Effect of pH on the gelling properties of pea protein-pectin composite gels

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Objective:
Investigate the combined effects of pH (5.5, 7, 8.5) and addition of pectin (0.5% and 1%) on the rheological properties and microstructures of pea protein gels.
Methods:
The physicochemical characteristics of pea protein-pectin dispersions at different pH were investigated, including particle size, zeta-potential, solubility, and phase separation behaviors. Pea protein-pectin interactions as function of pH were analyzed by a Quartz crystal microbalance with dissipation monitoring (QCM-D). The viscoelastic properties of samples were monitored during the whole gelation process and determined by rheology. Confocal laser scanning microscopy (CLSM) was used to observe gel microstructures changes. The in vitro digestibility of gel samples was also investigated.
Results:
At pH 5.5, the addition of pectin significantly increased the size of protein aggregates, which could be explained by the relative strong electrostatic attractions between pea proteins and pectins, revealed by QCM-D, leading to the formation of insoluble complexes and reduced soluble protein contents. During gelation, the association of unfolded proteins facilitated the connectivity of aggregates, resulting in the formation of coarse and particulate gel networks with increased storage modulus. However, larger aggregates formed in the presence of 1% of pectin weakened the gel strength. At pH's 7 and 8.5, the addition of pectin also increased the particle size of protein aggregates mainly due to phase separation of incompatible biopolymers since pea proteins and pectins were negatively charged. The excluded volume effect induced by phase separation increased the local concentration of proteins and promoted the formation of large aggregates, resulting in increased storage modulus of pea protein-pectin composite gels after gelation. Phase-separated gel structures were also found under confocal microscopy showing a protein continuous network and pectin occupying the void spaces. Furthermore, the addition of pectin revealed an increase of protein degradation extent under simulated gastrointestinal conditions at all pH values.
Conclusions:
The pH value and pectin concentration showed a significant impact on the mechanical strength and microstructures of pea protein gels, which could be ascribed to the different interaction modes of protein and pectin. By varying pH and pectin concentrations, novel pea protein-based gels with various mechanical properties and microstructures could be designed.