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SUSTAINABLE VALORIZATION OF WHEAT BY-PRODUCTS THROUGH A GREEN BIOPROCESSING

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ABSTRACT

Cereals, particularly wheat, are a fundamental part of the global diet, but their processing generates significant by-products, namely wheat bran (WB) and wheat germ (WG), yielding, annually and globally, approximately 150 million tonnes and 25 million tonnes of by-products, respectively. These by-products remain largely underutilized. Wheat bran is a valuable source of dietary fiber and minerals, while wheat germ contains proteins, lipids, and bioactive compounds, making both by-products promising for sustainable valorization. Their applications range from functional foods and high-protein pasta to oil-in-water cosmetic formulations and biodegradable packaging materials.

So, the wheat by-products can be divided into three categories: wheat bran (WB), wheat germ oil (WGO) and wheat germ proteins (WGP).

This study aims to achieve a complete valorization of wheat by-products through an innovative green bioprocessing strategy. The first stage focuses on wheat germ valorization by developing an enzymatic extraction process combined with a micellar phase designed to recover proteins, bioactive peptides, and wheat germ oil (WGO) in a single step. This study aims to optimize this extraction method and evaluate the physicochemical properties and bioactivities of the resulting extracts.

The extraction process began with the incorporation of Viscozyme to degrade the cell wall matrix, facilitating the release of proteins and lipids and enhancing the overall efficiency of the valorization process. Subsequently, enzymatic hydrolysis was performed using Alcalase (0%, 1%, and 2%), while different strategies were applied to mitigate lipid oxidation in WGO. Vitamin E and rosmarinic acid (1% and 2%) were tested as antioxidants, and Tergitol 15-S-7 (1% and 5%) was used to improve lipid phase separation. Following hydrolysis, the physicochemical parameters were assessed, including soluble protein content, lipid quantification, and the degree of hydrolysis. Additionally, functional properties such as antioxidant and antidiabetic activities were evaluated. Based on these analyses, the optimal conditions for maximizing protein solubility, lipid recovery, and bioactivity were identified.

These results will enhance the value of these products, contributing to the transition toward a zero-waste wheat valorization system. By demonstrating the potential of bioactive wheat compounds, this approach will drive the scalability of bioprocesses for industrial applications, support the development of functional ingredients, and promote more sustainable and circular agro-industrial practices. Furthermore, the insights gained from this study will serve as a foundation for future research on bioavailability, consumer acceptance, and regulatory feasibility, further strengthening the potential impact of wheat-derived bioactive compounds.

Keywords

Wheat valorization, wheat by-products, wheat bran, wheat germ, bioactive compounds, sustainable extraction.