Research Article

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Controlled ethanol-mediated polyphenol removal from sunflower meal: Impact on physicochemical, structural, flow-behavior, and functional characteristics of isolated proteins

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Abstract

BACKGROUND: Polyphenols present in sunflower meal act on sunflower proteins by reacting directly with their structures and thus influencing their purity, solubility, crystallinity, and functionality. However, the effect on these properties of varying concentrations of ethanol used in dephenolization has yet to be explored. The present study aimed to explore the impact of dephenolization using varying ethanol concentrations (60%, 70%, 80%, and 90%) on the physicochemical, color, thermal, structural, functional, and flow behavior of protein isolates extracted from sunflower meal.

RESULTS: Protein isolates originating from meals that were dephenolized using higher ethanol concentrations exhibited a protein content of 836.10 g kg^{-1}. As the concentration of ethanol increased, a reduction in crystallinity was observed from 24% to 14.15%. Fourier transform infrared (FTIR) spectroscopy revealed marked shifts in major peaks within the 1600 to 1700 cm−1 wavelength range, indicating significant structural and conformational changes. Sodium dodecyl-sulfate polyacrylamide gel electrophoresis (SDS-PAGE) results demonstrated that dephenolization caused decline in molecular weight ranging from 25 kDa to 60 kDa. Dephenolization induced significant changes in surface morphology resulting in more heterogeneous and disordered surfaces as indicated by field emission–scanning electron microscopy (FE-SEM) micrographs. Overall improvement in the functional properties was observed, with an increase in solubility from 15.20% to 22.03%. Improvement in the flow behavior with an increase in porosity from 38% to 60% was also observed, due to dephenolization.

CONCLUSION: Dephenolization using 90% ethanol induced structural changes that enhanced physicochemical and functional characteristics of sunflower protein isolates by improving purity and solubility, reducing crystallinity, and increasing flow behavior.

Keywords: dephenolization; conformation; molecular weight; flow behavior; solubility

INTRODUCTION

Sunflower meal, a valuable by-product derived from processed sunflower seeds, is a rich source of protein and has significant nutritional value. This unique by-product, constituting approximately 36% of the total mass composition, is renowned for its high protein content, varying between 45% and 50%.[1] The majority of the proteins present are albumins (17 to 30%), globulins (mostly helianthin protein, 300 to 350 kDa), and other minor proteins, such as oleosins.[2] Sunflower meal protein holds enormous potential for satisfying the requirements of the food industry, which is constantly searching for economical sources of protein. In comparison with other sources, such as cotton-meal with gossypol, protein-rich mustard bran with glycosylates, or soy-bean bran with protease inhibitors, sunflower protein isolates are substantially better because they are devoid of toxic components and contain significantly lower levels of antinutritional components. Moreover, sunflower proteins might serve as a good substitute for soy proteins, given the growing concerns about allergens related to soy and sustainability issues with soybean cultivation.[3] The application of sunflower seed meal offers the capability to mitigate malnutrition in nations that are impacted by it significantly.[4] Despite having the potential to address malnutrition, attributed to its elevated protein content, sunflower meal is currently underutilized as animal fodder, primarily because of the phenolic content, particularly chlorogenic acid (CGA), a

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