

Effect of Carrageenan Concentration and Surfactant Type on Rheological Properties of Dairy Cream-based Emulsions

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Introduction

Dairy cream is a representative oil-in-water emulsion and is used to produce various foods, but it is unstable due to high fat contents. Several studies concerning stabilizers and surfactants have been conducted to improve the physical properties of creams. Carrageenan (CG) is mainly used as a stabilizer in dairy products and several surfactants are applied to improve the stability of emulsions.

Aim

The objective of this study was to investigate the effect of different CG concentrations (0%, 0.05%, and 0.1%, w/w) on the rheological properties of cream emulsions stabilized by various surfactants. The sucrose fatty acid ester (SFAE), sodium caseinate (CN-Na), milk protein concentrate (MPC), and whey protein concentrate (WPC) were used as surfactants in this study.

Methods

The rheological properties were determined using a rheometer (HAKKE Roto Visco-1) with a plate-plate system at 4°C. The flow behavior index (n), consistency index (K) and apparent viscosity ($\eta_{a,10}$) were obtained from power law model (Eq. (1)) over a shear rate range of 0.4–300 s⁻¹.

$$\sigma = K\dot{\gamma}^n \quad (1)$$

The storage modulus (G') and loss modulus (G'') were obtained in a range of angular frequencies (0.63–62.8 rad s⁻¹) at 2% strain.

Results

All cream emulsions showed the shear-thinning behavior ($n = 0.19$ - 0.39). As CG concentration was increased, K and $\eta_{a,10}$ were increased and the cream with MPC had the higher K and $\eta_{a,10}$ values than those of creams with other surfactants (SFAE, CN-Na and WPC) at the same CG concentration. The G' was largely increased with an increase of CG concentrations, resulting in a decrease of $\tan \delta$ (G''/G').

Conclusion

The rheological properties of cream emulsions were changed by addition of CG, and they showed different rheological properties depending on surfactant types at the same CG concentrations. Thus, rheological properties of dairy cream-based emulsions can be affected by CG concentration, surfactant type, and interaction between CG and surfactants.