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Editorial: Exploring sustainable strategies for active compounds from low-quality crops: extraction, package, and development

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Editorial on the Research Topic
Exploring sustainable strategies for active compounds from low-quality crops: extraction, package, and development

With the explosive growth of the global population and the rapid development of agriculture and food technology, people have shown a huge demand for high-quality and diverse food (Tripathi et al., 2019), followed by the rapid development and expansion of the food processing industry. However, this also raises new problems. To pursue products with higher nutritional value on the basis of ensuring cost stability and work efficiency, food enterprises will produce a series of low-quality by-products in each link of the food industry. They directly waste numerous low-quality raw materials, and of course, numerous nutrients contained in them can also be wasted (Spiker et al., 2017). Considering the large global population base, how to realize the value-added of low-quality crops has become a hot topic in recent years (AliAkbari et al., 2021). In view of this, many researchers have put forward some ideas, such as using low-value crops as biomass energy (Jin et al., 2018; Ganesh et al., 2022), developing New foods (Ganesh et al., 2022), using advanced processing technology to produce high value-added products (Kewuyemi et al., 2022) and improving the extraction process of active substances (Putnik et al., 2018) etc. One strategy we have noticed is to extract and utilize the nutrient-active substances contained in these low-quality crops (Kita et al., 2023), to realize the reuse of extracted materials. In the future, we can not only realize the value-added of low-quality crops, but also use these extracted active substances to develop more functional foods to meet the needs of consumers, and even try to solve some technical problems faced by the current food industry to obtain products with higher market value. This paper analyzes the content of the four latest related studies to gain insight into the significance of these research results for the food processing industry and functional food development, and to provide theoretical guidance for future research directions.

Some of the new advances and solutions in food fields provide useful technical guidance for the food processing industry and functional food development, with advanced

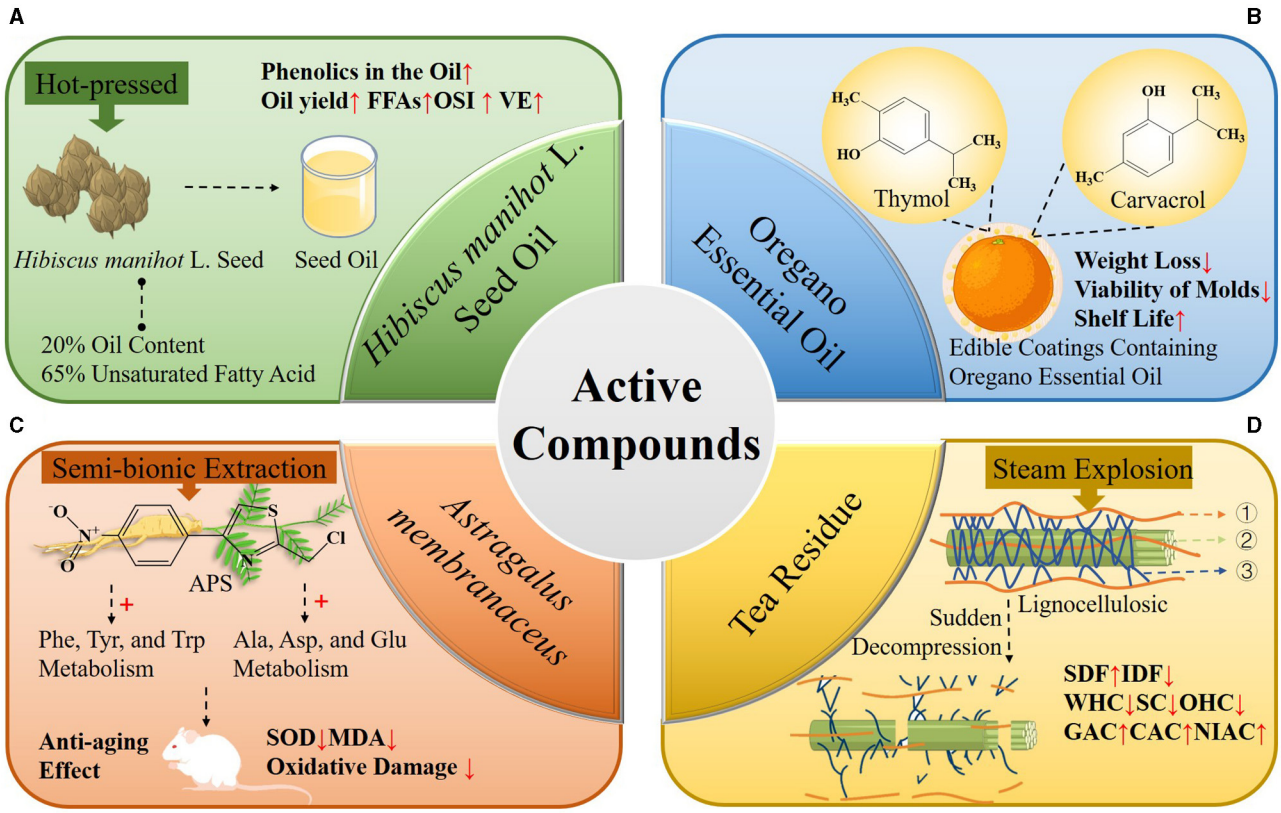

FIGURE 1
Graphical demonstration of the processing method and application effect of functional active substances in food by-products. **(A)** Hot-pressed method increased the yield of Hibiscus manihot L. Seed Oil as well as the changes in oil composition. FFAs, free fatty acids; OSI, oxidative stability index; VE, vitamin E. **(B)** Edible coatings containing oregano essential oil improved the freshness of mandarin fruits. The thickness of the coating was intentionally increased in order to show the details and enhance the readability of the picture. **(C)** Extraction of Astragalus polysaccharide (APS) from Astragalus membranaceus using semi-bionic extraction method and illustration of the anti-aging mechanism of APS *in vivo*. Phe, phenylalanine; Tyr, tyrosine; Trp, tryptophan; Ala, alanine; Asp, aspartate; Glu, glutamate; SOD, superoxide dismutase; MDA, malondialdehyde; **(D)** Steam explosion method modified dietary fibers from tea residue Illustration. SDF, soluble dietary fiber; IDF, insoluble dietary fiber; WHC, water holding capacity; SC, swelling capacity; OHC, oil holding capacity; GAC, glucose absorption capacity; CAC, cholesterol absorption capacity. GAC, glucose absorption capacity; CAC, cholesterol adsorption capacity; NIAC, nitrite ion adsorption capacity. ①, Lignin; ②, Cellulose; ③, Hemicellulose.

insights for future related research and product development. For a more intuitive presentation and enhanced comprehensibility of articles, four existing related articles were visualized (Figure 1). For *Hibiscus manihot* L. seed oil, a kind of plant-based edible oil that has recently attracted the attention of many researchers, Yan, Yang et al. compared different pressing methods effect on oil composition. The results showed that the hot-pressed method was of great significance to the industrial production and consumption of *Hibiscus manihot* L. seed oil. Compared with cold-pressed oil, hot-pressed oil can improve the oxidative stability of oil (Figure 1A) and reduce the content of triacylglycerol, but the content of free fatty acids and diacylglycerol will increase. This study provides a technical guidance for the food processing industry on how hot pressing can improve the quality of golden sunflower oil and maintain its nutrient activity. There is a tricky challenge in the storage, transportation and sales of citrus fruits: citrus fruits are prone to water loss and even spoilage after picking, leading to a significant reduction in their shelf life. Liguori et al. proposed a new method to improve the fresh-keeping technology of citrus fruits which demonstrates that encapsulating active compounds such as carvacrol and thymol in oregano essential oil in edible coatings is an operational strategy that not only successfully utilizes the bacteriostatic effect of the active substances to improve food quality, but also ensures food quality and reduces spoilage for sustainable development. It was the first time that an edible coating rich in oregola essential oil was prepared, and the citrus was soaked in it. The experimental results showed that this edible coating could inhibit the growth of mold, also effectively reduce the water loss and weight loss of citrus fruits (Figure 1B). This can not only extend the shelf life of citrus fruits, but also greatly increase the quality parameters of citrus. It has to be noted that although many food by-products contain more or less bioactive substances, they are mainly limited by the low extraction rate which seriously affects the value-added production of the by-products, therefore, exploring the optimal and safe way of extracting active substances is the key to maximizing the effect of active substances. Yan, Miao et al. proposed a semi-biological extraction method to improve the extraction rate of Astragalus polysaccharides (APS) from *Astragalus membranaceus*. The results showed that the APS extraction rate was significantly increased to 18.23% according to the traditional

extraction method, and the APS could promote the expression of two amino acid metabolic pathways (Figure 1C) to reduce the content of malondialdehyde (MDA) and increase the activity of superoxide dismutase (SOD) in rats. These are sufficient to confirm the anti-aging properties of APS. Thus, it can be assumed that the use of APS can be tried in future anti-aging products, which can increase the value of *Astragalus membranaceus*, as well as the feasibility of a safe and efficient method of extracting the active substance, which has been confirmed by continuous optimization of experimental conditions. Xing et al. further studied the physical and chemical properties and functional structure of dietary fiber in tea grounds. They used steam explosion (SE) to treat tea grounds. The experimental results showed that SE had different effects on the physical and chemical properties and functional structure of dietary fiber, especially the content of soluble dietary fiber, which was significantly increased. Therefore, we can obtain high-value dietary fiber with the highest glucose absorption capacity and nitrite adsorption capacity in tea residue by treating tea residue with an appropriate degree of SE (Figure 1D). This study demonstrated that food processing conditions have a significant impact on product quality, further contributing to the development of functional products with high nutritional quality.

Latest research results in the field of food science on food preservation techniques, optimization of dietary fiber properties, anti-aging actives, and improvement of product production methods have revealed the importance and potential of low-quality crop extracts, and have provided new ideas and directions for future related research and product development. However, considering the large variety and quantity of low-quality crops by-products, there are still many unknown functional actives that more suitable and also exploring the extraction of high-quality and high-concentration active substances through different sustainable strategies is a direction that requires the attention of future researchers. In addition, one of the key issues is how to fully utilize these extracts to value-add low-quality crops in order to develop market-competitive functional sustainable foods to meet the ever-changing consumer health and nutritional needs. Therefore, this paper indicates that one of the future research directions will focus on the development of functional foods based on functional extracts to advance the food processing industry.

Author contributions

KL: Investigation, Writing – original draft. ZM: Investigation, Project administration, Writing – review & editing. JG: Writing – review & editing. CF: Writing – review & editing.

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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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