Effect of alginate size, mannuronic/guluronic acid content and pH on particle size, thermodynamics and composition of complexes with β-lactoglobulin

Alginate is an anionic polysaccharide capable of forming insoluble particles with proteins. Hence, alginate has potential as a protein carrier. However, the role of physical properties of the polysaccharide, such as degree of polymerization (DP\textsubscript{n}) and mannuronic/guluronic acid ratio, remains to be fully explored. Particle formation of a high and a low molar mass alginate (ALG) with β-lactoglobulin (BLG) at pH 2-8 depends on the average DP\textsubscript{n} (HMW-ALG: 1.59·10^3; LMW-ALG: 0.23·10^3) and the mannuronic/guluronic acid ratio (1.0; 0.6) as supported by using Man\textsubscript{A6} and Gul\textsubscript{A6} as models. Dynamic light scattering (DLS) showed that particles of BLG with either of the two ALGs have essentially the same hydrodynamic diameter (D\textsubscript{H}) at pH 3 and 2, while at pH 4 particles of LMW-ALG/BLG have larger D\textsubscript{H} than of HMW-ALG/BLG. At pH 5-8 no significant particle formation was observed. Man\textsubscript{A6} did not form insoluble particles at pH 2-8, while Gul\textsubscript{A6} formed insoluble particles, albeit only at pH 4. K\textsubscript{d} was approximately 10-fold higher for LMW-ALG/BLG than HMW-ALG/BLG and 3 orders of magnitude higher for an alginate trisaccharide/BLG complexation as determined by isothermal titration calorimetry (ITC). The alginate trisaccharide did not form insoluble particles with BLG at pH 3 and 4, though interaction still occurred. δH\textsubscript{app} and molar stoichiometry of BLG in the complexes with the two ALGs differed by a factor of 7, as did their DP\textsubscript{n}, which thus affected the interaction strength, but not the BLG content. At pH 4 the BLG content doubled in the particle due to BLG dimerization. The findings emphasize the importance of DP\textsubscript{n}, mannuronic/guluronic acid ratio and pH in formulations containing alginate/whey protein particles.