Detailed characterization and gelation mechanism of mung bean albumin and globulin fractions

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Plant protein isolates are increasingly used in food formulations, particularly to produce plant-based yogurts [1]. However, their gelling properties remain difficult to control and standardize. Therefore, a comprehensive understanding of the gelling behavior of plant proteins is essential, particularly that of globulins and albumins, which are the two major protein fractions in most plant sources, including pulses [2].

This research investigates proteins from mung beans, an emerging and promising protein source that remains under-researched compared to other common pulses [3], yet is gaining increasing attention for its remarkable gelling properties [4]. The study first involved the production of mung bean albumin and globulin fractions, followed by characterization and analysis of their gelling properties.

Mung bean protein isolates were obtained by alkaline solubilization of mung bean flour at pH 9 for 2 h, followed by centrifugation and ultrafiltration-diafiltration (UF-DF) of the supernatant using a 30-kDa molecular weight cut-off membrane. Purified albumin and globulin fractions were obtained by isoelectric precipitation at pH 4.5 followed by centrifugation. The globulin was recovered from the pellet, while albumin from the supernatant was further purified by UF-DF. The globulin and albumin fractions contained 88.44% and 80.72% protein, respectively, as determined by the Dumas combustion method. Both fractions were further analyzed for their proximate composition and physicochemical properties, including solubility (pH 2-8), particle size, thermal behavior and secondary structure. Gelling properties were then investigated, starting with least gelation concentration, followed by water-holding capacity, rheological behavior, microscopic structure, and analysis of molecular interactions within the gel networks.

Notable differences were observed between the two fractions. Albumin fraction displayed a constant solubility (~60%) at all pH values, while globulin fraction followed a U-shaped curve with a minimum at pH 4.0 (26.10%) and a maximum at pH 8 (91.44%). The relatively low solubility of albumins was attributed to protein aggregation during purification. Additionally, albumins were characterized by smaller soluble particle size and a secondary structure enriched in α-helices. These features are consistent with its lower minimum gelation concentration (4%) compared to the globulin fraction (8%). However, the water retention capacity of albumin gels (80.3%) was lower than that of globulin gels (96.2%) at 8% proteins, suggesting a less firm network for the albumin fraction. Rheological and microscopic analyses confirmed these results, showing a higher final elastic modulus (G') for globulin gels (8908 Pa versus 1081 Pa for albumin gels) and a tighter gel structure. In contrast, the albumin fraction formed a loose and porous network with coarse particulate features, attributed to the aggregated conformation of albumins. Globulin gels were also characterized by increased protein incorporation and more extensive intermolecular bonding, primarily formed through hydrophobic interactions. In contrast, albumin gels were formed mainly through electrostatic interactions. Based on these findings, a gelling mechanism was proposed for each fraction, providing valuable insight into the distinct roles of albumins and globulins in the gelation of mung bean protein isolates.

Keywords:
Mung bean, proteins, albumin, globulin, surface properties, gelling properties, microstructure, protein interactions

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