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Editorial

Potential Health Benefits of Fruits and Vegetables II

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Consumer awareness regarding the significance of a well-balanced diet in preventing chronic diseases has increased significantly in recent years. Particularly, the consumption of plant-based foods, including vegetables and fruits, has been proven to play a crucial role in preventing various chronic diseases due to their abundance of bioactive compounds. Numerous researchers and scientists from diverse fields have dedicated substantial efforts to the study and characterization of the phytochemical profiles of numerous fruits and vegetables. They have also elucidated multiple mechanisms and metabolic pathways through which these plant-based foods exhibit their health-enhancing and disease-preventing properties.

The objective of this Special Issue was to gather the latest research on the phytochemical composition of fruits and vegetables, as well as on their health-promoting effects and mechanisms of action. This research encompassed various models, such as in vitro cellular models, animal trials, and human trials, to provide a comprehensive understanding of the applications and benefits of fruits and vegetables in promoting health.

In this Special Issue, 13 original contributions were received, comprising of 11 Research Articles (RA) and 2 Reviews (RV). The first level of research is usually the investigation of the antioxidant potential and the pattern of bioactive compounds in fruit and vegetables, which is achieved by analyzing their composition in different conditions (genotypes, environment, cultivation system, and post-harvest management). In this regard, most of the RAs received (5 out of 11) deal with the phytochemical composition of fruits (1) and vegetables (4). The only study reporting research on fruit was from Qaderi et al. (2023), which focused on strawberries, a perishable fruit rich in vitamins and phenolic compounds. The researchers examined the effects of different cold-storage temperatures (−20 °C and −80 °C) on three strawberry cultivars ('Arianna', 'Francesca', and 'Silvia'), and their various treatments (whole and dried fruits), over seven months. The goal was to evaluate how storage conditions and duration influenced the stability of nutritional compounds such as vitamin C, phenolic acids, anthocyanins, and folate in strawberries. The results showed that storage temperature significantly affected the fruit's nutritional quality, with −80 °C storage preserving more nutritional compounds compared to −20 °C. However, the storage time did not substantially impact the nutritional composition. Notably, oven drying had a detrimental effect on the vitamin C content, while folate levels increased during storage. The findings underscore the importance of considering storage conditions and duration for maintaining optimal nutritional quality in strawberries, thus informing future fruit storage strategies [1].

As mentioned above, this Special Issue attracted more RAs on vegetables, with five original contributions published. The study from Di Mola et al. (2023) aimed to assess the effects of two natural biostimulants on *Diplotaxis tenuifolia* L. plants grown under different salinity levels and harvested over six consecutive cropping cycles. The availability of quality irrigation water is declining due to soil salinization and aquifer deterioration, while at the same time, climate change requires intensified cropping systems for global food security.

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The combination of factors had variable effects on the tested parameters, highlighting the significance of considering growing conditions and cropping periods when using biostimulants under salinity stress in *D. tenuifolia* plants. Salinity, biostimulant application, and harvesting time affected the antioxidant activity, bioactive compounds (e.g., total phenols, carotenoids, and total ascorbic acid), and mineral profile in different ways. Increasing the salinity led to a decrease in nitrate content, whereas biostimulant application resulted in higher nitrate accumulation compared to untreated plants. Although biostimulant application showed potential in mitigating salinity stress, the response of *D. tenuifolia* plants to saline conditions and biostimulant application also depended on growing conditions and successive crop cycles [2]. The study from Biel et al. (2023) aimed to evaluate the proximate composition, total polyphenolic compound content, and antioxidant activity of 27 plant materials collected in West Pomeranian, Poland. The samples were analyzed using established methods for chemical composition and antioxidant activity assessment. The dry matter content varied among the plant materials, with black chokeberry having the lowest concentrations and milk thistle and black cumin having the highest concentrations. The total polyphenolic compound content ranged from 291.832 to 7565.426 mg of chlorogenic acid equivalent per 100 g of dry matter. The antioxidant activity was measured using different methods and exhibited a wide range of values across the plant materials. Milk thistle fruit extract showed the lowest antioxidant activity and total polyphenolic compound content, whereas extracts from garlic, stinging nettle, and cleavers had the highest. The study suggests that certain plant parts with high antioxidant potential could be valuable sources of bioactive compounds, but further research is needed to identify any potentially harmful compounds [3]. On the topic of vegetables, the study by Mezzetti et al. (2022) examined the antioxidant compounds in two Italian broccoli cultivars ('Roya' and 'Santee') and black cabbage. Different plant portions and developmental stages were analyzed. Black cabbage seeds showed higher levels of antioxidants, phenols, and anthocyanins than the leaves. Similarly, broccoli heads had higher levels than the stems. The harvest date influenced the antioxidant capacity, with the second harvest of 'Roya' broccoli showing better results. These vegetables provide valuable antioxidants and potential health benefits [4]. Another study by Janiszewska-Turak et al. (2022) focused on beetroot and red bell pepper as rich sources of active compounds and their potential health benefits. To extend their shelf life and create a new product with coloring and probiotic potential, lactic fermentation was employed as a preservation method. The impact of fermentation on the content of active compounds in pickled juices and freeze-dried powders was evaluated. *Levilactobacillus brevis* and *Limosilactobacillus fermentum* were used for fermentation. The research showed no differences in the pigment content in fermented juices, but color coefficients varied in raw juices. Freeze-drying reduced the pigment content while simultaneously increasing dry matter and providing good storage conditions. Fermentation combined with marinade yielded higher pigments and lactic acid bacteria content. All powders were stable and can be used as a colorant source, while higher bacteria levels are required for probiotic properties [5].

Besides the compositional analyses, the second step in evaluating the positive effects of the bioactive compounds present in fruits and vegetables is to extend the analysis to other bioactive characteristics, such as antimicrobial, bactericidal, and anticancer effects. Regarding the collection of RAs, three of them deal with these issues. Witbooi et al. (2021) investigated potatoes, an important cultivation for global food security, and it has been reported that pigmented potato cultivars provide health benefits. However, there is limited information on their antioxidant, anticancer, and antimycobacterial activities. This study focused on the 'Salad Blue' (SB) pigmented cultivar and non-pigmented control (BP1) extracts. Chlorogenic acid was the prominent phenolic acid in both cultivars. The extracts showed no significant activity against *Mycobacterium smegmatis*. The antiproliferative activity against HepG2 liver cells varied, and the study provides valuable information for future oncology and nutritional research to enhance the health benefits of these cultivars [6]. Also, fruits of the *Bromelia* genus have compounds with health benefits and biotechnological applications.

Bromelia karatas fruits, for example, contain antioxidants and proteins with bactericidal activity. However, further studies are needed to explore the activity and potential benefits of these metabolites. In this study, the bactericidal activity of the methanolic extract and its fractions from ripe *B. karatas* fruit was evaluated against several bacterial strains. The methanolic extract showed minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) values against the tested bacteria. Gas chromatography mass spectrometry identified 131 compounds in the extract, some of which have known biological activities such as bactericidal, fungicide, anticancer, anti-inflammatory, enzyme inhibiting, and anti-allergic properties. The most abundant compounds in the extract were maleic anhydride, 5-hydroxymethylfurfural, and itaconic anhydride. This study highlights the potential health benefits of the metabolites found in *B. karatas* fruits [7]. Then, Phong et al. (2022) isolated eight known secondary metabolites, including two isocoumarins and six coumarins, from the stems and branches of *Acer mono* Maxim. Their structures were confirmed using nuclear magnetic resonance spectroscopy and comparing the results to published reports. For the first time, the inhibitory effects of these compounds on *Escherichia coli* β-glucuronidase were evaluated using in vitro assays. Compound 1 (3-(3,4-dihydroxyphenyl)-8-hydroxyisocoumarin) displayed significant inhibitory effects against β-glucuronidase (IC50 = 58.83 ± 1.36 μM). Kinetic studies indicated that compound 1 acts as a non-competitive inhibitor. Molecular docking studies revealed that compound 1 binds to the allosteric binding site of β-glucuronidase, which was consistent with the results of kinetic studies. Additionally, molecular dynamics simulations provided insights into the dynamic properties of the protein–ligand complex formed by compound 1. These findings suggest that compound 1 could serve as a lead metabolite for developing new β-glucuronidase inhibitors [8].

The last step in the evaluation of the potential health benefits of fruit and vegetables is to test them with in vivo models, which can comprise animal trials and human trials. In this collection, we published two RAs with in vivo studies in mice, and one RA conducted in vivo in humans. The study by Azevedo et al. (2022) aimed to explore the effects of an elderberry extract (EE) on mice over a period of 29 days and evaluate its safety as a natural colorant. Twenty-four female mice were divided into four groups: control, EE12 (12 mg/mL EE), EE24 (24 mg/mL EE), and EE48 (48 mg/mL EE). The main anthocyanins detected in the extract were cyanidin-3-O-sambubioside and cyanidin-3-O-glucoside. Food and drink intake was similar among the groups, except for EE48, which consumed significantly less. Histological analysis of the liver indicated no pathological significance. The EE, particularly at doses of 24 and 48 mg/mL, significantly reduced oxidative DNA damage compared to the non-supplemented group. The elderberry extract exhibited a favorable toxicological profile, suggesting its potential use in the food industry [9]. Alegiry et al. (2022) concentrate their research on MDD, a prevalent and serious health condition that remains a global challenge, despite numerous studies and available antidepressants. *Carthamus tinctorius* (safflower) is traditionally used in food and medicine. This study aimed to investigate the chemical composition of safflower and its antidepressant-like effects using a hot water extract in male mice. The mechanism of action was explored through the transcriptomic analysis of the hippocampus. GC-MS analysis revealed that the hot water extract contained a significant amount of oleamide, which is known for its activity. Neurobehavioral tests showed that safflower treatment significantly reduced immobility time in the TST and FST, and improved performance in the YMSAT compared to the control group. RNA-seq analysis identified differential gene expression in several genes related to MDD regulation. Overall, this study demonstrated the antidepressant-like effects of safflower hot water extract, attributed to its bioactive ingredient oleamide, as evidenced by behavioral changes and gene expression patterns [10]. The human in vivo trial was conducted by Siripun et al. (2022) and investigated dyslipidemia, which is a risk factor for cardiovascular disease and a leading cause of global mortality. Lipid-lowering drugs can have side effects; therefore, consuming vegetables and fruits with probiotics is a potential alternative to positively influence plasma lipid profiles. This study aimed to

investigate the effects of consuming vegetable and fruit juice (VFJ) with and without probiotic *Lactobacillus paracasei* on various parameters in dyslipidemic patients over 30 days. The probiotic group showed significantly lower levels of total cholesterol, low-density lipoprotein cholesterol, triglycerides, and the TG/high-density lipoprotein cholesterol ratio compared to the placebo group. Additionally, the probiotic group had higher levels of high-density lipoprotein cholesterol. The probiotic group also demonstrated reduced levels of malondialdehyde (a marker of lipid peroxidation), increased levels of oxidative stress enzymes (catalase and glutathione peroxidase) in plasma, and increased bile acid levels in feces. These findings suggest that VFJ enriched with probiotic *L. paracasei* may serve as an alternative approach for preventing dyslipidemia in patients who have not yet started other medication, providing a primary intervention method [11].

The last two contributions to this collection are RVs, which provide a detailed overview of two different central topics for the evaluation of the potential health benefits of fruits and vegetables: the role of different vegetal-derived bioactive compounds in the modulation of colorectal cancer, and the main characteristics and health effects of berry fruit volatiles. According to Di Mola et al. (2023), colorectal cancer is a significant cause of illness and death, and drug resistance poses a major challenge in its treatment. Bioactive compounds derived from vegetables are being investigated as a potential strategy to enhance antitumor therapies by targeting key pathways involved in carcinogenesis and multidrug resistance. In both laboratory and animal studies, these compounds have shown the ability to reduce drug resistance and enhance therapeutic effectiveness when combined with cytotoxic drugs. This review aims to summarize the existing scientific literature on the antitumor and chemo-sensitizing properties of vegetable-derived biomolecules such as polyphenols, flavonoids, and terpenes. These compounds have the potential to offer promising prospects for improving the treatment of colorectal cancer [12]. In the second RV, Gu et al. (2022) state that volatile compounds give fruits their aroma, and berries are rich in these compounds, including esters, alcohols, terpenoids, and more. This review focuses on the volatile compounds in strawberries, blueberries, raspberries, blackberries, and cranberries. These compounds have various health benefits, such as anti-inflammatory, anti-cancer, anti-obesity, and anti-diabetic effects. Monoterpenes, like linalool, limonene, and geraniol, are particularly important in berry aromas and offer several health benefits. Further research is needed to explore the bioavailability and confirm the bioactivities of the volatile compounds from berries [13].

To summarize, this collection evidences an important step forward in the consolidation and verification of the potential health benefits of fruits and vegetables, starting from a compositional point of view and moving into in vivo studies, as well as reviewing crucial aspects of their effects. This work is in continuity with the previous Special Issue "Potential Health Benefits of Fruits and Vegetables I", to be followed by a similar collection (Potential Health Benefits of Fruits and Vegetables III), which will continue to underline the importance of fruit and vegetable consumption for human health.

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