

Formulation engineering of melt-in-the-mouth plant-based protein-rich gels

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This study aims to develop vegan gelatin analogue gels for patients with dysphagia who require melt-in-the-mouth meals with a soft texture. The goal is to produce a formulation that is both easy to swallow and nutritionally rich, particularly in protein content. A thermo-responsive soft gel system combining low-acyl gellan gum (LAG) and tamarind seed xyloglucan (TSX) was formulated to melt at in-mouth temperature. Differential scanning calorimetry (DSC) and rheological analyses indicated that LAG acts as the primary network-forming biopolymer, while TSX fills the pore spaces within the gel matrix, as confirmed by cryogenic scanning electron microscopy (Cryo-SEM). Depending on total polymer concentration and mixing ratio, TSX interacts with the LAG network, compromising the thermo-reversibility of the sol-gel transition. Thermo-reversibility is also affected by the level of incorporation of pea protein isolate (PPI). A maximum level of addition of ca. 5 wt% to maintain thermo-reversibility was established. The PPI used in this study was commercially sourced and, as commonly reported, exhibited limited solubility in aqueous media. Consequently, the final gel characteristics arose from the combined effects of both the dissolved protein fraction and, to a large extent, protein aggregates that could be seen microscopically. It is proposed that at sub-threshold levels of PPI incorporation, the protein aggregates occupied pore spaces within the LAG network, residing alongside the TSX. However, at concentrations above the threshold, the formation of the LAG network appeared to be disrupted, leading to a structural transition in which the overall gel properties became dominated by the characteristics of the PPI phase. To address challenges in accurately 3D printing the LAG-TSX-PPI system, the concentration of pea protein isolate (PPI) was stepwise increased (0–10%) and printability characterized using oscillatory temperature sweep tests. At 5 wt% PPI, the maximum level to maintain thermo-reversibility, samples with high shape fidelity could be printed; an example is illustrated in Figure 1. This formulation also fulfilled the melt-in-the-mouth and soft gel requirement and is thus a promising basis for the development of more complex vegan gelatin analogues for dysphagia patients. A nutritionally complete and tasty meal would also contain a lipid phase and taste or flavour additives.

Keywords:

Vegan gelatin analogue; Low acyl gellan gum; Tamarind seed xyloglucan; Pea protein isolate; Dysphagia; 3D food printing



Fig. 1. 3D printed gel cube from a mixture of low acyl gellan gum and tamarind seed gum containing 5 wt% pea protein isolate.

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