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Hydrocolloid-Assisted Granulation of Apple Pomace: Physicochemical Properties and Functional Potential

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Abstract

Dehydrated apple pomace powder (APP) is a promising dietary component due to its high content of soluble and insoluble fiber, bioactive compounds, and favorable physicochemical stability. This study proposes an innovative delivery approach by granulating APP with hydrocolloids (guar, CMC, xanthan) to improve its functional properties. The granulation aimed to enhance rheological behavior and flowability while preserving the nutritional potential. The process of wet granulation in a fluidized bed (pilot-scale device), chosen since it enables drying heat-sensitive material, good temperature control, equal temperature distribution, high drying capacity, short drying time, low maintenance costs, and large-scale production, was performed to obtain granulated powder. The APP, mixed with 3% hydrocolloids, was granulated by top-spray application of distilled water using a two-fluid nozzle at 1.8 bar. The mean liquid flow rate and air flow rate were 5 mL/min and 35 m^3/h, respectively. The granulated APP was subsequently dried by fluidization at 40 °C for 15 minutes. The physical and technological properties of APP before and after granulation, including bulk and tap density, particle size distribution, glass transition temperature (determined by DSC), and water activity (aw) were compared. The mean values of bulk and tapped densities were used to calculate the Carr Compressibility Index (CI) and Hausner ratio (H), which define flowability. According to the Carr Index (CI = 27.59) and Hausner Ratio (H = 1.38), the flowability of the initial APF was assessed as poor, whereas the granulated APP exhibited significantly improved flowability and was classified as fair. The particle size of the non-granulated APP ranged from 0 to 250 µm, whereas after granulation it extended from 25 to 600 µm. This corresponds to an approximate increase of 135% in maximum particle size. Granulated APF exhibits two glass transition temperatures (Tg). The lower Tg (~14 °C) corresponds to the transition of a matrix primarily composed of water and sugars. The higher Tg (53–61 °C), which is less visible and less affected by water plasticization, is likely associated with the macromolecular components of APP. The granulation process does not result in significant changes in the thermal properties compared to the starting material. Water activity monitored during storage confirmed the superior storability of granulated APP, which changed only slightly over a one-year storage period.
The use of granulated APP provides an easy and precise way to increase dietary fiber intake, which is essential for digestive health, regular bowel movements, and body weight

management. Additionally, when consumed before meals, it may help reduce postprandial glucose spikes, supporting its potential role in dietary strategies for improving metabolic health.

Keywords: apple pomace, granulation, hydrocolloids, dietary supplement

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