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Rheological properties of emulsions containing milk proteins mixed with xanthan gum

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Abstract

Oil in water emulsions (30% w/w) containing mixtures of milk proteins with xanthan gum were rheologically characterized at ambient temperature and the evolution of their properties was measured during a month under cold storage. The milk proteins used were sodium caseinate and whey concentrate at 2% mixed with xanthan gum at 0.3% or 0.5%. Emulsions properties were compared to those of respective aqueous systems and in general showed same rheological behaviour as their respective aqueous system, however, emulsions presented higher consistency index, due to oil droplets concentration. The flow behaviour index showed a small variation, increasing its value slightly. The consistency of emulsions with xanthan was similar, independently of the milk protein used, confirming that xanthan rheology predominates on emulsion rheology.

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Keywords: Emulsion; sodium caseinate; whey concentrate; rheology, stability

1. Introduction

Protein ingredients derived from milk are commonly used as food emulsifying agents while polysaccharides are added as stabilizers to develop low-fat emulsions. Functional properties of each one are advantageous when a protein/polysaccharide mixture is employed instead of some natural or modified polysaccharides with emulsifying properties that generally provide low viscosity. Rheological properties of complex emulsions rely on the characteristics of the constituents and, mainly, on the interaction forces between protein/polysaccharide mixtures which in turns are influenced by temperature, pH, ionic strength and previous treatments. Sodium caseinate, a mixture of four caseins (α_{s1}, α_{s2}, β, and κ-casein), is a

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milk protein widely used as an emulsifying agent. It imparts stability to emulsions by a combination of steric and electrostatic combination [1]. Whey concentrate, another milk protein used as an emulsifying agent, contains surface–active globular proteins composed by β -lactoglobulin and β -lactalbumin [2]. Xanthan gum is a polysaccharide added to emulsions as a thickener agent in order to modify the rheological behaviour of the aqueous phase and thereby to retard instability mechanisms.

Some studies on emulsions containing milk protein/xanthan gum mixtures have been developed. Sodium caseinate /xanthan gum mixtures have been carried out, where droplet size, microscopic structure and creaming properties were determined, using 1 and 3% sodium caseinate and varying concentration of xanthan gum [3]. Addition of low levels of xanthan gum (0.2%) caused flocculation of droplets that resulted in a large decrease on creaming stability. At higher xanthan gum concentrations, the creaming stability improved, apparently due to network formation by flocculated droplets. Studies made on emulsions with whey protein isolate /xanthan gum mixtures, where protein concentration was varied (0.2%, 1% and 2%), oil phase volume ϕ fraction (5%, 20% and 40% v/v), with 0.2 % xanthan gum [2, 4], showed that an increase on whey protein isolate concentration significantly affected droplet size, surface charge, and oxidative stability, but had little effect on creaming stability and emulsion rheology.

Considering that very few of studies were conducted on the rheology and the preservation of consistency during storage, the objective of this work is to characterize oil in water emulsions containing mixtures of milk proteins with xanthan gum and to follow the evolution of their rheological properties during a month under cold storage.

2. Materials & Methods

2.1 Aqueous systems

Commercial samples of sodium caseinate (Lactonat EN, Lactoprot, Germany), ~93% dry matter, whey concentrate (WPC34, Dairy Gold, Mitchelstown, UK), ~95% dry matter and food grade xanthan gum (Kelcogel F, Kelco, USA), ~91% dry matter, were used without any pretreatment. Sodium azide was added as an antimicrobial agent (0.03%), Purified water was used (E-Pura, México). All concentrations are given as a weight percentage.

Duplicate aqueous of milk protein solutions (2%) were prepared by adding the protein powder to water under magnetic stirring at room temperature to ensure complete dispersion. Duplicate xanthan gum solutions (0.3 and 0.5%) were also prepared by dissolving the powder in water at room temperature under magnetic stirring. Blends of protein-polysaccharide were made by mixing equal parts of duplicate aqueous solutions of individual components.

2.2 Emulsion preparation

Emulsions were prepared with Canola oil (Great Value, Wal-Mart, México), at 25°C. Appropriate quantities of oil were mixed with the protein-polysaccharide aqueous systems and individual sodium caseinate or xanthan gum systems mentioned above to give 30% (w/w) oil in the final emulsion. Lab-scale manufacture of emulsions was carried out using an Ultra-Turrax T25 basic (Ika-Werke, Germany) at 24000 rpm for 5 minutes at room temperature. All emulsions preparation processes were made per triplicate.

2.3 Rheological characterization

A stress rheometer (Low stress LS 100, Paar Physica, Spring, TX, USA) with a double gap concentric cylinder (DG10), 48 and 50 mm internal and external diameter, respectively, 36 mm length and radii ratio of 1.0417, was used to steady shear measurements. Flow curves were obtained after pre-shearing of