Food Hydrocolloids 96 (2019) 433–441

Contents lists available at ScienceDirect

Food Hydrocolloids

journal homepage: www.elsevier.com/locate/foodhyd

Physicochemical, molecular and thermal properties of high-intensity ultrasound (HIUS) treated protein isolates from album (*Chenopodium album*) seed

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ARTICLE INFO

Keywords:
Album protein isolates
Probe sonication
Physicochemical properties
Conformational changes
Molecular changes

ABSTRACT

Protein isolates from album seed were prepared and subjected to HIUS treatment using a probe method. The effect of ultrasonication on physicochemical, molecular and thermal characteristics were investigated and compared with those of the control. The color characteristics (L^*, a^*, b^* values), whiteness index, solubility, foaming capacity, and foam stability and molecular weight loss of album protein isolates (APIs) have been increased significantly ($p \leq 0.05$) than the native API as a result of HIUS treatment. However, HIUS treatment reduced the denaturation temperatures (T_d), enthalpies of denaturation (Δ_H), thermal stability, particle size, and whiteness index. With increase in ultrasonication treatment from 5 to 25 min, the T_d decreased from 84.56 to 75.90 °C and the Δ_H from 44.87 to 38.75 J/g. This decrease might be related to some structural and conformational changes that had occurred in APIs due to break down of molecular bonds by sonication. The highest reduction in particle size from 245.63 μm to 134.28 μm was observed in album protein isolates treated for 25 min. Most importantly, probe sonication had imparted the structural and conformational changes in API which were confimed form the results of SDS-PAGE, surface hydrophobicity, and weight loss analyses. SDS-PAGE and weight loss showed splitting of high molecular bands into lower molecular weight bands whereas, surface hydrophobicity of HIUS treated APIs was found significantly ($p \leq 0.05$) higher than that of native APIs. The changes in SDS-PAGE patten, surface hydrophobicity, and weight loss subsequently enhanced solubility along with improvement in thermal and other functional properties of album protein isolates.

1. Introduction

Plant proteins are being widely used to replace meat proteins in varieties of food formulations due to their low cost, higher nutritional benefits and the religious concerns. *Pseudo-cereal* proteins have recently gained the attention due to their excellent nutritional profile, particular their essential amino acids (Mir, Riar, & Singh, 2018). Amongst all the *pseudo-cereals*, protein isolates obtained from the quinoa and album seeds have been reported to possess higher nutritional profile in terms of their essential amino acid index, protein efficiency ratio, nutritional index, and the biological value when compared to other plant proteins (Mir, Riar, & Singh, 2019). *Pseudo-cereals* are also considered to be the good sources of phenolic compounds (Paśko, Sajewicz, Gorinstein, & Zachwieja, 2008), and have shown the promising results in the prevention and reduction of many neuro-degenerative diseases.

Chenopodium album commonly known as '*Bathua*' in India belongs to the *pseudo-cereal* family and is found in the fields of wheat, barley, mustard, and gram. This plant species is known for its balanced protein and high amino acid spectrum. Additionally, it is odorless, and has been efficiently utilized in traditional medicinal systems due to its anti-pruritic, antinociceptive, hepatoprotective, and antimicrobial properties (Dai et al., 2002; Ibrahim et al., 2007; Javaid & Amin, 2009; Khoobchandani, Ojeswi, Sharma, & Srivastava, 2009; Pal, Banerjee, Banerjee, Masih, & Pal, 2011; Singh, Kumar, & Dhak, 2011). Jabbar, Zaman, Iqbal, Yaseen, and Shamim (2007) reported that *C. album* possesses anthelmintic activity, *in vitro* and *in vivo*, thus, justifying its use in the traditional medicine systems. The albim seeds also possesses antioxidant potential due to the presence of flavonoids (Vysochina, 2010), cinnamic acid amides (Cutillo et al., 2003), and apocarotenoids (DellaGreca, Di Marino, Zarrelli, & D'Abrosca, 2004). Despite having tremendous health benefits, this inexpensive and valuable source of protein and other essential compounds goes waste in India due to the lack of adequate processing technologies. In our recent findings (Mir et al., 2019), nutritional profile and functional properties of protein

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https://doi.org/10.1016/j.foodhyd.2019.05.052
Received 8 February 2019; Received in revised form 28 April 2019; Accepted 28 May 2019
Available online 30 May 2019
0268-005X/