Abstract

The increasing demand for sustainable, health-oriented, and resource-efficient food systems has intensified interest in plant-based protein products and the valorization of agro-industrial by-products. The present work aimed to develop an integrated processing strategy combining food waste valorization, non-thermal modification of plant proteins, and formulation of functional plant-based foods. Mango peels (MPs), a major by-product of mango processing industries, were valorized as a functional ingredient. MPs were pretreated using steam blanching and subsequently dried using tray, vacuum, and microwave drying techniques. Drying kinetics, moisture diffusivity, and energy consumption were evaluated, and mathematical modeling was applied to describe the drying behavior. The Page model best fitted the experimental data across all drying methods, with high coefficients of determination (R^2 = 0.989–0.999) and low RMSE values. Steam blanching significantly enhanced moisture diffusivity and reduced energy consumption. Ultrasound-assisted extraction followed by HPLC analysis confirmed mangiferin as the major bioactive compound, with maximum retention observed in steam-blanched vacuum-dried samples (0.799 mg g^{-1}) and microwave-dried samples at 540 W (2.462 mg g^{-1}). The findings established dried mango peel powder (MPP) as a nutritionally rich and sustainable functional ingredient. Further, the modification of soy protein isolate (SPI) and pea protein isolate (PPI) using dielectric barrier discharge cold plasma treatment (CP) was carried out. CP significantly influenced the functional properties of both proteins, enhancing water and oil holding capacities, foaming properties, and rheological behavior while altering particle size and electrophoretic profiles. Modified proteins were utilized to develop plant-based noodles, wherein partial substitution of SPI with PPI improved cooking quality and texture. The formulation containing 30% SPI and 40% PPI (S30/P40) exhibited reduced cooking time and solid loss, indicating improved functional performance and suitability for low-glycaemic food applications. Then, CP–treated SPI–PPI blends were combined with mango peel powder and structured into plant-based meat analogues using low-moisture extrusion (LME). The incorporation of MPP enhanced hydration, binding capacity, and structural integrity of the extrudates while reducing cooking losses. Rehydration behavior followed the Peleg model, and textural and digestibility analyses revealed that the S40/P30 formulation offered optimal physicochemical, functional, and nutritional attributes. This research demonstrated that integrating CP technology with mango peel valorization and protein blending can successfully yield sustainable, high-quality plant protein-based products. The developed process technologies contribute to food waste utilization, improved protein functionality, and the advancement of next-generation plant-based foods.

Keywords: Soy and Pea protein isolate; Cold plasma processing; Mango peel valorization; Plant-based protein products; Drying kinetics; Low-moisture extrusion