Thepkunya Harnsilawat 2006: Protein-Polysaccharide Interaction and Its Effect on the Stability of Oil-in-Water Emulsion. Doctor of Philosophy (Agro-Industrial Product Development), Major Field: Agro-Industrial Product Development, Department of Product Development. Thesis Advisor: Associate Professor Rungnaphar Pongsawatmanit, D.Agr. 108 pages.
ISBN 974-16-2332-1

Proteins and polysaccharides are used as functional ingredients in many food products. Their interactions play an important role in the development of novel foods. Since the protein-polysaccharide interactions are sensitive to the molecular characteristics and solution conditions (pH, ionic strength and temperature), therefore the interaction between β-lactoglobulin (β-Lg) and sodium alginate (NaA) was selected and investigated in aqueous solutions and in oil-in-water emulsions. The effect of polysaccharide type and concentration, pH, ultrasound treatment, ionic strength and temperature on the formation, stability and properties of solutions and emulsions was determined using isothermal titration calorimetry, static and dynamic light scattering, ζ-potential, soluble protein, turbidity, creaming stability, and optical microscopy measurements. Initially, the influence of pH on the properties of NaA, β-Lg, and their mixtures in aqueous solutions was studied. The electrical charge of isolated β-Lg went from positive to negative as the pH increased from 3 to 7 with the isoelectric point being around pH 4.8, while the electrical charge of isolated NaA was negative at all pH values. Light scattering measurements indicated that isolated NaA was completely soluble from pH 3 to 7, but isolated β-Lg formed large complexes that scattered light at pH 4 and 5. When β-Lg and NaA were mixed together at pH 3 and 4 they formed large complexes, while at pH 5, β-Lg and NaA formed fairly soluble complexes. At pH 6 and 7, β-Lg and NaA did not form complexes due to electrostatic repulsion. When the influence of pH, sodium alginate and ultrasound treatment on the properties of 5 wt% palm oil-in-water emulsions stabilized by β-Lg was determined, anionic NaA adsorbed to the surfaces of β-Lg coated droplets at pH 3-5 due to electrostatic attraction. At pH 6 and 7, adsorption did not occur because of the strong electrostatic repulsion. Emulsion droplets coated by β-Lg-NaA complexes were prone to bridging flocculation which promoted creaming instability. However, high intensity ultrasound treatment was able to reduce the degree of droplet flocculation in these emulsions, thereby increasing creaming stability. The effect of ionic strength and mixing condition was examined in 0.1 wt% corn oil-in-water emulsions containing droplets stabilized by β-Lg-NaA interfaces. NaA adsorbed to the β-Lg-coated droplets from pH 3 to 6, which was attributed to electrostatic attraction between the anionic polymer and cationic patches on the droplet surfaces. Droplets coated by β-Lg-NaA had better stability to flocculation than those coated by β-Lg alone, especially around the isoelectric point of the adsorbed proteins and at low ionic strengths (< 100 mM NaCl). Mixing conditions had an impact on the formation and stability of secondary emulsions. More stable emulsions could be formed if the droplets and polymer were mixed at a pH where they had the same sign charge, and then the pH was adjusted to a value where they had different charges. Finally, the model beverage emulsions were selected as a food model. The emulsions consisted of 0.1 wt% corn oil droplets coated by β-Lg and β-Lg/alginate compared to those coated by β-Lg/ι-carrageenan, or β-Lg/gum arabic interfacial layers (pH 3 or 4). The emulsions were subjected to variations in pH (3 to 7), ionic strength (0 to 250 mM NaCl) and thermal processing (30 or 90°C) and the influence on their stability was determined. The emulsions containing alginate and carrageenan had the best stability to ionic strength and thermal processing. This study shows that the controlled formation of protein-polysaccharide complexes at droplet surfaces may be used to produce stable beverage emulsions, which may have important implications for industrial applications.

T. Harnsilawat — Student's signature

P. Pongsawatmanit — Thesis Advisor's signature

29 / 05 / 2006