CHARACTERIZATION OF CONCENTRATED O/W EMULSIONS PREPARED WITH SURFACTANT BLENDS

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ABSTRACT

The characterization of concentrated sunflower oil in water emulsions (70/30 and 80/20), which constitute the base for industrial Caesar and Ranch dressings, was developed. The samples were prepared using surfactant blends at laboratory scale. The commercial ethoxylated non-ionic surfactant (CS) concentration was established at 4000 and 2000 ppm, while the active egg yolk (AEY) concentration varied in 1000, 2000, 4000, and 5000 ppm. The emulsions' mean drop diameter (d_{43}) and their drop size distribution, as well as their stability, were analyzed. The samples which contained exclusively CS were more stable in time than the ones containing AEY. When the blend of surfactants was employed it was evident that the emulsifying effect was generated by the CS, because of the minimum decrease (approximately 6%) registered for the d_{43} when egg yolk's concentration increased. Though it is evident the more efficient emulsifying effect of the CS, the incorporation of egg yolk is important to maintain the dressing's sensorial properties. The prepared industrial emulsions that contained solid ingredients like herbs, salt and other condiments were compared with the laboratory scale concentrated ones, and there was very little difference in their overall monodisperse behavior, demonstrating that the incorporation of other ingredients has little effect on this property in the concentrated base emulsion.

Keywords: emulsions, surfactant blends, egg yolk, stability, mean drop diameter d_{43}.

INTRODUCTION

In the food industry there are a number of products based on emulsions like mayonnaise, butter, ice cream, salad dressings which are dispersions stabilized by different surfactant agents.

Figure 1. Food emulsions

Some emulsion properties determine its stability, for example:

Lower drop diameter
Higher viscosity → Improve Emulsion Stability
Monodispersity

Surfactants frequently used in the food industry are:

Egg yolk

- ✓Most commonly emulsifier used in food products
- ✓Sensorial properties
- ✓Functional properties: phospholipids

Monostearates

- ✓Classical emulsifiers with a great number of applications
- ✓Hydrophilic character
- ✓Low molecular weight, easy adsorption on an interface

- ✓Lower cholesterol content
- ✓Lower fat content
- ✓More microbiological stability
- ✓Lower costs

In this study, concentrated sunflower oil in water emulsions (80/20) and (70/30), bases of Caesar and Ranch industrial dressings, prepared with surfactant blends were analyzed. Commercial ethoxylated non-ionic surfactant and egg yolk were employed to determine the optimum concentration that generates the lower mean drop diameter values and the higher stability. The emulsion which provided the best characteristics at laboratory scale was prepared at industrial scale.

MATERIALS AND METHODS

For the emulsions preparation, distilled water (continuous phase) and sunflower oil (disperse phase) were used. Common egg yolk and a non-ionic surfactant (CS) (polyoxyethylene sorbitan (20EO) monostearate) with HLB=15 were employed as emulsifying agents.

Egg yolk's phospholipid portion was considered its active emulsifying part (AEY) and it constitutes 32% of the egg yolk (EY)[1].

$$EY = \frac{AEY}{0{,}68 \cdot 0{,}48} \qquad (1)$$

Commercial surfactant/Active Egg Yolk proportions studied were 4:0, 4:1, 4:2, 4:4, 4:5, and 0:4 for 4000 ppm of CS and 2:0, 2:1, 2:2, 2:4, 2:5, and 0:2 for 2000 ppm of CS. A manual blender, similar to a rotor-stator homogeneizer, was used to agitate and incorporate the ingredients and prepare the emulsion. The emulsions were refrigerated at 280 K..

Mean Drop Diameter and Stability Measurement

✓The mean drop diameter, d_{43}, and drop size distribution of emulsions were determined by laser light diffraction using a Malvern Mastersizer 2000 analyzer.

✓Mean drop diameter was measured in time because its large increase in time is a flocculation and instability evidence.

Figure 2. Malvern Mastersizer

RESULTS AND DISCUSSION

Commercial surfactant and active egg yolk emulsifying effect comparison

The increase of surfactant concentration generated an evident decrease of the mean drop diameter. The d_{43} values obtained for similar CS and AEY concentrations were considerably smaller for CS (Table 1), demonstrating the more efficient effect of the CS.

Table 1. d_{43} for emulsions prepared with different concentrations of CS and AEY

	CS Concentration (ppm)				
	1000	2000	4000	10000	20000
d_{43} (μm)	20,15	10,50	7,00	5,35	3,14
	AEY Concentration (ppm)				
	1600	4900	6500	13000	20000
d_{43} (μm)	48,75	17,12	11,89	7,66	4,59

Mean drop diameter values were considerably low for both pure surfactants. Therefore, the effect of their combination and possible synergy was evaluated.

The d_{43} values obtained for the combination or blending of CS and AEY, at a constant concentration of CS of 4000 ppm and 2000 ppm, varying the AEY concentrations: 1000, 2000, 4000, and 5000 ppm are displayed in Table 2.

Table 2. d_{43} for emulsions prepared with different blends of CS and AEY

	Active Egg Yolk Concentration (ppm)			
	1000	2000	4000	5000
d_{43} (μm) 4000 ppm CS	6,73	6,55	6,47	6,34
d_{43} (μm) 2000 ppm CS	11,39	10,49	9,54	9,85

When surfactants blends were used, the increase of AEY concentration originated a non significant variation in the d_{43} of emulsions. It seems that adsorption at the interface is exclusively of CS because the mean diameter values obtained are similar to the ones obtained for the pure surfactant at the same concentrations.
CS has a low molecular weight while EY is a macromolecule. This structural difference explains the egg yolk lower emulsifying effect, because of their competition for adsorption in the same medium, CS is more available to move quickly and be adsorbed at the interface of high concentrated emulsions[2].

Emulsions Stability

The prepared emulsions where stable in time (see Fig. 3).

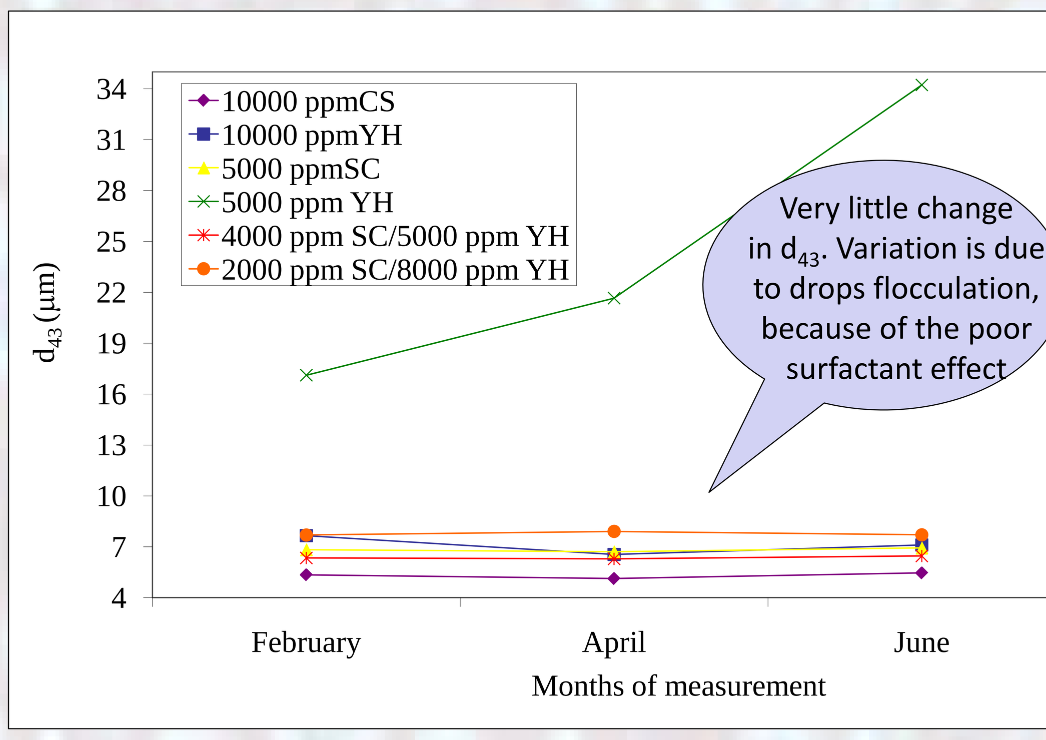

Figure 3. Static stability in time

Industrial Dressing Analysis

The final product at 80/20 and 70/30 relations and using a proportion of 4000ppmCS/5000ppmAEY contains ingredients like herbs, salt and other solid condiment (see Fig. 4). This surfactant blend concentration was employed because it generated the best functional and sensorial properties combination.

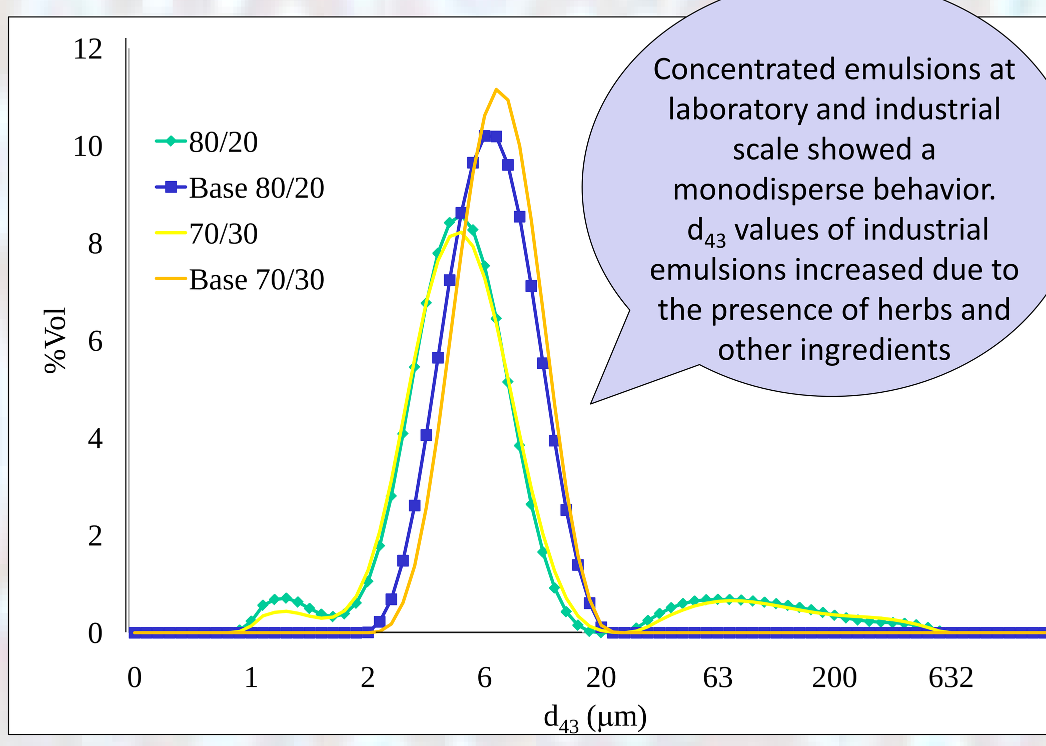

Figure 4. Mean drop diameter distribution for the final product and concentrated emulsions (laboratory scale)

CONCLUSIONS

- ✓The mean drop diameter of the concentrated emulsion decreases as AEY and CS concentration increases.
- ✓When AEY and CS are blended the reduction of the d_{43} is due to the CS concentration increase, while the effect of egg yolk concentration variation is insignificant.
- ✓At low CS concentrations emulsions are stable.
- ✓The mean drop diameters of the industrial product were bigger than the ones obtained for the base emulsion, but in both cases the the monodisperse behavior was maintained.

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