The structure of casein in heated suspensions affects the acid gelification of milk

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Purpose of study

Improving texture properties of yoghurt through the modification of milk composition:
-by substitution of 12% of micellar casein by Na (Nacas) or Ca caseinate (Cacas) and by a native phosphocaseinate as control (Pcas)
-by fractionation into a small and a large micelle fractions using centrifugation.

Methods and materials

Substitution of micellar casein

Reconstituted milk at 31 $g.kg^{-1}$ casein

- Milk powder from Ingredia, Arras, France
- Sodium and calcium caseinate (Armor Protéines, 35460, France)
- Native phosphocaseinate obtained by microfiltration of milk on 1.4 µm membrane: Pcas (INRA-Rennes-LRTL, 35042, France)

12 % of the micellar casein was substituted by the caseinates

Small and large micelles

Fractionation of the Pcas at 94 $g.kg^{-1}$ casein dissolved in water into:

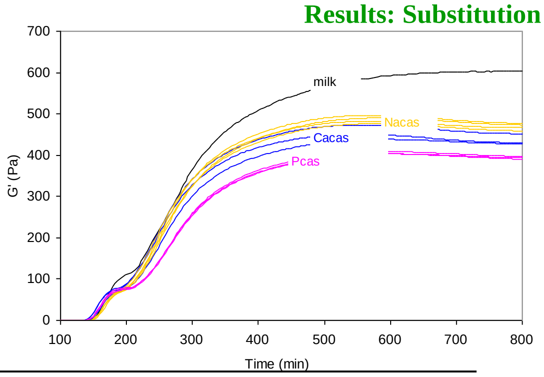
- a pellet at 10 000 g - 30 min
- a supernatant at 30 000 g -30 min

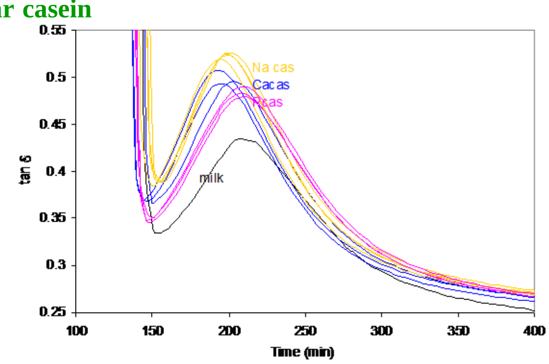
Reconstitution in a milk microfiltrate

Heat treatment of suspensions at 90°C for 10 min
The acidification with a yoghurt starter at 42°C was followed by the dynamic viscoelastic method at 2% shear strain.

Analyses
- Nitrogen in the following fractions before and after the heat treatment (totalN, NCN, NPN)
- Mineral partition between colloidal and soluble phase by ultrafiltration and atomic spectroscopy
- Particle diameter by light scattering
- Acid gelation

Results: Substitution of micellar casein

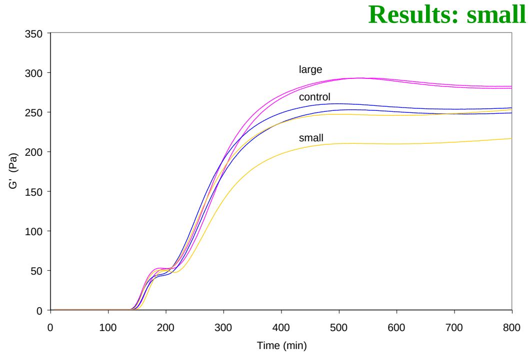


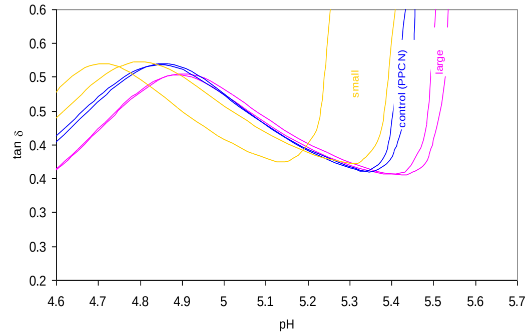


	Any suspension ($g.kg^{-1}$)	Nacas	Cacas	Pcas
Ca_{tot} ($mg.kg^{-1}$)	-	1179	1283	1394
Ca_{sol} ($mg.kg^{-1}$)	-	290	304	300
Na_{tot} ($mg.kg^{-1}$)	-	621	544	526
	non heated	in percent of non heated milk		
Casein	31	110	109	110
Whey proteins (WP)	4.7	28.7	30.4	31.8

Concentration in whey protein (WP) was the same in the 3 substituted suspensions, but the suspensions had increased levels of calcium in order: Nacas, Cacas and Pcas. Lower G' values and slightly higher tan δ were obtained for the suspensions than for milk, due to a lower concentration in WP than in control milk. The less structured casein (NaCas) led to a slightly higher complexation between casein and whey protein and to the higher G'. The higher structured casein (Pcas) led to the lower G' values. The less structured casein led to a more viscous character.

Results: small and large micelles





	Large	Control (Pcas)	Small
Casein ($g.kg^{-1}$)	27.3	26.3	26.9
WP ($g.kg^{-1}$) (non heated)	5.91	5.74	6.55
WP (% of non heated milk)	36.4	37.4	39.8
Micelle diameter (nm) (non heated)	228	237	191
Micelle diameter (nm) (heated)	250	218	202

The effect of the size of casein micelle was studied because small micelles are known to contain more κcasein and could probably lead to more complexes between κcasein and βlactoglobulin. Suspensions with small micelles contained more whey proteins, because they originated from supernatant. As the casein concentration was low in supernatant compared to the pellet, higher amounts of aqueous phases were introduced in small micelle suspensions and higher concentrations of whey proteins, as the phosphocaseinate contains traces of whey proteins. Contrary to our assumptions, small micelle suspensions with higher whey protein amounts showed a lower level of protein complexation. The higher complexation in the suspensions with large micelles was accompanied by a higher G' value and a higher pH of gelation (5.5 for large micelle against 5.3 for the small ones).

Conclusion

The higher moduli and tan δ were obtained for Nacas, Cacas and Pcas in the decreasing order, meaning a more viscous character in a firmer gel when the lower level of structuration and the lower mineralisation of the micelles was present. The suspension with smaller micelles led to the lower modulus, though it had the higher concentration of WP and though small micelles contain more κ-casein, which could enhance the formation of heat-induced complexes between casein and whey proteins, and could improve the acid gelification of milk. The lower residual concentration of WP and the higher complexation in the heated suspension of large micelles led to a higher pH at gelation (pH 5.5) than for the smaller micelles (pH 5.3). The structure of casein micelles affected the acid coagulation of heated suspensions of milk proteins.

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