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Editorial: Sustainable functional food's sourcing, production, and process

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Editorial on the Research Topic
Sustainable functional food's sourcing, production, and process

Introduction

In the era of modernization, the health of both individuals and the planet has been compromised and deteriorated at an alarming pace. Consequently, with heightened awareness, a significant shift in consumer predilection toward food choices and environmental consciousness has been observed. Functional foods support sustainability at a large scale by reducing waste production, promoting plant-based diets, enhancing nutrition, supporting local economies, and lowering environmental impact, thereby emerging as a bridge between human challenges (nutrition, disease prevention) and the planet. Functional foods are rich in antioxidants, essential vitamins and minerals, phytochemicals, and probiotics; therefore, they were found effective in not only improving public health but also in improving immunity, gut health and reducing the risk of chronic diseases. The purified, extracted compounds recovered from various food sources are termed nutraceuticals, capable of reducing the burden of chemical drugs used in the conventional treatment of health implications. Sustainable practices adopted for the production and processing of food stuff help ensure the food supply for future generations without causing any complications and harm to the environment through waste production and packaging material misuse.

In this context, the current Research Topic "*Sustainable functional food's sourcing, production, and process*" was planned, which includes five original articles on sustainable production, processing is received. Those were focused on the production of clean-label food products with enhanced nutrition quality and shelf life, use of green techniques in nutrients recovery and safe production to ensure health of both the consumers and the planet.

Major findings

Fish are a vital source of protein and essential fatty acids for billions of people globally, but climate change, overfishing, and pollution threaten their sustainability. Kang et al. in their article emphasized that lab-grown "clean fish" offer a promising, safe, nutritious, and sustainable alternative, reducing the risk factor associated with conventional fish, and potentially supports both human nutrition and marine ecosystem recovery.

Sustainable sources and production of food are crucial for deciding the nutritional and medicinal potential of food. Therefore, a wide variety of crops are more nutritious as compared cultivated crops in terms of their phytochemicals, antioxidants, amino acids, vitamins, anthocyanins, and mineral content. To further elucidate this point, Oli et al. compared the nutraceutical potential of *Glycine soja*, a wild ancestor of cultivated soybean found in Uttarakhand, India, with the cultivated seeds based on their phytochemical and biochemical contents using standard methods. It was found that wild soybean *G. soja* contains a significant quantity of total phenols, flavonoids, antioxidants, and essential minerals (zinc), vitamins, and amino acids (histidine, isoleucine, leucine, lysine, methionine, threonine) as compared to the cultivated soybean seeds.

Sustainable processing of food using green techniques helps enhance the functional properties and applications of foods. In this context, research conducted by He et al. modified the functional properties of Millet bran dietary fibers (MBDF) through heating, dual enzymolysis (cellulase and xylanase), and further treating with acrylic-grafting (MBDF-HDEAG) or hydroxypropylation (MBDF-HDEH). These modifications significantly improved the physicochemical characteristics such as surface area, water retention, soluble fiber content, and expansion capacity. MBDF-HDEAG and MBDF-HDEH were incorporated into heat-induced egg white protein gels (H-EWPG) to evaluate the functional efficiency. It was found that gel structure and texture were enhanced due to an increase in β-sheet content, hardness, gumminess, chewiness, and water-holding capacity, while reduction in transparency and freeze-thaw dehydration characteristics. By valorising agricultural or food by-products as functional food ingredients, the texture and stability of food can be improved sustainably, along with a reduction in waste generation, as suggested by the findings. The modification of food waste is aligned with clean-label food production and functional food trends.

To meet the consumer demand for natural and transparent food additives or ingredients, clean-labeled products are widely accepted and prioritized. Incorporation of green techniques, such as microwave or ultrasound in the recovery of bioactive compounds further drives this approach toward sustainable practice through advancing functional food innovation and environmentally responsible production. In the same line, Khalid et al. extracted bioactive compounds from *Chenopodium album* using microwave-assisted extraction (MAE) and ultrasound-assisted extraction (UAE) to be used as clean-label additives in ostrich meat patties to enhance the nutritional quality and shelf life. It was found that by incorporating 2% UAE extract, quality parameters such as pH, color stability were improved, whereas lipid oxidation, peroxide levels, and microbial counts were reduced significantly. *C. album* extract confirms its strong bioactivity due to the presence of high antioxidant (TPC, DPPH, FRAP, and ABTS) content. Considering the high antioxidant potential of C. album extracts, it can be used as a natural preservative, replacing artificial additives with plant-based bioactives through green technologies, promoting food quality, safety, and aiding in clean-label product development.

Additionally, Wan et al. confirmed the potential of sustainable green extraction techniques in the extraction of rose hydrosol from Yunnan Dark Red Rose floral by-products, minimizing chemical inputs, reducing waste and clean production. In the steam distillation process, strong antioxidant activity (DPPH), hydroxyl, and superoxide anion scavenging capacity were observed in optimized conditions including flower-to-liquid ratio, reflux time, distillation temperature, and sodium chloride content. Rose hydrosol was found to be rich in valuable polyphenols and flavonoid content, advocating its functional food potential. Solid phase microextraction gas chromatography-mass spectrometry (HS-SPME-GC-MS–MS) revealed the presence of health-promoting volatile compounds. The research provides a valuable foundation for incorporating rose hydrosol into clean-label food and cosmetic formulations as a natural, health-promoting, and eco-friendly additive.

Conclusion

The present Research Topic highlights the capacity of functional foods and sustainable practices in development of functional and clean-label foods conserving the health and wellbeing of the individuals and the planet. Green extraction techniques are instrumental in conserving the bioactive treasure from agro-waste, and further elucidating the potential as functional food additives in enhancing the nutritional quality and shelf life of the food. The natural bioactives are bountiful in health benefits; therefore, these studies collectively demonstrate the alignment between food innovation, health benefits and environmental stewardship through waste reduction and resource optimization. Sustainable approaches contribute to a resilient, health-focused, and eco-conscious food system for future generations.

Author contributions

PS: Writing – original draft, Writing – review & editing, Project administration, Conceptualization. TK: Methodology, Formal analysis, Project administration, Writing – review & editing, Validation. NP: Writing – review & editing, Supervision, Formal analysis, Project administration. SS: Project administration, Writing – review & editing, Writing – original draft, Methodology, Conceptualization.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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