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FP10 Spectroscopic and tribological studies of the interactions between β-lactoglobulin and mucins

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Proteins are important ingredients for food products in terms of providing desirable textural, sensory, and nutritional properties. In oral processing, food products are continuously mixed with saliva and it is the resulting aggregates that are ultimately consumed by human body. In order to understand the interaction mechanisms of food proteins-saliva/gastrointestinal fluid on a molecular level, we have selected β-lactoglobulin (BLG) and mucins (bovine submaxillary mucin (BSM) and porcine gastric mucin (PGM)) as representative macromolecules of food proteins and saliva/gastric juice, respectively. Various spectroscopic approaches, including Dynamic Light Scattering (DLS), circular dichroism (CD) spectroscopy, fluorescence spectroscopy, and low and high field Nuclear Magnetic Resonance (NMR) spectroscopy were employed to understand the structural changes upon interaction. Additionally, tribological techniques were applied to investigate the interaction of BLG with mucins under tribological stress. To understand the pH effect, three pH values, pH 3.0, 5.0, 7.4, were used. The most interestingly, the changes in the size distribution of the mixture as studied by DLS suggested attractive interaction between BLG and BSM molecules to form a more compact conformation of the BSM molecules. Moreover, high field NMR showed stronger interactions at lower pH due to electrostatic attraction of the protonated amino groups of BLG to the negatively charged mucin. The High field NMR results for the BSM-BLG mixture indicated that spectral differences were mostly observed for solvent exposed groups, especially the mucin glycan chains, while hydrophobic core residues of PGM-BLG mixture were also highly affected.

Surface adsorption properties of the proteins by bicinchoninic acid (BCA) assay revealed that both mucins adsorbed onto the hydrophobic substrates in a large amount to form either highly compact layers or multilayers, whereas BLG appeared to adsorb to a much less extent. Even in the absence of tribostress, the adsorbed masses of the mixed protein solutions reduced significantly, and BLG appeared to dominate the surface adsorption event, presumably due to the reduced concentration of mucins as well as the Vroman effect. Nevertheless, BSM apparently dominated the tribological interface, which highlights the excellent lubricating capabilities of BSM, while PGM's intrinsically weaker lubricity remained largely unchanged even in the interaction with BLG. The pH dependent lubricating properties of BLG-BSM mixed solutions appeared to be determined by competitive adsorption of the two proteins onto the substrates, which suggests that they do not form as strong aggregates as BLG-saliva, especially under tribological stress. The combined spectroscopic and lubricating properties of BLG and mucins provided advanced understanding on the molecular level interaction between two macromolecules, representing food proteins and bodily fluids.