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Techno-Functional and Bioactive Potential of Celery Pomace Flour Produced from Juice Industry By-Products

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Abstract

Celery stalk pomace, generated as a by-product of the juice industry, represents an abundant but underutilized biomass with considerable potential for valorization within sustainable food systems. In this study, celery pomace was dehydrated using a controlled drying procedure developed at the Institute of General and Physical Chemistry (2020), resulting in the production of stable celery pomace flour (CPF). The objective of the work was to investigate its techno-functional properties, storage stability, and bioactive potential. Thermal analysis, water activity monitoring, and microbiological profiling performed over a one-year storage period demonstrated that CPF exhibits high physicochemical stability and long-term microbiological safety under ambient storage conditions. DSC identified a glass transition temperature at 43.2 °C, while TGA revealed a multistep degradation pattern typical of fiber-rich plant matrices. Initial weight loss below 160 °C was associated with moisture evaporation and release of low-molecular-weight volatiles, followed by the main degradation stages between 250 and 460 °C related to decomposition of hemicellulose, cellulose, and other structural polysaccharides. Techno-functional characterization showed that CPF possesses very high water-holding and oil-binding capacities, which are essential properties for its potential application as a functional food ingredient. These properties are attributed to its high dietary fiber content of 46.9, with 35.6 insoluble and 11.30 soluble fiber. Carb to fiber ration was very low, 1.35. Content of fat was very low 1.48 while content of protein 15.50. The phenolic profile of CPF was analyzed using LC-MS. Apigenin glycosides were identified as the dominant class of compounds, with apiin being the major constituent, quantified at approximately 5.8 mg/g. Luteolin derivatives were present in significantly lower concentrations. Minor constituents included methoxy- and acetylated derivatives of apigenin glycosides, indicating a complex phenolic profile typical of celery-derived matrices. To assess bioaccessibility, CPF samples were subjected to in vitro gastrointestinal digestion following the standardized INFOGEST protocol, alongside conventional solvent extraction. The same phenolic compounds were detected after digestion, although in reduced concentrations. Comparative analysis between extracted and digested samples confirmed digestion-induced changes in phenolic composition and provided insight into their stability and potential bioaccessibility. Overall, the results

demonstrate that CPF is a stable, fiber-rich material with high level of bioactive phenolic compounds. Despite partial losses during digestion, the persistence of apigenin derivatives suggests potential functional relevance in the human diet. These findings support the valorization of CPF as a sustainable raw material for the development of functional food ingredients.

Keywords: Celery pomace, functional food, dietary fiber, phenolic compounds, LC–MS, INFOGEST, bioaccessibility, food by-products, sustainability

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