

## Development of Protein-Enriched Breadsticks Fortified with Artichoke By-Product Extract and Inulin: Technological Performance, Antioxidant Activity, and Consumer Acceptance

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The development of functional bakery products based on upcycled plant by-products requires a balanced integration of nutritional enhancement, technological performance, and sensory acceptance. In this study, protein-enriched breadsticks were formulated using a high-protein wheat-based dough fortified with artichoke (*Cynara scolymus* L.) by-product extract at three inclusion levels (3%, 5%, and 7%, w/w) and artichoke-derived inulin (5%, w/w). A formulation optimization strategy was applied by combining phytochemical profiling, antioxidant activity, technological characterization, and consumer evaluation. UHPLC-DAD-HRMS analysis revealed an increase in artichoke-derived phenolic compounds with increasing extract concentration, while antioxidant activity assessed by DPPH and ABTS assays was significantly higher in the 5% formulation compared with the 3% sample ( $p < 0.05$ ). The 7% formulation did not provide additional functional benefits and was associated with excessive bitterness, negatively affecting sensory perception. Based on this integrated evaluation, the 5% extract formulation was selected as the optimal compromise, providing enhanced polyphenol content and antioxidant activity together with a mildly bitter taste perceived as pleasant by consumers. The optimized breadsticks showed a high protein content (15 g/100 g), allowing classification as a source of protein according to Regulation (EC) No. 1924/2006, and a high dietary fiber content (8.1 g/100 g). The product exhibited a low fat content (4.9 g/100 g), a moderate energy value (388 kcal/100 g), and water activity values below 0.40. Texture, color, and rheological analyses confirmed technological suitability, while consumer testing involving 100 panelists demonstrated high overall acceptance.

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