Public Abstract

First Name:Yan

Middle Name:

Last Name:Huan

Adviser's First Name:Bongkosh

Adviser's Last Name:Vardhanabhuti

Co-Adviser's First Name:

Co-Adviser's Last Name:

Graduation Term:FS 2013

Department:Food Science

Degree:MS

Title:Application of Soluble Whey Protein-Carboxymethylcellulose Complex in Emulsion and Acid-induced Gelation

Soluble complex between whey protein isolate (WPI) and carboxymethylcellulose (CMC) can be formed at pH above the isoelectric point of the protein. This complex can be utilized to enhance functional properties of the biopolymers and thus improve texture and stability of many food products. This study investigated the effect of molecular weight and concentration of CMC on emulsion stabilization and acid-induced gelation.

In the first study, the influence of CMC concentration and molecular weight (Mw = 270k, 750k, and 2,500kDa) on the stability and properties of WPI/CMC-stabilized oil-in-water emulsions was investigated. Emulsions were prepared using soluble WPI-CMC complexes by homogenization 5% vegetable oil with 95% mixed WPI-CMC solution (0.5% WPI and 0-0.5% CMC, pH 7.0) at 12,000 rpm for 1 min, followed by sonication at 30% amplitude of total power for 5 min, and the pH was adjusted to 5.2. Emulsions were assessed by measuring zeta-potential, droplet size, creaming stability, rheological properties, and protein surface coverage. In the absence of CMC, the WPI-stabilized emulsions were unstable to droplet flocculation and coalescence due to the relatively low droplet charge. Zeta-potential and droplet size indicated that WPI-CMC complexes adsorbed to the droplet surfaces and thus reduced droplet flocculation and coalescence. Both CMC Mw concentration and significantly influenced the properties and stability of acidified emulsions. At low CMC concentrations, stability was improved due to increased droplet charge and protein surface coverage, while the effect of viscosity dominated at high CMC concentrations. High Mw of CMC contributed to better stability compared to lower Mw CMC. At proper concentration, emulsions containing high Mw CMC (2,500k) were the most stable and showed no separation even after 15 day storage. In the second study, acid-induced gelation of heated whey protein isolate (WPI) and carboxymethylcellulose (CMC) soluble complex was investigated. Heated soluble WPI-CMC complexes were prepared by mixing the biopolymers at pH 7 and heated at 85 oC for 30min. Gels were formed by the addition of glucono-delta-lactone (GDL) and compared to those formed from WPI polymer (protein heated alone) with added CMC. All gels contained 5% protein and 0-0.125% CMC (Mw = 270k, 680k, and 750kDa). Results showed that CMC molecular weight and biopolymer ratio were the major factors affecting gel properties. For 270k and 750k CMC, gels from heated WPI-CMC complex showed improved gel hardness and, at certain CMC concentration, improved water holding capacity. Confocal laser scanning microscopy (CLSM) results revealed that gel structure largely depended on CMC concentration. Overall, gels from heated WPI-CMC complex showed smoother structure and less porosity, indicating less phase separation. Furthermore, gels showed better mechanical properties when heated WPI-CMC complex at higher protein concentration.

Overall, both unheated and heated WPI-CMC complex improved the emulsification and cold gelation of whey protein. The Mw of CMC significantly affects their interactions with whey protein and thus the functional properties of the complexes. High Mw CMC at optimum concentration resulted in the improvement of emulsion stability and acid-induced gel properties. By utilizing proper Mw and optimum concentration, WPI-CMC complex can be applied as a novel food ingredient.