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New studies on basil (*Ocimum bacilicum* L.) seed gum: Part II—Emulsifying and foaming characterization

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ABSTRACT

BSG is composed of two major fractions with different molecular weight: PER-BSG (5980 kg mol^{-1}) and SUPER-BSG (1045 kg mol^{-1}). In the present work, the emulsifying and foaming properties of BSG and its fractions were investigated as a function of molecular weight, chain flexibility and physicochemical features (protein and acid uronic content). BSG prevented creaming of emulsion for 4 weeks. This high stabilization may be related to formation a solid-like structure and viscoelastic film of BSG around oil droplets which protected oil droplets against aggregation. The low molecular weight fraction (SUPER-BSG) created more stable emulsion than high molecular weight fraction (PER-BSG). The foam capacity and stability of albumin solution increased by adding BSG. The highest foam stability was observed at the highest gum concentration (0.3% w/v). Removing protein moieties of BSG led to emulsion and foam stabilization properties of BSG weakened, which presents the importance of protein in emulsifying and foaming properties of BSG.

1. Introduction

Hydrocolloids are high-molecular weight and hydrophilic biopolymers, which usually introduced as thickening, texturizing, stabilizing and gelling agents (Dickinson, 2003). However, hydrocolloids mostly are used to increase continuous phase viscosity of emulsions and foams and they enhance stability by retarding the movement of droplets. But a few hydrocolloids can act as a surface active agent and used as emulsifying and foaming agents like gum arabic, hydrophobic modified starches, modified celluloses, some kinds of pectin, and some galactomannans (Dickinson, 2009). Existence of hydrophobic and hydrophilic side chains in their polymers structure make them surface active agents (Huang, Kakuda, & Cui, 2001). The surface activity of hydrocolloids has its molecular origin in either (i) the non-polar character of chemical groups attached to the hydrophilic polysaccharide backbone (in hydrophobically modified starch/cellulose) or (ii) the presence of a protein component linked covalently or physically to the polysaccharide (like gum Arabic, pectin, etc.) (Dickinson, 2009).

Basil (*Ocimum bacilicum* L.) is a well-known source of fiber, flavoring agent and essential oil with antioxidative and antimicrobial activities (Hosseini-Parvar, Matia-Merino, Goh, Razavi, & Mortazavi, 2010; Javanmardi, Stushnoff, Locke, & Vivanco, 2003). Iranian basil (*O. bacilicum* L.) seed is black in color and oval in shape with mean dimensions of 3.11 ± 0.29 mm (length), 1.82 ± 0.26 mm (width) and 1.34 ± 0.19 mm (height) (Hosseini-Parvar et al., 2010). The main role of basil seeds is for propagation (Hornok, 1992). Basil seeds when soaked in water become gelatinous and the high mucilage content of basil seeds can make it a novel source of edible gum (Razavi, Bostan, & Rezaie, 2010). Basil seed gum (BSG) is a plant-derived hydrocolloid with high viscosity and pseudoplastic behaviour (Hosseini-Parvar et al., 2010). It is a high molecular weight (MW) polysaccharide (2320 kg mol^{-1}), which mainly consists of two different molecular weight factions: PER-BSG (6000 kg mol^{-1}) and SUPER-BSG (1045 kg mol^{-1}) (Naji-Tabasi, Razavi, Mohebbi, & Malaekeh-Nikouei, 2016). All fractions consist of glucose, galactose, rhamnose, arabinose, mannose and xylose in different ratio. Iranian basil (*O. bacilicum* L.) seed gum also contains 6.51% uronic acid (Naji-Tabasi et al., 2016). BSG offers various application potential in food industry as thickener, gelling agent, stabilizer, fat replacer and controlling crystal growth (BahramParvar & Goff, 2013; Hosseini-Parvar, Matia-Merino, & Golding, 2014; Niknia, Razavi, Koocheki, & Nayebzadeh, 2011; Osano, Hosseini-Parvar, Matia-Merino, & Golding, 2014; Rafe & Razavi, 2013; Razavi, Shamsaei, Salehi, & Emadzadeh, 2012). In addition, previous study also confirmed that BSG reveals promising

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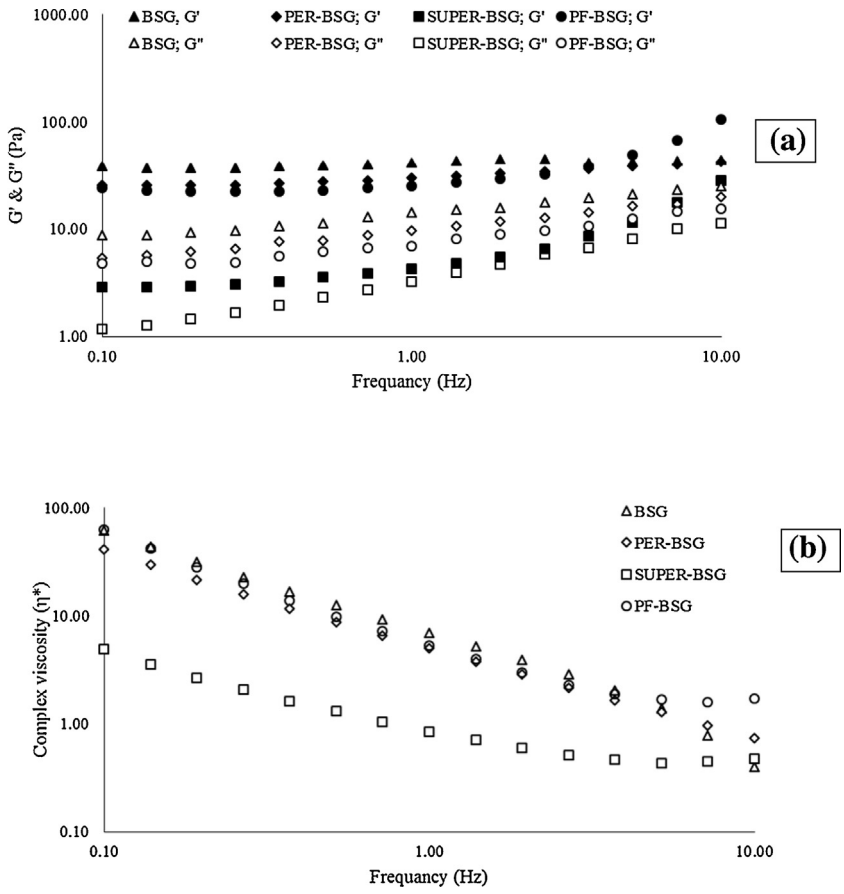

Fig. 1. Mechanical spectra of BSG and its fractions emulsions oil in water (30% w/w) as a function of frequency ($\tau = 0.1$ Pa, 20 °C); (a) Storage (G′) and loss (G″) modulus; (b) Complex viscosity (η^*).

surface activity and emulsifying properties (Hosseini-Parvar, 2009; Naji-Tabasi et al., 2016; Osano, Matia-Merino, Hosseini-Parvar, Golding, & Goh, 2010; Osano et al., 2014). The major factor that influenced on BSG surface activity is protein moiety, which is associated with them (2.37, d.b.%) (Naji-Tabasi et al., 2016; Osano et al., 2010; Osano et al., 2014). Besides protein moiety, MW played a pivotal role in BSG surface activity, which lower MW fractions of BSG have more tendencies to adsorb on interface (Naji-Tabasi et al., 2016). Presence of uronic acid and flexible structure of BSG are the other factors that improve surface properties of this gum (Naji-Tabasi et al., 2016). Since basil seeds are available in abundance and consumers have more tendencies to plant-derived materials consumption, there is a great potential to utilize BSG as a functional ingredient in the food industry due to its potential applications.

In previous part (part I of this series), BSG was fractionated by non-solvent fractionation technique and chemical composition, monosaccharide units, molecular weight (MW) and surface activity of fractions were determined (Naji-Tabasi et al., 2016). The results showed BSG have reasonable surface activity; therefore the main goal of this study was to investigate the influences of molecular weight, chain flexibility and physicochemical features (protein and acid uronic contents) on emulsifying and foaming properties of BSG and its fractions.

2. Material and methods

2.1. Materials

O. bacilicum L. seeds were purchased from a local medicinal market at Mashhad city in Iran and Mohammad Reza Joharchia, plant taxonomist from Research Centre for Plant Sciences of Ferdowsi University of Mashhad, Iran, authenticated their species. Proteinase *k* was obtained from Sigma-Aldrich, USA. Sodium azide (NaN_3) and albumin were obtained from Applichem Inc. (Dramstadt, Germany). Sodium dodecyl sulphate (SDS) was purchased from Merck, Germany.

2.2. Basil seed gum extraction and purification

BSG powder was prepared according to the procedure of Hosseini-Parvar et al. (2010) and Naji-Tabasi et al. (2016). In brief, cleaned seeds were soaked in distilled water at 68 ± 1 °C, pH ~7 and water/seed 20:1 for 20 min. The swelled seeds were passed through an extractor equipped with a rotating rough plate that scraped the mucilage layer on the seed surface. The extracted mucilage was filtered and mixed with three volumes of 96% ethanol to precipitate polysaccharide. The precipitated polysaccharide was dissolved in water and dried by an air forced oven (38 °C). The dried gum was milled, sieved, packed and kept at cool and dry condition.

2.3. Basil seed gum fractionation

BSG was fractionated according to M_W by non-solvent fractionation technique (precipitation method) as described by Naji-Tabasi et al. (2016). In precipitation method, dissolution power decreases by increasing of ethanol in a solvent/nonsolvent mixture and decreasing temperature. According to this method, the first precipitated fraction contains molecules with the highest Mw. BSG solution was prepared at 0.1% (w/w) in deionized water as low polymer concentration improves fractionation efficiency especially in