ABSTRACT - BIOTECHNOLOGY IN THE FOOD INDUSTRY;

# VALORISATION OF WHEAT MILLING BY-PRODUCTS: PRODUCTION OF FUNCTIONAL ENZYMES FOR THE BAKING INDUSTRY

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This study aimed to evaluate the production of fungal enzymes using different types of wheat bran—FT1, FT2, FT3, and FT4—obtained at various stages of industrial milling, as inducers in solid-state fermentation. The focus was on applications in the food industry, particularly the baking sector. Enzymatic activities were quantified, and ergosterol content was measured as an indicator of fungal biomass, allowing correlation between enzyme productivity and mycelial growth. Wheat bran, a low-cost agro-industrial by-product rich in fibres and polysaccharides, was used as substrate due to its potential to induce enzyme production. The enzymes studied—amylases, cellulases, xylanases, proteases, and β-glucosidases—have direct applications in baking, improving dough softness, volume, texture, digestibility, and shelf-life. The fungal strain Penicillium ucense was cultivated on wheat bran supplemented with mineral salts. Inoculum preparation, enzyme extraction, and activity assays followed Camassola and Dillon (2007), and ergosterol quantification followed Stoffel et al. (2019). Amylase activity was highest in FT3 (0.320 U/gms) on day 6, followed by FT1 (0.294 U/gms), with similar ergosterol levels (1.168 and 1.196

mg/g, respectively), indicating both high productivity and biomass. FT3 also showed the highest total cellulolytic activity (FPA), reaching 69.29 U/gms, followed by FT1 and FT4. These results suggest FT3 is suitable for fibre modification in wholegrain products. Endoglucanase activity was also highest in FT3 (8.24 U/gms) and FT1 (7.93 U/gms), both associated with elevated biomass. These enzymes aid in breaking down cellulose and modifying bran, enhancing texture and digestibility in baked goods. FT1 was most productive for β-glucosidases (8125 U/gms), followed by FT3 (4506 U/gms), with high ergosterol levels in both. These enzymes are essential for releasing fermentable sugars, directly influencing dough fermentation and flavour. Similarly, FT1 also showed the highest exoglucanase activity (1959 U/gms), followed by FT3 (1244 U/gms), consistent with biomass data. These enzymes degrade structural polysaccharides in flour, improving dough functionality. Protease production peaked in FT2 (401 U/gms), despite low ergosterol (0.090 mg/g), suggesting enzyme expression may be regulated independently of biomass. FT1 and FT3 also showed strong protease activities (~390 U/gms), contributing to dough extensibility and softness. Xylanase activity was highest in FT4 (52.91 U/gms) and FT1 (52.84 U/gms). Notably, FT4 induced high xylanase levels despite low biomass, indicating possible activation of specific metabolic pathways. These enzymes improve dough volume and crumb structure. Overall, FT1 and FT3 had the highest ergosterol concentrations (1.196 and 1.168 mg/g) and enzyme yields. FT2, although with limited growth, showed selective potential for protease production. FT4, with lower biomass, excelled in xylanase and endoglucanase activities, highlighting the influence of substrate composition on enzyme expression. In conclusion, solid-state fermentation with FT1 and FT3 is the most promising strategy for producing enzyme complexes for the baking industry. These substrates support the development of functional and natural food products, while enabling sustainable and efficient biotechnological processes aligned with modern industry demands.

References

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Palavras-chave: wheat bran; solid-state fermentation; fungal enzymes; baking industry; penicillium ucense; enzyme activity.