Analysis of saponin-chitosan mixtures at the air-water interface with vibrational sum-frequency generation and their role in foam properties

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ABSTRACT

Mixtures of natural surfactants are widely used as stabilizers of emulsions and foams for many applications, where it is important to have bio-compatible and biodegradable products, such as body-care and bio-medical fields. Surface properties of saponin and saponin-chitosan mixtures were analyzed as a function of their bulk mixing ratio composition using vibrational sum-frequency generation (SFG), surface tensiometry, and dilational rheology measurements. Moreover, the dynamics of foam formation and foam stabilization were additionally investigated. Our experiments show that saponin-chitosan mixtures present some remarkable properties, such as a strong amphiphilicity of the saponin and a high dilational viscoelasticity. This makes them interesting for foam stabilization. SFG spectroscopy is inherently surface specific and indicated the presence of chitosan in the adsorption layer, which is likely due to strong intermolecular interactions between saponin and chitosan molecules. In fact, analyzing the SFG intensity of the O-H stretching bands from interfacial water molecules, we found that for mixture consisting of 0.1g/dm3 saponin and 0.0025g/dm3 chitosan the adsorption layer was electrically neutral. This conclusion from SFG spectra, is corroborated by results from tensiometry that show an significant reduction of the dynamic surface tension as well as maxima in the surface dilational elasticity and surface viscosity exactly at mixing ratios where SFG spectra indicate zero interfacial net charge at the air-water.

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