

11th International Congress on Engineering and Food (ICEF11)

Viscoelastic characterization of fluid and gel like food emulsions stabilized with hydrocolloids

Gabriel Lorenzo^{a,b}, Noemi E. Zaritzky^{*a,b}, Alicia N. Califano^a

^a *Centro de Investigación y Desarrollo en Criotecnología de Alimentos (CIDCA), La Plata - CONICET. Facultad de Ciencias Exactas, UNLP. 47 y 116, La Plata (1900). Argentina. Facultad de Ingeniería, UNLP.*

^b *Departamento de Ingeniería Química, Facultad de Ingeniería, UNLP, La Plata, Argentina.*

Abstract

Food emulsions exhibit a great diversity of rheological characteristics; hydrocolloids are usually added to deal with creaming instability. Viscoelastic measurements provide information about the microstructure of the system. The objectives of this work were: a) to determine the viscoelastic behavior of two different low in fat oil-in-water food emulsions: a gel like and a fluid type emulsions stabilized with hydrocolloids (gellan gum and xanthan-guar mixtures respectively) b) to model and predict the mechanical relaxation spectrum for both emulsions and continuous aqueous phases. Low-in-fat oil-in-water emulsions (20g/100g) were prepared using sunflower oil and Tween 80 (1 wt.%). Fluid emulsions containing xanthan and guar gums were formulated using a synergistic ratio 7:3, with total hydrocolloid concentration ranging between 0.5 to 2 wt%. The aqueous phases contained NaCl (2 wt.%) and acetic acid (2 wt.%). The effect of hydrocolloids was studied using oscillatory measurements (G' and G'' vs. frequency) within the linear viscoelastic range previously determined by stress-sweeps. Time-Concentration Superposition principle was applied to find the master curves that describe the mechanical spectra of the viscoelastic materials. Superposition allows to obtain a wide spectrum of nearly ten decades of frequencies in emulsions containing xanthan-guar mixtures, whereas gellan gum systems did not show a significant frequency displacement. Viscoelastic behavior of the systems was satisfactorily modeled using Baumgaertel-Schausberger-Winter (BSW) equation. This empirical model was used to predict the mechanical relaxation spectrum for both emulsions and continuous aqueous phases. Validation of the predicted spectra was carried out through creep compliance data for emulsion-filled gels and steady-state flow curves for emulsions containing xanthan-guar mixtures.

© 2011 Published by Elsevier B.V. Open access under [CC BY-NC-ND license](https://creativecommons.org/licenses/by-nc-nd/4.0/).

Selection and/or peer-review under responsibility of 11th International Congress on Engineering and Food (ICEF 11) Executive Committee.

Keywords: Oil-water emulsions; rheology; viscoelastic behavior; hydrocolloids; mechanical relaxation spectrum; BSW model.

* Corresponding author: Tel/FAX: +54-221-4254853/4249287.

E-mail address: zaritzky@ing.unlp.edu.ar; zaritzkynoemi@gmail.com

1. Introduction

Food emulsions exhibit a great diversity of rheological characteristics, ranging from low-viscosity Newtonian liquids to viscoelastic and plastic materials. Hydrocolloids are usually key components in food emulsions to deal with creaming instability. There is a growing emphasis on understanding the colloidal basis of the rheology of food emulsions. Viscoelastic measurements are appropriate tools for obtaining information about the microstructure of the system related to the organization of the macromolecules in the medium. The existence of a broad distribution of relaxation times (λ) in polymeric materials can be represented by the mechanical relaxation spectrum derived from experimental values of the dynamic moduli: G' (storage modulus) and G'' (loss modulus). The objectives of the present work were: a) to determine the viscoelastic behavior of two different low in fat oil-in-water food emulsions: a gel like and a pourable fluid type emulsions stabilized with hydrocolloids (gellan gum and xanthan-guar mixtures respectively) b) to model and predict the mechanical relaxation spectrum for both emulsions and continuous aqueous phases.

2. Materials & Methods

Low-in-fat emulsions (20g/100g) were analyzed in two distinct formulations: (a) a pourable fluid dressing type emulsion and (b) an emulsion-filled gel.

(a) Oil-in-water emulsions were prepared using sunflower oil (20%) and Tween 80 (1%). Fluid emulsions containing xanthan and guar gums (XG) were formulated using a synergistic ratio 7:3, with total hydrocolloid concentration ranging between 0.5 to 2%. The aqueous phases contained NaCl (2%) and acetic acid (2%).

(b) Gel type emulsions contained high acyl gellan gum (GG) were heated up to 90°C maintaining a constant stirring, then 5mM CaCl_2 was added followed by rapid cooling down to 20°C. High acyl gellan gum (Kelcogel, CA) concentration ranged between 0.1-0.5%. Both types of emulsions were prepared using an Ultraturrax at 11500 rpm during 4 minutes.

The rheological measurements were performed on the continuous phases and on the emulsions using a Controlled Stress Rheometer Haake RS600 (Thermoelectron, Germany). The effect of gums was studied using oscillatory measurements (G' and G'' vs. frequency) within the linear viscoelastic range (LVR) previously determined by stress-sweeps.

3. Results & Discussion

3.1. Food o/w emulsion stabilized with xanthan/ guar gums mixtures

Mechanical spectra of the emulsions were obtained from oscillatory tests. The percentage of hydrocolloids influenced mostly the rheological behavior of the emulsions (Figure 1a). When gum concentration was 1.25% or higher, emulsions showed a weak gel-like behavior with G' higher than G'' in the frequency range analyzed. A similar behavior between continuous phases and o/w emulsions was found in this range of gum concentration (Figure not shown). When the total biopolymer content was 0.5%, the dispersed phase contribution to the viscoelastic behavior became significant.

The time-concentration superposition enables the extrapolation of data to experimentally inaccessible timescales and moduli, in the same way as allowed by time-temperature superposition in polymer systems [1]. Data were processed using the shifting mode of IRIS Rheo-hub 2007 program [2] to perform superpositions and spectrum calculations. In Figure 1b the dynamic data of the XG emulsions were replotted using a reference concentration of 1.25%. The dynamic data was shifted horizontally by a shift

Download English Version:

<https://daneshyari.com/en/article/1264952>

Download Persian Version:

<https://daneshyari.com/article/1264952>

[Daneshyari.com](https://daneshyari.com)