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Modification of chicken feet gelatin with aqueous sweet basil and lemongrass extract

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ABSTRACT

The effects of aqueous extracts of sweet basil leaves and lemongrass stem at different levels (0, 1, 1.5, 2, 2.5 and 3 ml/100 g dry gelatin) on the physical and rheological properties of chicken feet gelatin gels were investigated. Chicken feet gelatin gels cross-linked by plant extracts were more turbid than control, had reduced water holding capacity (WHC) and swelling ratio. Nevertheless, the increase in gel strength, thermal stability, and elastic modulus was found with increasing plant extract levels and increased the stability of gelatin within a certain concentration range of plant extracts. Complex viscosity (η^*) values of gelatin with and without addition of plant extracts were decreased with increasing temperature. Therefore, plant extract at an appropriate level could act as a natural gel enhancer of chicken feet gelatin.

1. Introduction

Food and pharmaceutical industries throughout the world are observing a growing demand for collagen and gelatin. The most popular and used is the gelatin of mammals (pigs and cattle), which are subjected to greater restrictions and skepticism among consumers, by socio-cultural and health concerns (Gómez-Estaca, Montero, Fernández-Mantín, & Gómez-Guillén, 2009). Recent studies reported that poultry (Kim, Kim, Lee, Kim, & Kim, 2012; Sarbon, Badii, & Howell, 2013) and fish (Rawdkuen, Sai-Ut, & Benjakul, 2010) could provide a valuable source of gelatin.

Gelatin source from poultry is mostly come from chicken. Studies on gelatin from chicken feet, head and skin reported that gelatin from chicken feet (De Almeida, Lannes, Calarge, Farias, & Santana et al., 2012), head (Du, Khiari, Pietrasik, & Betti, 2013), and skin (Sarbon, Badii, & Howell et al., 2013) have high potential and nutrition quality for application as an alternative to commercial gelatin.

Gelatin is a soluble protein obtained by partial hydrolysis of collagen, the main insoluble fibrous protein constituent of bones, cartilages and skins with high potential applications in food and pharmaceutical industries (Gan, Zhang, Liu, & Wu, 2012). The mechanical properties of gelatin can be improved through chemical cross-linking. Once cross-linked the sample becomes much more stable in aqueous environments (Chiou, Avena-Bustillos, Shey, Yee, Bechtel, Imam et al., 2006). Undoubtedly, a natural cross-linking agent with no toxicity is of great interest for improving the properties of gelatin. Because of this reason, growing interest in using plant extracts as natural sources of antioxidant and antibacterial (Lucera, Costa, Conte, & DelNobile, 2012), mechanical, and rheological properties (Chiou et al., 2006) have been applied.

Phenolic compounds as food components represent the main group of secondary metabolites in plant foods. They are characterized by a wide range of specific structures and functions, but also as generally possessing an aromatic ring bearing one or more hydroxyl substituents (Parr & Bolwell, 2000). Interest in these compounds is related to their dual role as substrates for oxidative browning reactions and as antioxidants, underlining their impact on organoleptic and nutritional qualities of fruits and vegetables, their role in plant growth and metabolism and, more recently, their demonstrated physiological activity in humans (Rawel, Kroll, & Kulling, 2007). Phenolic compounds can interact with proteins through non-covalent and covalent interaction (Maqsood, Benjakul, & Shahidi, 2013). Therefore this study investigates the influence of the aqueous sweet basil and lemongrass extract on the physical and rheological properties of the chicken feet gelatin gels.

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2. Materials and methods

2.1. Materials

Main material used was fresh chicken feet obtained from local market, Selangor, Malaysia. Chicken feet were kept in freezer until extraction process was done. NaOHand HCl were obtained from Sigma (St. Louis, MO, USA). Sweet basil leaves and lemongrass stem were obtained from local market. All other chemicals used were of analytical grade.

2.2. Preparation of chicken feet gelatin

Washed chicken feet were soaked in 10 vol (v/w) of hydrochloric acid solution (5 ml/100 ml HCl) in ambient temperature for 24 h to swell the chicken feet. After soaked in acid treatment done, chicken feet were neutralized with flowing water. For extraction of chicken feet with heating, chicken feet was put in boiled water at 75 °C for 2 h. Extracted gelatin was frozen at −71 °C and dried at −40 °C with freeze-dryer (Freezone, Labconco, USA). Chicken feet gelatin was dried until constant weight for 48 h in freeze-dryer (Kim et al., 2012).

2.3. Preparation of plant extracts

Sweet basil leaves and lemongrass stem were picked and washed with water to remove all unwanted materials. Dried in the dark (25 °C ± 2 °C) and stored in an airtight container for further use before ground (IKA MF 10.1 milling machine, Germany) to fine powder.

A 5 g of powdered samples were added into 50 ml of distilled water and allowed to stand at 40 °C under constant agitation during 1 h. The resultant extracts were then filtered (using double filter paper) for further experiments (Soares, Alves, Pires, Oliviera, & Vinha, 2013). Dilutions were performed if necessary. Supernatant were stored in capped bottle and kept at −20 °C until further use.

2.4. Preparation of cross-linked chicken feet gelatin

Gelatin (10 g/100 ml) was solubilized in water using an overhead stirrer and held in water bath at 60 °C for 30 min. To prepare gelatin solutions at pH 8 or 9, gelatin was solubilized for 15 min and then NaOH (1 M) was added to raise the pH to 8 or 9 and left stirring in water bath (60 °C) for another 15 min. Plant extracts (basil and lemongrass with concentration of 0–3 ml/100 g dry gelatin) were added to the gelatin solution and reacted at 60 °C in water bath for 20 min (Kosaraju, Puvanenthiran, & Lillford, 2010).

2.5. Turbidity

Turbidity of gelatin with addition of basil and lemongrass extract was determined using a method performed by Fernàndez-Dõaz, Montero, and Gomez-Guillen (2001) with a slight modification. Gelatin was dissolved with distilled water at 60 °C to obtain the final concentration of 6.67 g/100 ml. The solution was stirred until the gelatin was solubilized completely. Turbidity of gelatin solution was measured by reading the percentage transmittance at 360 nm using spectrophotometer (UV-1800 UV-VIS, Shimadzu, Japan) at room temperature (25 °C).

2.6. Water holding capacity

Water holding capacity (WHC) was measured by a partially method of Cho, Kwak, Park, Gu, Ji, Jang, et al. (2004). 1 g of gelatin was placed in centrifuge tube and weighed (centrifuge tube and gelatin). For measuring WHC, 50 ml distilled water was added and held at room temperature for 1 h. The gelatin solutions were mixed with vortex mixer for 5 s every 15 min. The gelatin solutions were then centrifuged at 450 g for 20 min (Eppendorf centrifuge 5810 R, USA). The upper phase was removed and the centrifuge tube was drained for 30 min on a filter paper tilting to a 45° angle. Capacities were calculated as the weight of contents of tube after draining divided by the weight of the dried gelatin, and expressed as the weight percentage of dried gelatin.

2.7. Gel strength

Gel strength of gelatin was determined at 10 °C using a Model TA-XT2 Texture Analyzer (Stable Micro System, Surrey, UK) with a load cell of 5 kg. A 1.27 cm diameter flat-faced cylindrical Teflon® plunger was used. The gel strength was determined by penetrating the sample held in a plastic container with a 10 mm diameter flat ended probe at a crosshead speed of 5 mm/min. The force at the first peak in the force–distance curve was taken as a measure of gel strength.

2.8. Differential scanning calorimetry (DSC)

DSC was performed on a Netzsch DSC 200PC (Netzsch Bavaria, Germany) fitted with an air cooling compressor and a liquid nitrogen cooler at ambien temperature. The temperature was calibrated effectively using indium as standard. Sample was weighed (5 mg) accurately and sealed in aluminum pans. At least triplicate samples were heated from 30 °C to 120 °C at a scanning rate of 2 °C/min, with an empty sealed pan as a reference (Yan, Li, Zhao, & Yi, 2011).

2.9. Swelling ratio

Swelling ratio of cross-linked gelatin gel was determined using a method by Strauss and Gibson (2004) with slight modification. Approximately 0.5 g samples of 5 g/100 ml gelatin gels were placed into 50 ml beakers and dried to constant weight at 40 °C in a vacuum oven (Binder VD53, Germany). Twenty milliliter of 0.05 M pH 7 phosphate buffer saline (PBS) was added to the dried samples, allowed to equilibrate for 4 h, and then decanted. The swollen samples were blotted with filter paper and weighed, thus giving the swollen per dry weight ratio.

2.10. Rheological measurements

Oscillatory shear deformation measurement was performed on rheometer (Anton Paar Physica, Graz, Austria). A 6.67 g/100 ml (w/v) solution was prepared and heated at 60 °C for 30 min. Hydrogels were equilibrated in water at room temperature for 2 days before the rheological measurements were taken. The rheological experiments at oscillatory shear deformation of the gelatin hydrogels were carried out with Anton Paar rheometer parallel plates of 25 mm diameter. The storage (elastic) G' and loss (viscous) G'' moduli were recorded at constant temperature (27 °C) and at shear strain of 0.05% in a range of frequency from 0.1 to 10 Hz (Fonseca-Silva, Habibi, Colodette, & Lucia, 2011). Dynamic temperature sweeps for all of the cross-linked gelatins were conducted within the linear range at a constant strain of 5% and a given frequency of 1 Hz and were heated from 27 to 50 °C at a rate of 1.5 °C/min (Dash, Marcus, & Arthur, 2013).

2.11. Statistical analysis

All experiments were performed in triplicate ($n = 3$). The