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A full insight into the valorization of wheat by-products

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Wheat is one of the most consumed cereals globally, significantly contributing to human nutrition [1]. However, wheat processing generates underutilized by-products, primarily wheat germ and bran, despite their high nutritional value [2][3]. Wheat bran (WB) is a primary source of dietary fiber, proteins, and phenolic compounds and contributes to approximately 25% of the total weight of the wheat grain [4]. Therefore, studies have been conducted to valorize this by-product. Enzymatic hydrolysis combined with ultrasound-assisted extraction enhances the release of ferulic acid, phenolic compounds, and bioactive peptides, improving their antioxidant and antimicrobial properties [5]. Solid-state fermentation has further increased the bioavailability of phenolics and the solubility of dietary fiber [6]. Furthermore, this valorized WB can be used in cosmetic or food products [5][7].

Wheat germ (WG), rich in protein (34%), fat (10%), tocopherols, and essential minerals, possesses antioxidant properties [8]. This by-product can be separated in two main products, the wheat germ oil (WGO) and the wheat germ proteins (WGP). Moreover, the WGO has been effectively valorized through supercritical CO_2 extraction to obtain nanoemulsions for cosmetic and food products [9]. In addition, WGO can be extracted using cold pressing, to produce wound-healing agents [10]. Additionally, enzymatic hydrolysis of wheat germ proteins has yielded antioxidant and antimicrobial peptides [11]. These proteins and peptides can be applied in functional foods and biodegradable packaging materials [12][13]. WG proteins and peptides can also be obtained using microwave extraction for further use in wound-healing agents [14].

Despite these advances, challenges remain in scaling up extraction/valorization processes, improving economic feasibility, and achieving full valorization of wheat by-products. Future research should focus on optimizing green extraction techniques, broadening industrial applications, and promoting a circular economy in wheat processing. By integrating sustainable strategies, wheat by-products can transition from low-value waste to high-value bioactive ingredients, fostering both economic and environmental sustainability.

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