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# Editorial: Technological advancements for the processing and preservation of fruits and vegetables

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## Editorial on the Research Topic

### Technological advancements for the processing and preservation of fruits and vegetables

Fruits and vegetable-rich diets contain plenty of vitamins, dietary fiber, and minerals, particularly bioactive compounds and antioxidant activities, which are advised for their health-boosting effects. Toxicological, epidemiological, and nutritional studies proposed the relationship between fruit and vegetable intake and a lower prevalence of diseases, including cancer, heart problems, Alzheimer's, and diabetes. New products, processing methods, and distribution conditions will increase fruit and vegetable consumption. Recently, transformations have occurred as many food processing and preservation technologies evolved and advanced, particularly within the agro-food sector. Undoubtedly, all have mainly transpired due to evolving consumer needs for fresh and highly nutritious foodstuffs with improved shelf life. Since consumers are influential in the agro-food sector, consumer needs have been a vital motivation to other parties in the agro-food industry, including food scientists, who are paramount in ensuring the quantity and quality of foods. The current research issue strives to contribute to plugging the research gap in the knowledge regarding technological advancements for fruit and vegetable processing and preservation. In this context, fourteen papers were published; nine are original research papers, and the rest of the five are reviews.

In review, [Hassan et al.](#) unveil the potential of physically stimulating methods for seed invigoration to increase the sprouting rate, such as laser irradiation, gamma irradiation, microwaves, plasma, magnetic fields, ultrasonic waves, and sound waves. Physical methods offered different advantages than conventional methods, including high germination rate, environment-friendly, early seedling emergence, protection from chemical hazards, uniform seedling vigor, and enhanced yield. In the second review, [Bhatti et al.](#) proposed an in-depth knowledge of the antibacterial properties of *Nigella sativa*, *capsicum*, *Musa paradisiaca* L. peels, and *Citrus limetta* with its potential food applications. Also, the review summarizes the advantages and disadvantages of each novel extraction technique

applied to extract these antimicrobial agents. [Shaukat et al.](#) unveiled the recent progress on tea polyphenols, their potential health benefits, and effective traditional and modern techniques to extract polyphenols. [Ragu and Teo](#) stated the art of available few-shot learning models, networks, and classifications and proposed insights into future research routes. Few-shot learning shows higher accuracy in vegetable disease detection in a limited dataset. They also revealed that few-shot learning is trustworthy with few instances and less training time. [Yépez-Ponce et al.](#) stated the potential use of mobile robotics in farming to address environmental impact, productivity, crop losses, food safety, and sustainability challenges. The existing agricultural robotic systems are expensive and large because they use a computer as a server and mobile robots as clients. One technological solution that could be executed is designing a fully independent, low-cost agricultural mobile robotic system without a server.

About the original research, [He et al.](#) developed enzymolysis and microwave-assisted enzymolysis methods to improve the water-holding capacity of kombucha cellulose hydrolysates while lowering the oil-holding capacity. *In vitro*, digestion outcomes proposed substituting kombucha cellulose hydrolysates would have no harmful health impacts in the deep-fried donut formula. [Saleem et al.](#) studied the effect of freeze-drying on mung bean peel powder and soybean peel powder and their incorporation into functional yogurt at different concentrations. The results revealed that the physicochemical profile of functional yogurt had a linear proportional relationship with both powder concentrations. When powder concentration increases, bioactive compound, antioxidant activity, and rheological properties significantly improve with better sensory acceptability. Results offer that soybean and mung bean peel could be utilized in food products as a source of bioactive compounds after freeze-drying. [Wiset et al.](#) established a combined method of microwave drying with hot air drying at 45°C, successfully preserving the bioactive compounds, volatile organic compounds, and overall quality of the two cultivars of holy basil leaf for pharmaceutical and food industries. This alternative drying method is viable for drying red and green holy basil with better product qualities, better bioactive compound retention, and lower electrical energy consumption at industrial scales.

[Khalil et al.](#) evaluated the *Terminalia chebula* varieties (black, Kabuli, and green), revealing that the Kabuli and green varieties possess better minerals and proximate composition than the black variety. In muffin development, the 7.5% level of all three showed better acceptability. The current study has proved that white flour supplementation with *Terminalia chebula* varieties develops functional muffins. [Suthiluk et al.](#) reported the potential of pomace from “Phulae” pineapples for making new functional snacks due to their physicochemical properties. Employing the Box–Behnken design allowed the determination of optimum parameters for processing pineapple pomace-fortified crispy mushroom sheets with maximum antioxidant activities and soluble dietary fibers. The results of the present study revealed that crispy sheet mushroom products are functional food and a better alternative protein snack fortified with dietary fiber. [Mthembu et al.](#) investigated the efficacy of hexanal-based enhanced freshness formulation, having antioxidants such as ascorbic acid,  $\alpha$ -tocopherol, and geraniol on preserving the bioactive components of gold kiwifruit harvested at

two maturity stages. The results revealed that enhanced freshness formulation significantly affected antioxidant capacities, bioactive compounds, and the enzyme activity entangled in the synthesis and oxidation of bioactive compounds. The maturity stage significantly impacts the bioactive compounds.

[Yang et al.](#) proposed the Kalman filter fusion algorithm, an online monitoring system for real-time monitoring of the moisture content in an air-impingement dryer. It was employed to evaluate the optimal state of the original detection values of the weighting sensor and air velocity sensor. This monitoring system has better detection accuracy for moisture content in the drying process and also improves the automation level of the drying equipment for fruits and vegetables. The suggested Kalman filter fusion algorithm also provides a reference for other multifactor fusion detection. [Karacan et al.](#) unveiled that food costs and food shortages caused by population growth and climate change, along with the drought, make it more critical to prevent food losses with the across-the-board use of cold storage. In the current study, the authors examined the energy consumption data of cold stores obtained from different countries. Obtained results revealed that cold storage energy consumption increased by up to 30%, based on operational conditions. Thus, cold stores must be examined by the concerned department during their operation. [Gondal et al.](#) proposed a blockchain-based food supply chain solution for the food supply chain industry. The proposed methodology is the combination of blockchain technology and the Internet of Things, brilliant contracts, to ensure the highest quality delivery of strawberries. The Internet of Things-enabled container provides information about the quality of the strawberry, humidity, temperature, and shipment location.

Conclusively, the scientific efforts led to the utilization of new food processing technologies without high heat processing involvement, including microwaves, spray drying, and ohmic heating, to better retain nutritional quality. Also, novel non-thermal processing technologies, such as ultrasound, irradiation, pulsed electric field, high-pressure processing, cold plasma, and freeze-drying, proved promising for processing fruits and vegetables. Likewise, spray drying is employed for slurry or liquids using hot gas. This method is preferable for thermally sensitive materials, while freeze-drying is used for rehydrated products without changing the product's original shape.

## Author contributions

MM: Conceptualization, Data curation, Funding acquisition, Supervision, Writing—original draft, Writing—review & editing. RS: Data curation, Writing—original draft, Writing—review & editing. AH: Writing—original draft.

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## Conflict of interest

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