Influence of pH on freeze structured plant proteins

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Meat analogues have a poorer texture and mouthfeel than animal meat, in particular whole cuts. This prevents consumers from switching to a more sustainable, healthier, plant-based diet. The unsatisfactory texture properties of plant-based meats can be attributed to a fibrous texture that does not resemble the hierarchical fibrous texture of the animal muscle. Structure is linked to water holding capacity and succulency, and both product attributes are typically compromised in the case of plant-based meat analogues. While extrusion is the commercial technology of choice, it does not create the desirable, hierarchical, fibrous structures.

In this research freeze-structuring is investigated as an alternative approach. Although this technology is not novel, it needs to be further developed to outweigh, ideally overcome, the challenges of scale-up. In brief, elongated or needle-like ice crystals are directionally grown through a protein slurry and parallel structures form between the ice crystals. Melted structures are then held in place through gelation and intermolecular bond formation of the hydrocolloids present.

To meet nutritional targets of meat analogues, the use of polysaccharides should be minimised and protein maximised. Polysaccharides are relied upon for their contributions to strength and texture. To minimise polysaccharide use, their functionality should be optimised; plant protein contributions to texture should be exploited to offset the need for them. For texture enhancement, plant proteins must be able to make intermolecular bonds (which does not occur in their native state). Freeze structuring requires free water in the slurry for ice crystals to grow. To balance maximising protein content and water availability, pretreatments should improve protein solubility.

To assess the hypothesis that the denaturation state of the protein relates to the final texture, mixtures of plant protein and sodium alginate were non- and uni-directionally frozen followed by texture analysis. Non-pH adjusted protein, with all other conditions unchanged, resulted in a disordered not self-supporting final composite material. Whereas alkaline treatment led to a highly structured and firm composite. Non-directionally frozen samples had a random and disordered structure whereas uni-directionally frozen samples were aligned and anisotropic. The impact of freezing on texture will be explored. Relationships between the choice and effects of protein pre-treatment, sample composition, and processing protocol will be discussed, as well as impacts on final material properties.