Using seeding technique in the manufacture of inulin enriched dairy desserts

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INTRODUCTION

Inulin is a prebiotic ingredient that can be also used as fat replacer. In aqueous systems, long-chain inulin form microcrystals that interact with each other, occluding water and creating a particulate gel (Torres, et al. 2010) that can improve consistency of low-fat products (Tarrega & Costell, 2006) but at the same time it can produce an undesirable roughness sensation (Gonzalez-Tomas, et al. 2009). Seeding technique is often used in pharmaceutical and food industry with the aim to control crystal size or size distribution in a product. The objective of this work was to study the effect of seeding on rheological properties and microstructure of low fat dairy desserts with different long chain inulin concentration (2.5, 5 and 7.5%). During seven days of refrigerated storage the rheological properties and particle size distribution of samples were studied and compared with control desserts (with the same amount of inulin but not seeded)

MATERIALS AND METHODS

Samples composition and preparation

Modified tapioca starch (C* CreamTex 75,720, Cerestar), long chain inulin (Frutafit ® TEX, Sensus) skimmed-milk powder (Central Lechera Asturiana), commercial sucrose, mineral water (Font Vella) and preservatives (potassium sorbate 500 ppm; potassium benzoate 500 ppm; Panreac Quimica SA) were used to prepare dairy desserts varying in the inulin concentration (2.5, 5 and 7.5%).

Starch (3.75%), skimmed milk (75%), sucrose (6%) and inulin were weighed in a flask and mixed for 10 min. Flask was placed in a water bath at 97 ± 1 ˚C and stirred for 25 min. Sample was cooled in a water bath at 20˚C and during cooling they were inoculated (or "seeded") with a small amount of powdered long chain inulin. Samples were transferred to a closed flask and stored under refrigeration (4±1˚C) for seven days. Desserts with the same amount of inulin but not seeded were also prepared as control samples. Rheological properties, particle size distribution and microstructure of samples were studied after 1, 4, and 7 days of storage

Rheological measurement

Rheological measurements were carried out in a controlled stress rheometer RS1 (Thermo Haake, Germany), using a parallel plates geometry (60 mm diameter; 1mm gap) and a sample temperature of 10±1ºC. Flow curves were obtained by recording shear stress values when shearing the samples at linear increasing shear rates from 1 to 200 s-1 through 60 s and down in reverse sequence through the same time.

Particle size distribution

Particle size distribution was determined by using a Laser Diffraction Particle Size Analyzer (Mastersizer 2000 Malvern Instruments), connected to a cell for liquid measurements (Hydro 2000S mixing, Malvern Instruments, Worcestershire, UK) with distilled water as dispersant. The percentage of volume corresponding to each observed population and the diameters D10, D50 and D90 were calculated. These parameters indicate that 10%, 50% and 90% of the particles are smaller than the D10, D50 and D90 values, respectively. Calculations were done with the software provided with the equipment (Mastersizer 2000 V. 5.40)

Light microscopy

Samples were placed in slides with a cover slip and observed at a magnification of 20x under a light microscope (Nikon Eclipse 90i). Photomicrographs were acquired with a digital camera (Nikon DS-5Mc)

Statistical analysis

The effects of storage time and elaboration process (inulin seeded and not seeded) on the rheological parameters were studied for each inulin level studied by analysis of variance (ANOVA) of two factors. The Fisher test (a=0.05) was used to calculate the minimum significant difference. Calculations were carried out with XLSTAT-Pro Version 2007 (Addinsoft, Paris, France).

RESULTS AND DISCUSSION

Rheological behavior

All flow curves showed a time-dependent and shear thinning flow behaviour. Data from the ascending curve was fitted to the Ostwald-de Waele model ($0.98 \leq R \geq 0.99$) (μ= K n) and values of consistency index (K) and the flow index (n) were used to study the variation with time in the samples flow (Fig. 1).

In a general way, consistency and pseudoplasticity of samples increased over time indicating a reinforcement of the system structure. The magnitude of changes depended on the inulin concentration and the procedure of manufacture. For samples containing 2.5% inulin the change with time was very low or not significant while an important variation was observed for samples with 5 and 7.5% inulin.

Regarding the manufacture procedure, the increase in consistency and pseudoplasticity was higher and faster when seeding procedure was used. At the fourth day of storage, seeded samples already had reached the same values than those observed at the seventh day of storage while for unseeded samples changes in flow properties still occurred after the fourth day.

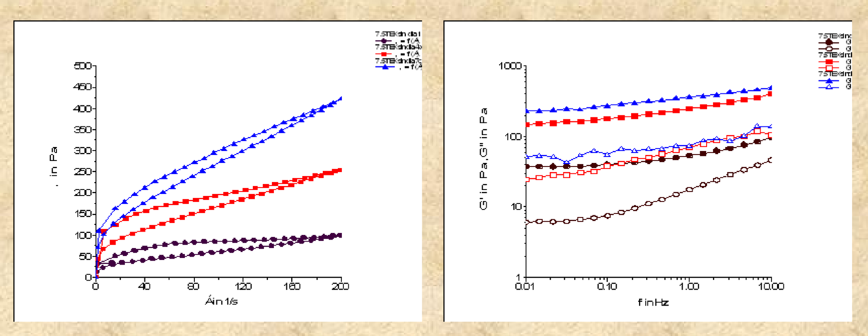

Figure 1. Flow curves and mechanical spectra of dairy desserts

Microstructure

Particle-size distribution and microscopy

Two populations of particles were identified, one ranged from 10.0 to 91.2 μm and corresponded to the dispersed swollen starch granules and the other that appeared below 10 μm corresponded to inulin particles. For 5 and 7.5% inulin samples, the characteristics of population of particles below 10 μm are shown in Table 1 (in samples with 2.5%inulin particles were not detected). Seeding technique favoured a faster crystallisation of a greater amount and more regular size inulin crystals. And, as could be observed by microscopy (Figures 2 and 3), seeding resulted to be an effective method for avoiding the formation of the big inulin crystals observed in the unseeded samples.

Procedure	Storage time (days)	5% Inulin				7.5% Inulin			
		% volume	D10 (μm)	D50 (μm)	D90 (μm)	% volume	D10 (μm)	D50 (μm)	D90 (μm)
No seeding	1	-	-	-	-	2.41d	3.69a	5.28a	7.48ab
	4	4.75c	2.78 a	5.41 a	6.70ab	10.46c	2.28c	4.49b	7.38ab
	7	6.99b	2.64 a	5.05 a	7.38 a	11.96b	2.18c	4.59b	7.69 a
Seeding	1	-	-	-	-	10.33c	2.79b	4.56b	7.02ab
	4	7.83ab	2.18 a	3.71 b	5.89 b	15.53a	2.30c	4.64b	7.55ab
	7	8.71a	2.43 a	4.06 b	6.35 b	15.35a	2.38c	4.79ab	7.91a

Table 1. Characteristics of the population of particles with size < 10 μm found in inulin enriched desserts over storage time.

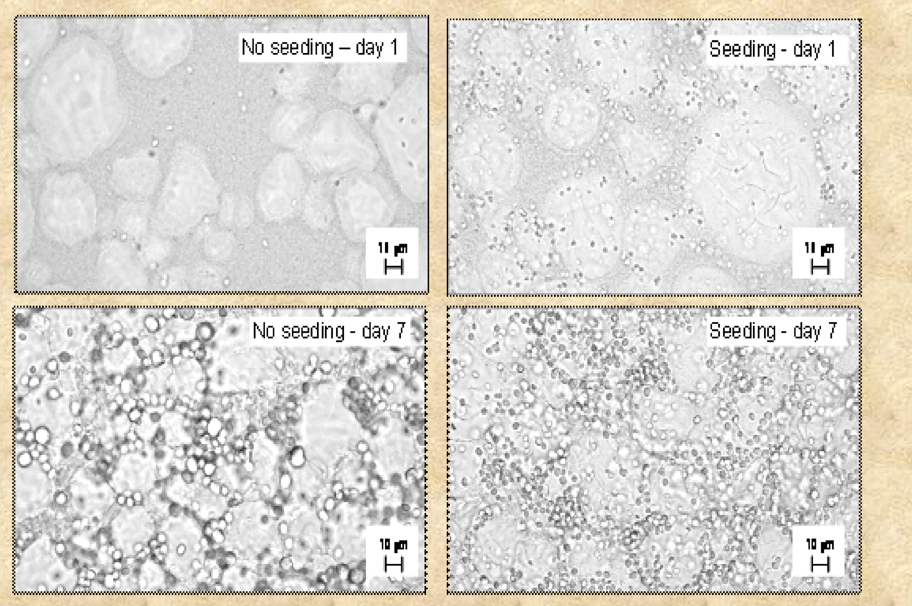

Fig. 2. Light micrograph images of dessert samples enriched with 5% inulin.

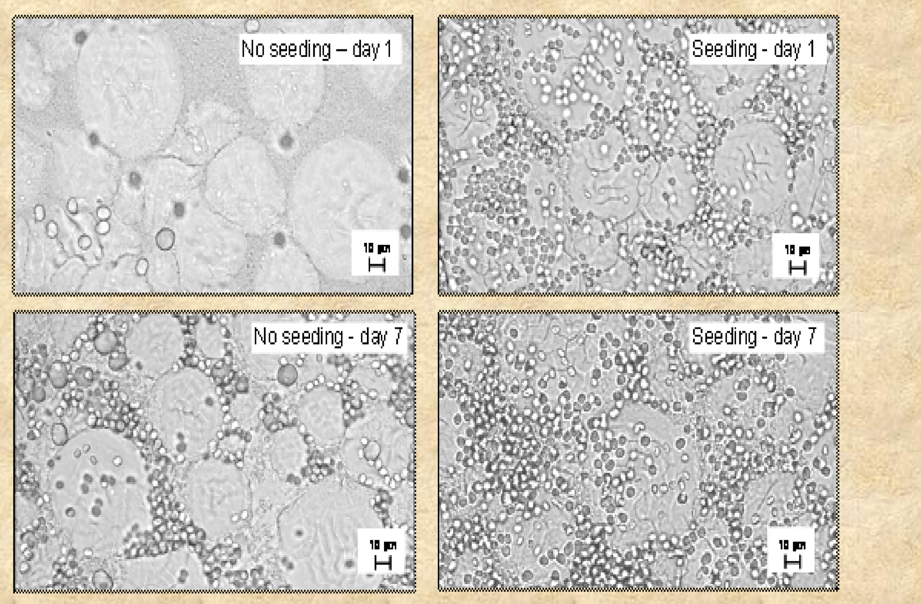

Fig.3. Light micrograph images of dessert samples enriched with 7.5% inulin.

CONCLUSION

Changes in rheological properties and particle size distribution depended on both inulin concentration and seeding. For all inulin concentrations, seeding technique favoured a faster crystallisation of a greater amount and more regular size inulin crystals.

The effect of seeding in the mean diameter of particles depended on inulin concentration. For long chain inulin concentration below 7.5%, seeding resulted to be an effective method to prepare low fat custard desserts with small and regular size inulin crystals.

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