of the gel suggested potential utility in different food and non-food industries.

Keywords: palm, *tassey*, *Arenga obtusifolia*, native starch, general characteristics

Effect of Cold Plasma on Proximate Composition of Desi Chickpea Seeds

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Cold plasma treatment is an emerging non-thermal technology widely explored for food processing and nutritional enhancement of legumes. The present study investigates the effect of cold plasma treatment on the proximate composition of desi chickpea (*Cicer arietinum L.*) seeds, variety Pusa 3062. Seeds were exposed to atmospheric cold plasma jet at voltages of 9.5 kV and 11.5 kV for 5 minutes at 30 kHz frequency. The treated and untreated samples were analysed for proximate parameters including moisture, crude protein, crude fat, ash, and carbohydrate content using standard AOAC methods. The results indicated a marginal reduction in moisture and fat content with increasing voltage, while crude protein and ash contents showed a slight increase, possibly due to surface modification and removal of non-protein components. Overall, cold plasma treatment was found to influence the proximate composition without causing significant nutritional deterioration. The findings highlight the potential of cold plasma as a sustainable pre-treatment method for improving the nutritional and functional quality of chickpea seeds.

Keywords: Cold plasma, Proximate analysis, Desi chickpea, non-thermal technology, Nutritional quality

Development and Characterization of Edible Coatings Enriched with Probiotics for Enhanced Food Preservation

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The incorporation of probiotics into edible coatings offers an innovative and consumer-friendly approach to enhance food quality and health functionality. This study aimed to develop a natural, biodegradable coating enriched with live probiotic strains to simultaneously protect food surfaces and deliver gut-beneficial microbes. A biopolymer-based matrix was optimized to ensure strong adhesion, transparency, and controlled moisture transfer. Probiotic cells were micro-encapsulated to preserve viability during storage. Micro-encapsulated probiotic cells were used to keep them alive while they were being processed and stored in the cold. Viability tests showed that probiotic counts remained above the minimum therapeutic threshold (e.g. $\geq 10^6$ CFU/g) over extended refrigeration storage periods (4°C). Coated food samples were evaluated for physicochemical quality, microbial stability, texture retention, and probiotic survival. The coating also contributed to improved barrier properties reducing water loss, delaying spoilage, and limiting fungal or bacterial growth on coated produce, maintained appealing sensory properties as compared with uncoated controls. Overall, edible coatings with probiotics show promise as dual-purpose systems: acting as protective packaging for perishable foods and as carriers for delivering probiotics to consumers in effective concentrations, thus contributing to the next generation of functional foods. Further research should aim at scaling up the process, optimizing probiotic-strain/coating-matrix combinations, and validating in vivo health outcomes.

Keywords: Probiotic incorporation, Edible coatings, Biopolymer matrix, Micro-encapsulation, Food protection, Probiotic viability, Functional foods, Shelf-life extension, Microbial stability

Physico-chemical and phytochemical characterization of amla (*Emblica officinalis*) cultivars: Identifying suitable genotype for juice extraction

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Indian gooseberry (Emblica officinalis), commonly known as amla, is a fruit of considerable nutritional and therapeutic significance in Ayurveda. It is an excellent source of vitamin C, minerals, and diverse phytochemicals contributing to its functional and health-promoting properties. Multiple cultivars of amla are cultivated across India, exhibiting variations in their morphological and biochemical characteristics. The present investigation aimed to evaluate seven prominent cultivars viz. *Balwant*, *Banarasi*, *Chakaiya*, *Desi*, *NA-6*, *NA-7*, and *NA-10* for their potential in juice extraction. Comprehensive characterization of physical parameters of fruit (average fruit weight, flesh content, seed proportion, juice yield, pomace content, moisture, and total solids), physico-chemical attributes (pH, total soluble solids, titratable acidity, and reducing sugars), and phytochemical constituents of juice (ascorbic acid, total phenolic content, DPPH scavenging activity and tannin content) were performed. *Banarasi* cultivar exhibited highest average weight, flesh% and juice yield%; however, recorded lowest seed% and pomace%. Conversely, *Desi* recorded lowest juice yield and highest seed% and pomace%. No significant changes were observed among cultivars in physico-chemical properties. Ascorbic acid and TPC ranged between 393.49-698.63 mg/100 mL and 238.28-582.10 mg GAE/L, respectively, with Desi having highest values followed by *Chakaiya* and *Banarasi*. DPPH scavenging activity and tannin content varied from 48.29 to 68.63% and 1.39 to 1.48%, respectively. Additionally, multivariate analysis was carried out to highlight the differences among the cultivars. Finally, taking into consideration that superior juice yield and with appreciably high phytochemical content, *Banarasi* was selected as the most suitable cultivar for amla juice extraction.

Keywords: Amla juice, Juice yield, Ascorbic acid, Principal component analysis

Food Preservation in Conflict Zones: Strategies for Securing Nutrition during Crises

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Food preservation plays a crucial role in ensuring nutrition security, especially in conflict-affected regions where food supply chains are disrupted and access to fresh produce is limited. During crises, traditional distribution networks often collapse, leading to severe shortages, malnutrition, and dependence on emergency aid. This paper explores innovative strategies and context-specific preservation techniques that can enhance food availability and stability in conflict zones. It examines low-cost, low-energy preservation methods such as solar drying, fermentation, salting, and community-based cold storage systems that can function without a continuous power supply. The role of humanitarian logistics, local food processing units, and mobile preservation technologies is analyzed as part of an integrated approach to food security. Furthermore, the study emphasizes the need for policy frameworks and international collaborations that empower local populations—particularly women and small-scale producers—to adopt resilient preservation practices. By combining traditional knowledge with modern innovations, food preservation in conflict zones can shift from short-term relief to long-term nutritional resilience, reducing dependency on external aid and strengthening community self-reliance.

Optimization of pre-treatments for milling and storage of barnyard millets (*Echinochloa frumentacea*)

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Barnyard Millet (*Echinochloa frumentacea*) is a collective term used for small-seeded annual grasses grown as grain crops, mainly on marginal lands in arid and semi-arid regions across temperate, subtropical, and tropical zones. The present study aimed to assess and optimize pretreatments for barnyard millet to improve its processing efficiency and storage stability. Hydrothermal treatments such as soaking, steaming, and boiling, along with microwave heating, were applied before drying to a moisture content of 12 ± 0.5%. Dehulling was performed using a millet dehuller, followed by sieve analysis to determine whole, coarse, and fine fractions. Ground barnyard millet flour was also analyzed to evaluate particle size distribution, where D60, D30, and D10 values were obtained using different sieves. Optimization was done using Design Expert software to identify the best pretreatments based on maximizing dehulling efficiency, milling efficiency, and uniformity coefficient. The optimized pretreated flour samples were packed in low-density polyethylene (100 gauge) and vacuum packs (300 gauge) and stored under ambient conditions for 90 days, during which physicochemical and microbial analyses were carried out at 15-day intervals. The study found that microwave heating was best pre-treatment at 3 min for achieving maximum dehulling efficiency, milling efficiency, and uniformity coefficient of 97.05%, 89.91% and 2.166, respectively. The optimized pretreated millet flours could be stored for 90 days in vacuum packages without significant quality loss.
Keywords: Barnyard millet, pretreatments, optimization, microwave heating, storage

Air-Cooling System in Attrition Mill for Temperature Profile of Wheat Flour

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The milling of whole-wheat flour in traditional *atta chakkis* is characterized by high rates of frictional heat generation. This heat frequently elevates the flour temperature to levels that compromise its nutritional profile, reduce its shelf life, and cause operational issues like clogging. The critical need to mitigate thermal degradation during milling is the focus of our work. Our primary objective was to design, develop, and test a low-cost, effective air-cooling system, capable of maintaining the grinder and flour temperature below 400C. Methodology involved modifying a conventional *atta chakki* by installing a 0.5 HP centrifugal blower and an external metal casing. This setup created a forced air passage around the grinding chamber to continuously remove heat and prevent air recirculation. Temperature readings were taken using an infrared thermometer at 5 minute for both the conventional mill and the newly developed air-cooled mill. The major findings demonstrate the significant effectiveness of the system. Over a 40-minute run, the flour temperature in the conventional mill rose to 52.20C, whereas the air-cooled mill's temperature only reached 41.20C, achieving a net temperature reduction of 110C. Furthermore, the calculated heat generated was reduced by 46.5% (from 0.544 kW to 0.2907 kW). This reduction directly minimized the thermal degradation risk, proving the air-cooling system to be an efficient and practical solution for preserving the quality and integrity of whole-wheat flour produced by traditional mills.
Keywords: Atta Chakki, Air-Cooling System, Thermal Degradation, Quality.

Assessing the efficiency of iron-salt oxygen absorption for paddy stored in different types of bags

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Hermetic storage is a safe, eco-friendly, and pesticide-free method that preserves grain and seed quality by maintaining an airtight environment, minimizing gas and moisture exchange. This study focused on evaluating the oxygen absorption potential of iron-based absorbers under organic hermetic storage conditions. Two experimental approaches were taken: first, determining the optimal quantities of iron filings and common salt (NaCl) to use as oxygen absorbers; and second, applying the optimized combination to 50 kg batches of paddy stored in different bag types-hermetic, polythene, and jute. Preliminary trials in 1000cc glass jars, using varying iron and salt ratios, identified that 1g of iron combined with 0.1g of NaCl absorbed up to 124cc of oxygen. This ratio was then upscaled, guiding the absorber quantities for large storage. For the six-month storage study, hermetic bags demonstrated superior performance, retaining CO_2 and providing a modified atmosphere potentially suppressing insect activity. Over 180 days, oxygen concentration in hermetic storage fell from 20.9% to 9.13%, whereas CO_2 rose to 8.86%. The bags maintained stable temperature (28.37°C), relative humidity (72%), and moisture content (12.52%). Minimal reductions were observed in thousand-grain weight (27.3g to 26.78g) and bulk density (595.36 to 588.24 kg/m³). Free fatty acid levels rose slightly to 0.84%, while mold incidence was lowest at 2.67%, highlighting the effectiveness of hermetic bags in preserving grain quality throughout long-term storage.
Keywords: Hermetic Storage, Oxygen absorbers, Iron filings, Paddy, Carbon dioxide accumulation, Rusting reaction.

Development and Evaluation of Shelf- Stability of Osmotically Dehydrated Sand Pear (*Pyrus pyrifolia L.*) Candy

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Sand pear (*Pyrus pyrifolia L.*) is a nutritious but highly perishable fruit with limited postharvest life due to its high moisture content and susceptibility to browning. The present study aimed to develop a ready-to-eat sand pear candy using osmotic dehydration followed by convective drying to enhance its shelf stability and value addition. The optimum conditions for the development of sand pear candy were as 70 ºBx sucrose concentration, 70ºC osmotic solution temperature and 110 minutes process duration to achieve desirable product quality. The osmotically treated samples were further convectively dried at 60°C. Moisture sorption isotherms of the candy were determined gravimetrically at 30 °C, 40 °C, and 50 °C using saturated salt solutions of known relative humidities and fitted to various mathematical models to describe the equilibrium moisture (EMC) behavior. Storage studies were conducted for six months under two temperature conditions (10 ± 1°C and 25 ± 1°C) using three different packaging materials: aluminium laminate (ALP), high-density polyethylene (HDPE), and low-density polyethylene (LDPE). Physicochemical, microbiological, and sensory attributes were evaluated at regular intervals. Results revealed that osmotic dehydration followed by convective drying significantly improved texture, color, and overall acceptability. The EMC of the osmotically dehydrated Sand pear candy decreased with temperature at constant humidity, showed type II sigmoid isotherms, and were best described by the Modified Exponential model. Among all packaging types, ALP under refrigerated storage (10 ± 1°C) effectively preserved the product's physicochemical integrity and sensory quality with minimal microbial growth, demonstrating enhanced stability during storage. Overall, osmotic dehydration proved to be an efficient preservation technique for producing high-quality, shelf-stable, and consumer-acceptable sand pear candy, thereby reducing postharvest losses and promoting effective value addition of underutilized fruits.
Keywords: Sand pear candy, osmotic dehydration, sorption isotherms, storage stability

Comparative Analysis of Protein and Starch-Based Biodegradable Films: Physicochemical Properties and Hydrophilic Behavior

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The proliferation of non-biodegradable plastic packaging, a significant contributor to environmental deterioration, has heightened the urgency in pursuing sustainable substitutes, leading this research to examine the production of biodegradable films from apricot seed protein in comparison to corn starch-based films. Fabricated using a solution-casting procedure with glycerol plasticizer, a detailed physicochemical evaluation revealed that the protein-based films exhibited superior hydrophilic properties. Specifically, the protein-based films demonstrated higher moisture content (22.93±1.1%), water solubility (29.37±1.7%), and swelling levels (49.95±1.5%) relative to the starch-based films, which showed corresponding values of 18.56±1.4%, 25.37±1.9%, and 46.95±2.3%. This confirmed a high potential for biodegradability but simultaneously constrained mechanical performance and moisture barrier effectiveness. Therefore, while these agro-based films present a viable, eco-friendly alternative, the study concludes that developing biopolymer blends or multi-layer constructions is essential to enhance water-barrier characteristics and overall stability, thereby accelerating the packaging industry's transition to a circular economy.
Keywords: Biodegradability, physicochemical, agro-waste, sustainability, circular economy.

Chemically Modified Indian Teff (*Eragrostis tef*) Starch Biofilms: Quality Maintenance and Shelf-Life of Grapes

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Teff (*Eragrostis tef*) starch, a nutrient-dense yet underutilized cereal starch, faces limited industrial exploitation due to suboptimal stability, functionality, and digestibility. This study aimed to development of biodegradable films from chemically modified Teff starch and its application on green grapes packaging. Native starch was modified via oxidation (sodium hypochlorite) and cross linking (Citric acid) and films were developed from them. The native and modified films were evaluated for improved strength, barrier performance, thermal stability, and effectiveness in preserving fresh green grapes. The native film (NF) showed a tensile strength of 3.07 MPa and 38.21% elongation at break. Oxidized films exhibited higher tensile strength (7.88 and 3.91 MPa) with similar flexibility, while cross-linked films achieved strengths of 6.62 and 6.71 MPa, maintaining comparable elongation, indicating improved mechanical properties and rigidity. The NF exhibited a water vapor permeability (WVP) of 4.09×10^{-8} g/m²·s·Pa. In contrast, OF (2.09 and 2.5×10^{-8} g/m²·s·Pa) and CF (3.00 and 3.98×10^{-8} g/m²·s·Pa) showed substantially lower WVP values, reflecting improved moisture barrier properties. The OF and CF showed increased thermal stability, with decomposition temperatures exceeding 260 °C, highlighting their suitability for durability applications. Application trials on green grapes revealed that modified films significantly reduced weight loss, preserved firmness, and slowed acidity reduction during storage, extending fruit shelf life. The modifications—oxidation and cross-linking- significantly enhanced the films' mechanical strength, barrier properties, and thermal stability. The enhanced properties of chemically modified teff starch films suggest their viability in various packaging applications. The sustainable nature of teff starch and its improved post-modification performance align well with current trends toward eco-friendly materials in the packaging industry.

Keywords: Teff, Oxidation, Biodegradable films, Green grapes

Technological Assessment of Hydrothermal Treatment in Millets: Modifications in Nutrition, Milling Characteristics, Functional Properties and Storage Stability

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Millets constitute a heterogeneous group of small-seeded cereals valued for their resilience to marginal agro-ecological conditions and their superior nutritional profile, which includes high dietary fibre, essential amino acids, minerals, and bioactive phytochemicals. However, their broader industrial utilization is constrained by challenges such as poor dehusking and decortication efficiency, vulnerability to lipid oxidation due to high fat content, and the presence of antinutritional factors including phytic acid, tannins, and enzyme inhibitors. Hydrothermal processing—particularly parboiling—has gained prominence as an effective strategy to overcome these limitations. It enhances milling performance by softening the husk–endosperm interface, reducing grain breakage, and improving head grain recovery. Nutritionally, hydrothermal treatment facilitates the migration of water-soluble vitamins and minerals from the outer layers into the endosperm, while simultaneously decreasing antinutrient levels. These changes collectively improve mineral bioaccessibility and protein digestibility. Moreover, parboiling induces critical alterations in starch structure, including partial gelatinization, reorganization of crystalline and amorphous regions, and modifications in thermal and pasting behaviours. Such structural transitions influence water absorption, swelling capacity, retrogradation behaviour, and overall textural attributes. Consequently, parboiled millets exhibit enhanced suitability for a wide range of traditional foods—such as porridges, steamed grains, and fermented products—and modern applications including extruded snacks, composite bakery systems, and functional or nutraceutical formulations. Emerging evidence highlights that hydrothermal treatment significantly enhances both technological quality and nutritional functionality. Overall, parboiling represents a sustainable and value-adding approach that improves the processing potential and nutritional contribution of millets, thereby supporting their role in advancing food and nutrition security.

Keywords: Millets, parboiling, milling, nutritional characteristics, functional, processing.

Best from Waste: Valorization of Rice Milling by-product into Biodegradable Packaging Material for Dairy Products

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Rice milling by-products, especially post-maltodextrin extracted broken rice (PMEBR), is an excellent source of protein, and has significant potential for sustainable use towards a circular economy. This highlights the necessity for exploring ways to extract and increase protein yield and utilize this agro-waste source into a valuable ingredient. The current study explores methods to enhance protein yield of PMEBR, and its use in preparation of biodegradable protein films for sustainable dairy packaging applications. PMEBR protein concentrates were prepared using alkali-acid precipitation and enzymatic modification with phytase and xylanase. The enzymatic process enhanced protein purity and functional properties, as evidenced by FTIR, XRD, FESEM, and CLSM analyses, which revealed improved β-sheet organization, compact structure, and reduced lipid residues. Thermal characterization (DSC and TGA) confirmed higher glass transition temperature (Tg = 73.6 °C) and thermal stability in enzymatic protein concentrates, indicating stronger protein-protein interactions. Utilizing the extracted PMEBR, biodegradable films were fabricated by addition of dual plasticizers (glycerol and sorbitol), in varying ratios and optimized through machine-learning modelling (Extra Trees algorithm, R^2 = 0.89). The mixed-plasticizer formulation exhibited the highest overall desirability (0.729), and subsequent crosslinking with 5% formaldehyde produced films with superior tensile strength, minimal solubility, and excellent water resistance. The developed PMEBR-based protein films offer an eco-friendly alternative to petrochemical plastics, highlighting an innovative approach to agricultural by-product utilization in food packaging.
Keywords: PMEBR, biodegradable film, sorbitol, glycerol, machine learning, circular economy

Comparison of Predictive Modeling and Optimization Techniques for Microwave-Assisted Extraction of Polyphenols from Ash Gourd Peel Waste using an Optimized Solvent Mixture

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This study explores the extraction of polyphenols from ash gourd peel waste using an optimized solvent mixture. Solvent mixtures of ethanol, water, and acetone were screened through simplex lattice design, which identified a ternary composition (29.4% ethanol, 36.4% water, and 34.2% acetone) as the most effective for polyphenol recovery compared with individual or binary solvents. To further intensify extraction, microwave-assisted extraction was applied and optimized using a Box–Behnken design (BBD) under response surface methodology (RSM). The maximum polyphenol yield of 24.17 mg GAE/g, accompanied by 73.51% antioxidant activity, was achieved under optimized microwave conditions. Statistical analysis indicated microwave power as the dominant factor influencing extraction efficiency, with optimum conditions of 600 W power, 39.7 mL/g solvent-to-solid ratio, and 3.2 min extraction time. To improve model accuracy and prediction, artificial neural networks (ANN) coupled with grey relational analysis (GRA) were employed. ANN architectures of 3-15-1 for total phenolic content and 3-16-1 for antioxidant activity outperformed RSM in terms of statistical fit and predictive capability. The ANN–GRA approach identified slightly modified optimum conditions (600 W, 40 mL/g, and 4 min), which yielded higher polyphenol recovery and antioxidant activity than the RSM-optimized values. These results demonstrate that microwave-assisted ternary solvent extraction, when guided by ANN–GRA modelling, provides a more efficient and reliable strategy for maximizing the recovery of bioactive phenolics from ash gourd peel. The approach highlights the potential of coupling hybrid modelling with green extraction techniques for sustainable valorization of agri-food by-products.
Keywords: ash gourd peel, polyphenols, simplex lattice design, artificial neural network, gray relational analysis

Effect of Argon Cold Plasma Jet on the Morphological and Physicochemical Properties of Mature Dolichos lablab Bean Seed Starch

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Non-thermal argon cold plasma jet represents an excellent approach for material processing, such as surface modification. The present study was conducted to investigate the effects of argon cold plasma jet treatment on the morphological and physicochemical properties of underutilized mature Dolichos lablab seed starch (DSS). The DSS was exposed to a range of different voltages (10, 15, and 20 kV) at different durations (15, 20, and 30 min). Both the untreated and treated starch samples were analysed for gel hydration properties such as water holding capacity, water absorption capacity, swelling power, solubility, and amylose content. The plasma treatment resulted in a higher water-absorbing capacity, resulting in higher swelling power. Also, it is seen that there is a significant reduction in the pH of the starch from 7.22 to 5.81, which is caused due to the plasma-induced reactive species and free radicals. It was observed from SEM that there are fissures on the surface, while the granule integrity remains intact. The FTIR results didn't show any new peaks, but changes can be observed in the intensities of the peaks. For example, the broad peak is centered at nearly 3391cm-1, showing an increase in OH stretching, which is strong evidence of increased hydroxyl content due to plasma-induced oxidation. We observed changes such as a decrease in the reducing sugar and an increase in amylose content with an increase in the treatment voltage and duration. Consequently, these plasma voltage/time-dependent changes in the starch structure and properties can be further optimised according to the required characteristics.

Application and challenges of guar gum as an innovative, advanced, and natural hydrocolloid source

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People nowadays are more conscious about their health. They are aware of the fiber present in natural forms. The addition of polysaccharides in foods affects the functional, sensory, and textural properties. Both soluble and insoluble fibres are biodegradable, natural, inexpensive, and eco-friendly. Guar gum exudates from the guar bean, which contains guar protein. Guar protein and guar gum are widely used in the pharmaceutical and food industries. It is also used in encapsulation formulations because it enhances the textural, rheological, and physicochemical properties. This review highlights the promising role of this vital hydrocolloid in various health benefits, its applicability in food products, and its sustainability.
Keywords: Guar gum, hydrocolloids, food application, encapsulation, properties.

Development and Characterization of a Composite Soup Powder Utilizing Food Industry By-Products: A Study on Nutritional, Functional and Sensory Properties

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This study focuses on the formulation and quality evaluation of a novel instant soup powder utilizing nutrient-rich, underutilized food by-products: potato peel powder (PPP), tomato peel powder (TPP), mushroom powder, and tamarind kernel powder (TKP). The proximate analysis revealed that mushroom powder is a high-protein (23.76%) ingredient with excellent water (274.24%) and oil (167%) absorption capacities. TKP contributed significant carbohydrates (66.53%) and protein (19.11%), along with good functional properties for texture and stability. PPP was rich in fiber (14.80%) and showed exceptionally high water (563%) and oil (284%) absorption, while TPP provided the highest fiber content (44.17%) and valuable antioxidants like lycopene. Four soup formulations (T0-T3) were developed, with T3 (containing 15% PPP and 5% TKP) being optimized based on superior sensory acceptance. The optimized soup powder exhibited enhanced nutritional profile, desirable functional properties, and acceptable microbial quality over a 45-day storage period. Techno-economic analysis confirmed the commercial viability of the product due to the low cost of raw materials. The research successfully demonstrates a sustainable approach to converting agro-industrial waste into a nutritious, functional, and consumer-acceptable food product.
Keywords: Soup Powder, Food By-products, Nutritional Enhancement, Sustainability, Sensory Evaluation

Optimization of Orange Peel Candy Formulation Using Response Surface Methodology: A Sustainable Approach for Citrus Waste Valorization

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The growing demand for sustainable food production and waste utilization has highlighted the potential of fruit by-products, such as orange peels, as valuable raw materials. This study focuses on the development and optimization of orange peel candy as a functional confectionery product, utilizing Response Surface Methodology (RSM) to model and enhance key processing parameters. Box–Behnken Design (BBD) was employed to investigate the effects of three independent variables—sugar syrup concentration(50-70°Brix), Time of immersion(30-90 min), and Temperature of solution (50-70℃) on the Water Loss and Sugar gain of the final product. The experimental data were fitted to second-order polynomial models, and statistical analysis confirmed the significance and adequacy of the models. Optimization results suggested that a sugar syrup concentration of 57.11 °Brix, immersion time of 52.66 minutes, and a Syrup temperature of 59.30℃ produced the best combination of taste, texture, and shelf stability in accordance to maximum water loss and targeted sugar. The optimized candy dried at 50℃, 60℃ and 70℃ temperatures at the hot air dryer scored high in sensory evaluation but also retained a considerable amount of bioactive compounds such as ascorbic acid at 60℃, underlining its nutritional potential. This research demonstrates the feasibility of transforming citrus peel waste into value-added products, promoting circular economy practices in the food industry.
Keywords: Orange Peel, Optimization, Osmotic dehydration, Response Surface Methodology

Water hyacinth Biomass Valorization: A Sustainable Approach

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Stems of water hyacinth are abundantly present and considered waste biomass, especially in the Northeast (NE) region of India. In the current work, these stems have been examined qualitatively as well as quantitatively through diverse solvents (conventional solvents as well as Ionic liquid as solvent) to substantiate solvent specific extraction of phytochemicals. Further, the compounds were explored for their functional activities that can open new avenues in pharmaceutical as well as food industries. Qualitative analysis of extracts exhibited a variety of phytochemicals such as alkaloids, phenols, sterols, N- & S-compounds etc. Remarkably, ionic liquid extract had a similar phytochemical composition to that of conventional solvent extracts signifying effective extraction capability, except for acidified methanolic extract which possessed a unique bioactive compositional matrix altogether. Ionic liquid extract displayed highest yield ((6.67±0.11) %), and a high polyphenolic content second only to acidified methanol extract. Ionic liquid extract also demonstrated high antioxidant capacity following acidified methanolic extract. On the other hand, the presence of a unique phytochemical matrix as well as high polyphenolic content of acidified methanol extract are reasonable contributors to its high antioxidant capacity (1223.15 ± 6.80 µmol/ g & 597.64 ± 4.25 µmol/ g in ABTS & CUPRAC assays, respectively) as well as exclusive antibacterial activity. Interestingly, acidified methanol extract demonstrated equal bactericidal efficacy (0.08 mg/mL) against both *E. coli* and *S. aureus*. This work not only addresses waste utilization concerns but can also aid in boosting the overall circular economy of the NE region.

Keywords: Water hyacinth biomass; Ionic liquid; Bioactive compounds; Antioxidant activity; Antibacterial activity

Exploring Fruit Waste Utilization in Bihar for Sustainable Edible Film Production: A Review

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Bihar, one of India's major fruit-producing states, generates a significant amount of fruit waste that estimated at around 20-30% of total production due to post-harvest losses, poor storage, and processing limitations. Major regional fruits such as litchi, Jardalu mango, Palmyrah fruit, water chestnut and wood apple contribute large quantities of peel, seed and pulp residues rich in valuable biopolymers and phytochemicals. Litchi peel contains anthocyanins and polyphenols with antioxidant potential; Jardalu mango peel and kernel are abundant in pectin, starch and natural oils; palmyrah fruit pulp offers polysaccharides and carotenoids; water chestnut pericarp provides starch and cellulose; and wood apple rind is a good source of pectin and fiber. These components make fruit wastes ideal feedstocks for developing eco-friendly edible films that can serve as biodegradable packaging materials with good mechanical strength and antioxidant or antimicrobial properties. Utilizing these locally available wastes for sustainable edible film production not only supports waste reduction and plastic substitution but also promotes circular economy initiatives and livelihood opportunities within Bihar's agro-processing sector.

Keywords: Fruit Waste Utilization, Edible Film, Bihar and Sustainable Packaging.

Critical Review on Sustainable Utilization of Bihar's Fruit Waste for Essential Oil and Bioactive Compounds Production: A Review

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Bihar is the fourth-largest producer of fruits in India and ranks third in mango production, with an annual fruit yield of approximately 4.59 million tonnes. The state is a major producer of fruits such as wood apple, banana, mango and pomelo, from which 20-30% of the total production typically becomes waste. Pomelo, the largest fruit in the Rutaceae family, generates about 40% waste, mainly as peel. Mango waste, consisting of peel and seed/kernel, accounts for 20–25%, while banana produces 30–40% waste in the form of peel. In wood apple, the waste fraction comprising the hard shell, seeds, and peel that constitutes 35-65% of the total fruit weight. These fruit wastes are rich in bioactive compounds such as polyphenols, flavonoids, saponins, phenolic compounds (including catechin, anthocyanins, and tannins), terpenoids, and essential oils. Mango seed kernels, for instance, contain significant amounts of phenolic compounds, tocopherols, and essential oils. The essential oil content in wood apple ranges between 0.4-0.6% (mainly in the seeds and pulp) and is particularly rich in polyphenols and flavonoids. In comparison, mango contains 0.1-0.5%, pomelo has 0.5-1.5%, and banana possesses less than 1% essential oil. These bioactive compounds possess notable pharmaceutical, cosmetic and nutraceutical applications. Owing to their antimicrobial, antioxidant, anti-inflammatory and insecticidal properties, essential oils can be utilized in the development of biodegradable packaging materials. Furthermore, their aromatic and flavoring characteristics make them valuable ingredients in the food, cosmetic and pharmaceutical industries.
Keywords: Fruit waste utilization, Essential oil, Bioactive compounds and Food Packaging

Co-Digestion of Cow Manure and Cheese Whey: A Circular Bioeconomy Approach

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The accelerating intensification of dairy and livestock farming in India generates vast amounts of cow manure, while concurrent expansion of the dairy sector contributes large volumes of cheese whey. Together, these residues present serious environmental concerns but at the same time offer considerable opportunities for bioenergy recovery. If left unmanaged, they release methane and cause nutrient leaching, thereby contributing to greenhouse gas emissions and deterioration of soil health. Anaerobic digestion provides a sustainable circular bioeconomy solution by stabilizing these organic substrates while producing renewable energy and nutrient-rich biofertilizer. In this study, mesophilic batch experiments were conducted to compare the efficiency of mono digestion and co digestion of cow manure with cheese whey. Mono digestion of cow manure yielded 180 ± 5 mL CH_4/g VS, whereas cheese whey alone showed poor process stability and limited methane generation. Co digestion, however, achieved 344 ± 9 mL CH_4/g VS, representing nearly a 1.9-fold improvement over manure alone. This synergistic enhancement is attributed to a more balanced nutrient profile, dilution of inhibitory substances, and improved buffering capacity. The digestate resulting from co digestion was enriched with nitrogen and phosphorus, serving as a valuable organic fertilizer and reducing dependence on chemical inputs. These findings highlight the dual role of anaerobic digestion: the production of renewable biogas that can offset up to some extent on farm energy demand and the recycling of nutrients that improve soil fertility. By reducing emissions, closing nutrient cycles, and enhancing resource efficiency, anaerobic co digestion of cow manure and cheese whey emerges as a practical strategy to promote the circular bioeconomy and advance climate-smart agriculture.
Keywords: Anaerobic digestion, Cow manure, Cheese Whey, Renewable energy, Circular bioeconomy

Investigating the effect of sprouting on the extraction yield and Techno-Functional characterization of aquafaba from sprouted legumes using response surface methodology

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This study investigated the impact of sprouting on the extraction yield and techno-functional properties of aquafaba derived from sprouted legumes. The optimal extraction parameters were determined using response surface methodology (specifically the RSM-BBD method), which included 36 hours of sprouting, a seed-to-water ratio of 1:2.5, and a cooking time of 10 minutes. Key factors assessed included foaming capacity, foaming stability, emulsifying activity, protein content, total phenolic content, and anti-nutritional factors. The results showed that sprouting significantly enhanced viscosity (3±0.30 Cp), protein content (1.489±0.04 mg/mL), and total phenolic content (5.29±0.2 mg GAE/mL), along with an increase in foam density (0.27±0.07). Additionally, the sprouted legume aquafaba exhibited an antioxidant capacity of 89% and a reduced foam drainage volume of 9.3%. There were no significant differences in dry solids content or water recovery, as optimal cooking times and seed-to-water ratios remained similar. Foaming capacity and stability increased by 41% and 13%, respectively. Emulsion activity improved for the aquafaba derived from sprouted legumes (4.478 x 103), and turbidity also increased (3.182 x 103), while emulsion stability remained consistent at approximately 81.2%. The optimization process, conducted through RSM, identified conditions that balance maximum yield with desirable functional performance. Overall, the findings indicate that sprouting is an effective pre-treatment for enhancing the techno-functional characteristics of aquafaba, thus increasing its potential applications in functional foods and clean-label formulations.
Keywords: Sprouting, Response surface methodology, Functional foods, clean-label formulations, food waste valorization.

Garlic Peel: Unraveling the bioactive potential, extraction techniques and applications in food sector

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In recent decades, trend for by–product valorization has seen an upsurge ascribable to growing inclination towards sustainability and waste utilization goals. Garlic is an important bulb vegetable which is used in different food and culinary systems in various capacities, and also applauded for its numerous health benefits. Processing of garlic generates peel as a major by-product accounting for about 20-30% of the total rate of garlic bulb. This so called "waste" remains un-utilized, only adding to waste strenuous waste stream. Valorization of peels involve harnessing conventional (maceration) and non-conventional (microwave, ultrasound, enzymatic, sub-critical) extraction routes, to extract the valuable compounds. Garlic peels are endowed with several phenolic acids (*p*-Coumaric, caffeic, ferulic, p-Hydroxybenzoic, di-ferulic, sinapic, protocatecheuic acid), flavonoids (quercetin, kaempferol, rutin), and organo-sulphur compounds (alliin, allicin, diallyly disulfide) are reported which are known to impart an array of health benefits *viz*., antioxidant, anti-inflammatory and anti-cancerous properties. Effective utilization of garlic peels in circular economy represents a paradigm for implementation of "waste-to-worth" regime. Valorisation of garlic peel in food and health realm through usage in developing functional food packaging coatings and films, encapsulation, as antimicrobial agent, functional ingredient in different food systems actualizes the circular economy concept and serves the 12th Sustainable Development Goal (SDG) on responsible consumption.
Keywords: Bioactive compounds; garlic peel; waste management; biological properties; circular economy

Nutritional, Bioactive Compounds and Application of Tangerine Peel in Food Industries

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Citrus reticulate, commonly known as the tangerine, is a fruit crop that has a significant portion used in raw juice production. A substantial amount of fruit, especially peel, is wasted and creates disposal issues. However, citrus peel, specifically tangerine peel, is high in bioactive compounds, essential oils, and dietary fiber, make it a potential raw material for further value-added products. This review summarizes the literature regarding the use of tangerine peel to produce peel powder, processing parameters, nutritional benefits, bioactive compounds and potential industrial application. Using tangerine peel as a resource minimizes waste as well enhances economic returns to the citrus industry. Peel powder is prepared by drying and milling the peel into a fine powder, which can be incorporated into teas, bakery item, beverages, and dietary supplements as a natural flavoring and functional ingredient. Peel powder contributes to enhance economic value for farmers, food processors, and industries. Additionally, the presence of bioactive compounds viz., flavonoids, phenolic, terpenoids and pectin enhanced the functional properties such as antimicrobial activity, antioxidant potential, and flavor retention, make them suitable for use in health foods, natraceutical formulations, and clean label food products.

Keywords: Antioxidant activity, Bioactive compounds, Health benefits, Peel, Waste utilization

Waste to worth: Citrus peels as a valuable resource for developing nano-emulsion functional coatings/films for quality preservation of foods

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Citrus fruits are widely appreciated and the 4th most consumed fruit worldwide. Citrus fruits are valued for their nutritional composition and associated health benefits, which is why they are exploited at an industrial scale for a myriad of products. However, industrial processing of these citrus fruits generates a significant amount of waste, among which citrus peels are the major one, accounting for about 40-50% of the total fruit weight. These wastes, if overlooked, could only lead to a toilsome waste stream, causing serious environmental issues; henceforth, demand apt utilisation. The concept of functional coatings and films for food preservation is at its peak nowadays, and researchers are continuously probing novel materials and functional agents from agro-food resources. Citrus peel waste offers biopolymers (pectin) and natural polyphenolic compounds (flavonoids, phenolic acids) and essential oils, which can be utilised to develop and innovate edible coatings/films. However, these valuable components require being fetched through conventional and non-conventional extraction routes. Production of edible coating and film emulsion solutions with nano-scale precision can be actualised through low- (microfluidization, high-pressure homogenization, ultra-sonication) and high-energy (phase inversion composition, phase inversion temperature, and spontaneous-emulsification) methods with benefits of droplet size reduction, stability and their biological activity, which require characterisation through zeta-potential, droplet size, polydispersity index, antioxidant, and anti-microbial evaluation. Within the context of a circular economy framework, citrus wastes and by-products can enhance the functionality of nanoemulsions, promoting synergistic effects for the preservation of various food quality parameters.

Keywords: Citrus peels, waste management, sustainability, valorization, food preservation

Sustainable Extraction Technology for High-Value Functional Dietary Fiber Derived from Kinnow by-product

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Kinnow, one of the most abundant crops of Punjab, is processed not only to obtain juice, but also in the canning industry to produce marmalade, segments of mandarin and by the chemical industry to extract flavonoids and essential oils. However, massive industrial waste is produced in the industries resulting in severe environmental problems. Kinnow by-products are mainly composed of dietary fibers and pectin and contain a variety of other bioactive ingredients including protein, pigment, flavonoids, and essential oils. Previous studies have shown that the citrus fibers (CF) are more valuable than the cereal fibers for its higher total dietary fibers (TDF) content, with better functional properties (i.e. water holding and water swelling capacities). Kinnow peels, a primary residue of Kinnow processing industry, are rich in polysaccharides, such as soluble dietary fibers (SDF) and insoluble dietary fibers (IDF) which can be isolated and used as a functional ingredient in fortified beverages. Commonly used processing methods include chemical, physical methods like homogenization or a combination of these methods, however, result in a low content of SDF and thus can limit the functional properties and usage of dietary fibers derived. The transition from discarding horticulture byproducts to exploiting them for their bioactive potential has encouraged research on non-conventional extraction modification techniques such as extraction using microwave, ultrasound, high-pressure etc, which helps in modifying IDF to SDF. In the present work, ultrasound-assisted extraction (UAE) has been used to maximize SDF yield from Kinnow peel. The present investigation would provide convenient and sustainable method to improve the functional properties of dietary fibers and broaden its application in food industry.

Keywords: Kinnow, peel,soluble fibers,ultrasonication

Optimized Microwave-assisted Extraction of Vegan Chitosan from *Agaricus bisporus* Byproducts

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Rising global demand for mushrooms can lead to waste, such as stipes and cuttings, which are usually discarded during consumption. These wastes can be valorized for deriving functional components, such as chitin and chitosan. Therefore, *Agaricus bisporus* byproducts were used to extract chitin (SPCH) and chitosan (SPCHO). Microwave-assisted extraction (MAE) was employed to enhance the yield of SPCH and SPCHO, which were further optimized using Response Surface Methodology via Box-Behnken design. The main parameters for SPCH and SPCHO extraction were microwave irradiation time (MWT, min), microwave irradiation power (MWP, W), and NaOH % (w/v). For SPCH, NaOH % and MWP were found to have an insignificant effect ($p>0.05$) on % SPCH yield (w/w), while only MWP had an insignificant effect ($p>0.05$) on % degree of deproteinization (DoDP). The highest SPCH yield of 25.44 % with a satisfactory DoDP of 85.86 % was obtained at 360 W for 8 min with 12.5 % NaOH. On the other hand, MWT was found to affect the % yield (w/w) of SPCHO insignificantly ($p>0.05$). In contrast, all three parameters (MWT, MWP, and % NaOH) significantly affected ($p<0.05$) the % degree of deacetylation (DoD). The highest % yield of 29.95 % and a DoD of 84.43 % for SPCHO were recorded at 540 W for 8 min with 50 % NaOH. Therefore, an optimized, resource and time-efficient method was developed to extract vegan chitin and chitosan from *Agaricus bisporus* byproducts.

Keywords: Agaricus bisporus byproducts, RSM optimization, Chitosan extraction

By-product Utilization of Orange Peel and Development of Orange Peel Pickle

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This study focused on the utilization of orange peel waste (OPW) by developing an orange peel pickle as a value-added product. The preparation integrated traditional pickling methods with carefully selected spices and ingredients to enhance flavour and nutritional value. A thorough storage study over 60 days examined changes in physicochemical properties including moisture, carbohydrates, protein, fat, ash content, salt, and acidity, alongside sensory evaluation. Results showed the pickle to have substantial energy (272.82 Kcal/100 g), carbohydrates (31.57 g/100 g), protein (3.74 g/100 g), fat (14.62 g/100 g), and beneficial bioactive compounds like flavonoids and carotenoids. During storage, enzymatic and fermentation processes caused gradual decreases in carbohydrates and protein, slight fat oxidation, increased acidity from organic acid production, and rising salt concentration due to osmotic effects. Moisture content increased slightly, likely from polysaccharide breakdown, influencing texture. These findings support the potential of OPW as a sustainable ingredient for innovative food applications, offering both environmental benefits and new functional, sensory-rich food products. Overall, the developed orange peel pickle is a cost-effective, nutrient-rich condiment that valorises food waste, enhances shelf life, and expand the application of citrus by-products.

Keywords: edible straws, nutrient infusion, seaweed formulation, sustainable packaging, functional food innovation.

Grape Seed Proteins: Extraction Strategies, Hydrolysis Techniques, Functional Properties and Emerging Industrial Applications

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Grape seed (*Vitis vinifera L.*) is a substantial byproduct produced mainly by the winemaking industry. Although considered a waste product, grape seeds contain significant constituents, including phenolic compounds (such as flavonoids and proanthocyanidins), vegetable oil rich in polyunsaturated fatty acids, natural fibres, proteins, and carbs. The valorisation of grape seed waste entails the extraction of beneficial constituents, like grape seed protein, applicable across diverse sectors, including food, pharmaceuticals, cosmetics, and agriculture. Grape seeds comprise approximately 12% protein, encompassing all necessary amino acids. They may represent a prospective supply of functional proteins for application in the food and medicinal sectors. This review aims to emphasize recent advancements in protein extraction techniques and the manufacture of protein concentrates and hydrolysates from grape seeds. The discoveries on the bioactivities, functional attributes, and industrial applications of grape seed proteins are significant. The study was structured to examine pertinent research publications across six sections: grape seed protein extraction; grape seed protein concentrate/hydrolysates; amino acid profile; functional characteristics; bioactivities; and applications in food or biomedical industries. Grape seed protein isolates demonstrated significant foaming and emulsification capabilities, as well as water and oil absorption. Grape seed protein hydrolysate can be utilized industrially to enhance fruit juices, drinks, and plant-based dairy and meat alternatives with protein and bioactive peptides.

Keywords: Grape seeds; Protein hydrolysates; Amino acid profile; Functional properties; Bioactivities; Industrial applications

Integrated Nutritional, Functional and Antioxidant Assessment of Spring Onion (*Allium fistulosum*) Bulb, Pseudostem, and Leaves for Sustainable Waste Valorization

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Allium fistulosum, a member of the Allium family, alongwith onion, garlic, and chives, is a prominent source of nutrients and is used in salads, soups, stir-fries, and garnishes. However, the crop remains underutilized, thus necessitating an all-inclusive analysis of its nutritional, techno-functional, rheological, thermal, and antioxidant properties. This study, thus, presents a novel investigation of the different parts (bulb, pseudostem, leaves) of spring onion, highlighting their potential for functional food applications. Upon comparing the proximate composition, the leaves, comprising up to 52% of the plant weight, exhibited the highest crude protein (13.51%) and crude fiber (0.61%), whereas the bulbs, making up 33%, had the highest crude fat (0.16%). The physicochemical properties, including titratable acidity (0.15%), were superior in bulbs than in the leaves and pseudostems. Among the techno-functional properties, the leaves excelled in water and oil absorption capacities (6.41 g/g, and 7.67 g/g) and foaming capacity (5.27%). Pseudostems, which account for approximately 15% of the plant weight, showed high hygroscopicity (4.55 g/100g). Leaves also demonstrated higher antioxidant activity, with phenolic (34.584 mg GAE/g) and flavonoid contents (28.758 mg QE/g) and DPPH radical scavenging activity (93.81%). Rheological analysis revealed non-Newtonian behavior, with prolonged shear-thinning, especially in leaves due to their higher protein content. These findings position spring onion leaves, often discarded as waste, as a rich source of protein and bioactive compounds for developing antioxidant-rich functional foods to reduce the risk of various diseases, and as an alternative plant protein source in the preparation of fortified food products.
Keywords: spring onion, allium, antioxidants, protein, waste, functional food

Valorization of Litchi Kernel through Microwave-Assisted Starch Extraction and Characterization

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Litchi (*Litchi chinensis*) kernel, a starch-rich by-product of fruit processing industries, is often underutilized. This study compared conventional and microwave-assisted extraction (MAE) methods for starch recovery and characterization. Among conventional solvents, 0.5% (w/v) sodium hydroxide at a 1:2 (w/v) solid–liquid ratio gave the highest yield (23.87%) and purity (91.32%). Optimized MAE at 600 W for 10 s further enhanced starch yield (25.35%) and purity (94.21%). MAE improved physicochemical properties, including higher water and oil absorption, swelling, solubility, and amylose content. The mean granule size decreased from 18.81 µm (alkali) to 16.03 µm (MAE), with SEM showing more fragmented, rough-surfaced granules. FT-IR and XRD analyses confirmed similar functional groups and A-type patterns, with reduced crystallinity in MAE starch. Enhanced pasting and thermal properties indicate that MAE-extracted litchi kernel starch holds strong potential for value-added industrial applications.
Keywords: litchi kernel, starch, microwave-assisted extraction, waste valorizarion

Upcycling Date Seeds: A Coffee alternative for all

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Date (*Phoenix dactylifera*) seeds, often discarded as agro-industrial waste, present a unique opportunity for sustainable food innovation through their transformation into a coffee-like beverage. The process involves roasting and grinding date seeds to produce a caffeine-free powder that mimics coffee's aroma and taste, making it suitable for individuals sensitive to conventional coffee's stimulant effects. Nutritional analyses reveal that date seed coffee is rich in dietary fibre, essential minerals-such as potassium and magnesium, and powerful antioxidants including polyphenols and flavonoids. These components have been linked with improved digestion, heart health, immune support, and overall well-being. Studies highlight additional health benefits, such as the potential to reduce oxidative stress, inflammation, and muscle pain, and to promote mental health because of its bioactive compounds. Sensory evaluations consistently report high consumer acceptability, noting its pleasant nutty flavour and compatibility with various milk or plant-based preparations. Beyond individual wellness, the adoption of date seed coffee promotes circular economy principles, minimizes food industry waste, and encourages innovative, environmentally responsible food choices. This approach demonstrates how upcycling can deliver functional, safe, and enjoyable products that support both health and sustainability goals, making date seed coffee a compelling alternative for dive.rse consumer groups.

Enzymatic Upcycling of Guar Gum Processing Byproduct for Functional Protein Recovery

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The guar gum processing industry generates a protein-rich byproduct, guar meal, that remains largely underutilized. This study explored the sustainable upcycling of guar meal through enzymatic hydrolysis using Flavourzyme (FL) and Alcalase (AL) at 1% and 3% enzyme-to-substrate (E/S) ratios to improve its hydrolysis efficiency and bio-functional properties. Among all treatments, the hydrolysate produced with Alcalase at 3% E/S exhibited significantly higher ($P < 0.05$) DH (18.20%), protein yield (48.00%), and TCA solubility (62.80 ± 1.09%) compared to the Flavourzyme 3% E/S hydrolysate (DH: 10.80%; protein yield: 43.27%; TCA solubility: 52.33%). Color analysis indicated that the FL-treated hydrolysate was lighter (L* = 29.23), whereas the AL-treated one appeared darker (L* = 27.42). The control (unhydrolyzed) sample showed lower antioxidant values (DPPH: 14.24 and ABTS: 7.75 µmol TE/mg protein). Enzymatic hydrolysis markedly improved these bioactivities, with the AL-3% hydrolysate showing the highest ABTS and DPPH activities (65.14 and 32.32 µmol TE/mg protein, respectively), followed by the FL-3% hydrolysate (60.22 and 28.47 µmol TE/mg protein, respectively). SDS-PAGE revealed a more extensive breakdown of protein subunits in the AL-treated hydrolysate compared to the control. *In vitro* protein digestibility increased substantially from 52.28% in the control to 83.73% in the AL-3% hydrolysate. These findings demonstrate that enzymatic proteolysis using Alcalase and Flavourzyme effectively enhances the digestibility and antioxidant potential of guar protein. The approach provides a sustainable pathway for converting guar gum industry byproducts into biofunctional protein ingredients suitable for functional food and nutraceutical applications.

Keywords: Guar meal; enzymatic hydrolysis; *alcalase*; *flavourzyme*; protein digestibility; antioxidant activity; waste valorization; sustainable processing

Solvent Screening for Maximum Phytochemical Recovery and Antioxidant Potential of Nettle Leaves

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Nettle (*Urtica dioica*) is a well-known plant in traditional medicine and its leaves are considered a profound source of minerals (Na, K, Mg, Ca), trace elements (Fe, Cu, Mn, Zn), vitamins (C, K, A, B-complex) and bioactive compounds, making it beneficial for health. Nettle leaves are known to exhibit numerous pharmacological properties (antioxidant, antidiabetic, antimicrobial, and anti-inflammatory). However, despite being rich in phytochemicals and long history of usage in folklore medicine, nettle leaves remain insufficiently recognized in modern scientific research. Present study evaluates the phytochemical profile of nettle leaves undergoing conventional treatments (maceration, stirring, Soxhlet) using different solvents such as ethanol, methanol, water and petroleum ether. The obtained results revealed that the extraction method and solvent have a notable effect on extraction of bioactive compounds. Methanol outperformed in terms of extraction efficiency evaluated based on TPC, TFC and DPPH values, compared to ethanol, water and petroleum ether. Among different techniques employed, Soxhlet extraction showed most promising results when combined with methanol, having highest TPC (37.41mg GAE/g), TFC (21.57mg QE/g) and DPPH values (96.31%). Furthermore, methanol concentration (50-100%) was standardized for Soxhlet extraction, which showed optimum TPC (39.18mg GAE/g) at 90% methanol concentration. The present findings highlight the potential of screened methanolic Soxhlet extraction for recovering valuable phytochemicals, underscoring their industrial and therapeutic applications.
Keywords: nettle leaves, bioactive compounds, solvent screening, conventional extraction

Hydrothermal Extraction of Soluble and Insoluble Dietary Fiber from Pumpkin Seed Hulls: Process Optimization and Characterization of Dietary Fiber

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umpkin seed hulls, a by-product of pumpkin seed processing, were valorised through extraction of insoluble (IDF) and soluble dietary fiber (SDF). Hydrothermal treatment was used to extract dietary fiber and the processing conditions were optimized using Response Surface Methodology (Box-Behnken Design). The effect of independent variables, i.e., liquid-to-solid ratio, treatment temperature and treatment time on the extraction yield of IDF and SDF was evaluated. The fiber fractions obtained under optimized conditions were analysed for their structural properties, thermal stability, morphology and functional attributes. IDF and SDF showed almost similar FTIR spectra with varying peak intensities. X-ray analysis revealed the presence of both crystalline and amorphous regions in IDF and SDF, however, the degree of crystallinity was higher for IDF (31.6%), compared to SDF (10.4%). Owing to the higher crystallinity, IDF also showed greater thermal stability. In scanning electron microscopy, IDF structure appeared flaked and open (more surface area), while SDF showed a granular morphology. The observed morphologies correlated well with the functional properties of dietary fibers. IDF possessed greater oil holding capacity (3.50 g/g) and cholesterol adsorption capacity (11.69 mg/g), whereas SDF showed better water binding (4.18 g/g), swelling capacity (2.21 ml/g) and glucose adsorption (5.72 mmol/g). Good cholesterol and glucose adsorption capacities of IDF and SDF highlight their beneficial physiological effects on human body. Overall, hydrothermal treatment proved effective for the recovery of soluble and insoluble dietary fiber from the largely underutilized pumpkin seed hulls, contributing to zero-waste management and sustainable food processing.
Keywords: Pumpkin seed hulls, hydrothermal extraction, process optimization, characterization, waste valorisation.

Evaluation of Physico-Chemical and Techno-Functional Properties of Three Different Date Seed Powders

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Date seeds, often discarded as agro-waste, contain valuable nutritional and techno-functional compounds. This study analysed three varieties, Muzafati, Ajwa, and Khalas, to explore their potential in food and beverage applications. (1) To evaluate the physico-chemical and techno-functional properties of raw and roasted date seeds; (2) To prepare a date seed brew and analyse its refractive index, total soluble solids TSS, pH, browning index, and sensory properties. Seeds were cleaned, roasted, and ground into powders. Physical properties, including length, width, thickness, density, porosity, and colour, were measured. Chemical properties (moisture, ash, fat, TPC, TFC, and antioxidant activity) were determined as per AOAC methodology in the literature. For techno-functional characterisation (WAC, WSI, OAC, bulk density, emulsifying and foaming properties, and dispersibility) was assessed. Brew samples were analysed for TSS, refractive index, pH, browning index, and sensory properties. There was only a slight variance between varieties for the physical properties examined; the Ajwa showed greater width and thickness. WAC ranged from 1.45-2.39 g/g, OAC ranged from 1.11-1.44 g/g, and bulk density was between 0.54-0.59 g/ml. TPC values were consistent for all varieties (~206 mg GAE/100 g), and the TFC was different, with Khalas consistently having the highest. Antioxidant activity exceeded 93% in all samples. The brew values for refractive index were similar, and it had a moderate sensory acceptance.

Antioxidant Efficacy of Apple Peel Phytoconstituents on the Frying Stability and Oxidative Resistance of Mustard Oil

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The present study evaluates the antioxidant potential of apple peel extract (APE) in enhancing the oxidative stability of mustard oil (MO) subjected to repeated deep-fat frying. Hydroethanolic extract of lyophilized apple peel was prepared using sonication and vacuum drying, yielding total phenolic content (6.177±0.18 mg GAE/g), total flavonoid content (6.770±0.21 mg QE/g), and DPPH radical scavenging activity (81.45±2.34%), which was comparable to that of ascorbic acid (91.20±2.14%). GC-MS analysis identified key bioactive compounds, including 24-Norursa-3,12-dien (37.03%), Urs-12-ene (14.21%), 13-Docosanoic acid (8.46%), and squalene (4.14%). ATR-FTIR confirmed the presence of polyphenols, flavonoids, and phenolic acids, validating the extract's antioxidant richness. Mustard oil fortified with APE (200 mg/L) was evaluated against butylated hydroxyanisole (BHA) and quercetin. Initial oil quality indices, namely iodine value, acid value, peroxide value, p-anisidine value, TOTOX, and conjugated dienes, were within regulatory limits. During 20 frying cycles, color deterioration was most severe in control MO (ΔE=27.25±0.15), while fortified oils exhibited lower values, with BHA-added MO (20.56±0.04), quercetin-added MO (18.76±0.06), and APE-added MO (17.43±0.04). Fatty acid profiling revealed that APEMO exhibited the least reduction in the C18:2/C16:0 ratio and better retention of MUFA and PUFA compared to control, whereas BHAMO showed the smallest rise in saturated fatty acids. Overall, the findings confirm that APE effectively retards lipid oxidation and preserves fatty acid composition, highlighting its promise as a sustainable, plant-based alternative to synthetic antioxidants for edible oil stabilization during high-temperature processing.

Keywords: Apple peel extract**,** natural antioxidants**,** mustard oil**,** oxidative stability**,** deep-fat frying

The Impact of Family Support on Women Entrepreneurs: Insights from Family-Owned Enterprises in India

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Familial support makes a huge difference to the aspirations and outcomes of women entrepreneurs in family-run businesses in India. This article examines the influence of emotional support, financial support, mentoring and decision-making autonomy from family members on women's entrepreneurial empowerment. There is evidence to suggest that support from families can enhance confidence, bestow legitimacy and make leadership available as a possibility while constraining norms and patriarchal beliefs act as obstacles. Roshni Nadar Malhotra is now the chairperson of HCL Technologies and a prominent testimony to how trust and mentorship in familial businesses can help women breach gender walls. This research explores cultural and institutional influences that give explanation to dual aspects of family influence as a catalyst for, as well as the impediment in forming women's entrepreneurial paths. The research has important implications for policymakers, educators and family business members to create practices that promote gender inclusion as well as build the next generation of women leaders in the family enterprise.

Keywords: Women Entrepreneurs**,** Family Support**,** Empowerment**,** Mentorship**,** Gender Inclusion

Predicting Growth and Instability in rice production in Odisha Using Regression Techniques

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The rapid physiochemical degradation of Fresh Paneer poses a significant challenge to supply chain stability. This study develops a robust mathematical modelling framework to predict the remaining shelf-life (RSL) of Paneer under dynamic temperature conditions. We analyzed time-dependent variations in pH and Titratable Acidity using classical chemical kinetics, specifically testing zero-order and first-order reaction models. Temperature dependence was quantified using the Arrhenius Equation, yielding an activation energy. These kinetic parameters were integrated into a multivariate regression algorithm to handle non-linear environmental fluctuations. The proposed model demonstrated high predictive precision with a Coefficient of Determination (R^2) > 0.95 and a Root Mean Square Estimation. This study confirms that combining Arrhenius kinetics with statistical modelling provides a mathematically rigorous tool for real-time quality monitoring in the dairy industry.

Keywords: Mathematical modelling framework, chemical kinetics, Zero-order and First-order reaction models, Arrhenius Equation, Multivariate regression algorithm

Evaluation of the seeds of three diverse date fruit varieties for physicochemical, techno-functional and brew properties

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Date (*Phoenix dactylifera* L.) is a nutrient-rich fruit widely consumed in many parts of the world, with seeds contributing up to 20% of the fruit weight yet often discarded despite their high dietary fiber and phytochemical content. This study evaluated seeds of three date varieties (Muzafati, Ajwa and Khalas) for physicochemical properties (composition, colour, dimensions and densities) and the technofunctional properties of their powders. Water absorption capacity, water solubility index, oil absorption capacity, dispersibility, foaming capacity, foaming stability, bulk density, emulsifying activity index and emulsion stability index ranged from 1.45–2.39 g/g, 1.38–1.52%, 1.11–1.44 g/g, 35.9–39.0%, 4.0–6.2%, 6.7–66.6%, 0.54–0.59 g/ml, 0.03–0.01 m^2/g and 11–48 min, respectively. A date seed-based brew was also prepared and assessed for refractive index, total soluble solids, pH, colour (browning index), total phenolic and flavonoid contents, antioxidant activity and sensory parameters, with pH ranging from 5.47–5.89 and browning index from 0.128–0.184, indicating an acidic, variably browned beverage. While brews did not differ in total phenolic content (206.20-206.42 mg GAE/100 g), but showed wide variations in total flavonoid content, with Khalas exhibiting the highest value (1370 mg QE/100 g), followed by Ajwa (460 mg QE/100 g) and Muzafati (265 mg QE/100 g); Ajwa brew recorded the highest antioxidant activity, whereas Muzafati brew was most preferred sensorially, highlighting the potential of date seed brews, particularly Muzafati, as functional beverages and possible coffee substitutes.

Keywords: Date seeds; Brew; Physicochemical properties; Techno functional properties

Black Garlic as a novel functional ingredient: Assessment of production protocols and applications

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Black garlic is a novel functional ingredient of garlic which has wide acceptance in Southeast Asian countries such as Korea, Japan, and Thailand and investigated by food scientists globally for its incorporation in processed foods, such as beverages, meat products, and bakery products. Numerous scientific studies demonstrated diverse biological actions of black garlic including anticancer, anti-inflammatory, antimicrobial, antioxidant, hepatoprotective, anti-diabetic, cardioprotective, and immunomodulatory activities. Unlike raw garlic, black garlic is non-spicy/pungent. It has a sweet-light sour taste, soft and rubbery texture. Black garlic is prepared from raw garlic by a process of ageing which includes application of high temperature (40–90°C) and high humidity conditions (60–90%) for several days or weeks. The present investigation was carried out by varying temperature conditions for production of black garlic. The raw garlic bulbs were aged at different temperature 60ºC, 70ºC, 80ºC and 85ºC and 80% RH. Physicochemical changes such as pH, reducing sugar, pyruvic acid, moisture content, total phenolic content, color, texture were monitored during ageing process along with antioxidant potential of black garlic. A remarkable decline in pH of garlic was observed under all the ageing temperatures. The reducing sugar content of garlic was increased by approximately 19 to 27 fold during the ageing process. The ageing also resulted in approximately 30-40% loss of water and moisture content was recorded in the range of 38.45 to 44.57% of the final product. Ageing temperature of 70ºC and RH 80% was most suitable treatment for production of black garlic with higher sensory score.

Keywords: Garlic; black garlic, physicochemical properties; functional properties, antioxidant

Optimization of Supercritical Fluid Extraction of White Chia Seed Oil: Integrating RSM Design with ANN-Based Validation

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The optimization of oil extraction from white chia seeds using supercritical fluid extraction (SFE) was performed by the RSM technique coupled with a predictive ANN approach. The characteristics of the study were oil yield, iodine value, and total phenolic content (TPC) as key responses, based on three variables: extraction pressure (X_1), time (X_2), and CO_2 flow rate (X_3). The RSM employed a central composite design (CCD) to model the relationships, while the ANN used data from RSM experiments for predictions. The optimal ANN setup performed a backpropagation-trained network with three input nodes, a hidden layer of 10 neurons, and an output layer. Results indicated that extraction pressure and CO_2 flow rate primarily influenced oil yield, iodine value, and TPC, with extraction time significantly impacting iodine value and TPC. The optimal conditions identified were 400 bar pressure, 3.14 h extraction time, and a CO_2 flow rate of 17.72 g/min. The response conditions optimised were an oil yield of 28.32%, iodine value of 213.18 g I2/100g, and a TPC of 35.13 mg GAE/kg. The optimised oil sample was characterised for antioxidant activity based on DPPH (60.52%), FRAP (405.59 µg AAE/g), ABTS (163.29 µg AAE/g), HPSA (22.2%), and PMA (1.73 µg AAE/g) assay, showing a significant antioxidant seed oil potential. The predicted values closely matched the experimental results. Overall, while RSM effectively illustrated variable interactions for the SFE process, the ANN model provided superior predictive accuracy. White chia seed oil, rich in phenolic compounds and polyunsaturated fatty acids, is highly valued in the food, cosmetic, and pharmaceutical industries.

Keywords: White chia seed; Omega-3 fatty acid; total phenolic content; supercritical fluid extraction; PUFA; antioxidant properties

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