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Effect of heat treatment on the formation of acid milk gel: a kinetic study using rheology and confocal microscopy

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Introduction

In the manufacture of yoghurts, the extensive heat-treatment of milk at 80-95°C for several minutes has been shown to increase the pH of gelation and the final elastic modulus of the gel. These changes correlate well with the formation of micelle-bound (MC) and serum (SC) heat-induced whey protein/ κ -casein complexes. The objective of this study was to investigate the specific contributions of the heat-induced complexes and the casein micelles to the formation of acid milk gels using a highly relevant labelling procedure for CLSM, and rheology.

Results & Discussion

- Comparison C1S1/C2S2 systems confirms the literature on the effect of heat-treatment on acid gelation of milk : \nearrow pH_{gel}; \nearrow dG'/dpH; \nearrow G'; \nearrow solid-like behaviour; \nearrow tan δ _{max} present; \nearrow pore diameter; \nearrow visible connectivity (Fig1 and Table1)
- When MC or SC was present (C1S2 and C2S1) behaviour similar to heated milk system (C2S2): same pH_{gel}, G', tan δ and microstructure
- FITC-labelled SC visible in C1S2 and C2S2. super-imposable with RITC-labelled casein micelles \rightarrow co-location of SC and micelles

Table 1. Mean values for pH of gelation, pH at the local maximum of tan δ and G' and tan δ at pH 4.5

	pH _{gel}	pH _{max tanδ}	G' _{pH 4.5} (Pa)	tan δ _{pH 4.5}
C1S1	4.86 ^a	-	26 ^a	0.343 ^a
C1S2	5.11 ^b	4.90 ^a	363 ^b	0.294 ^b
C2S1	5.24 ^b	4.93 ^a	293 ^b	0.287 ^b
C2S2	5.22 ^b	4.92 ^a	421 ^b	0.270 ^b

Means with different superscripts in column differ significantly ($P < 0.05$)

Fig.1: Development of the elastic modulus and tan δ of milk systems during acidification. Right hand side images show the final microstructure of systems at pH 4.6. Scale bar is 10 μ m.

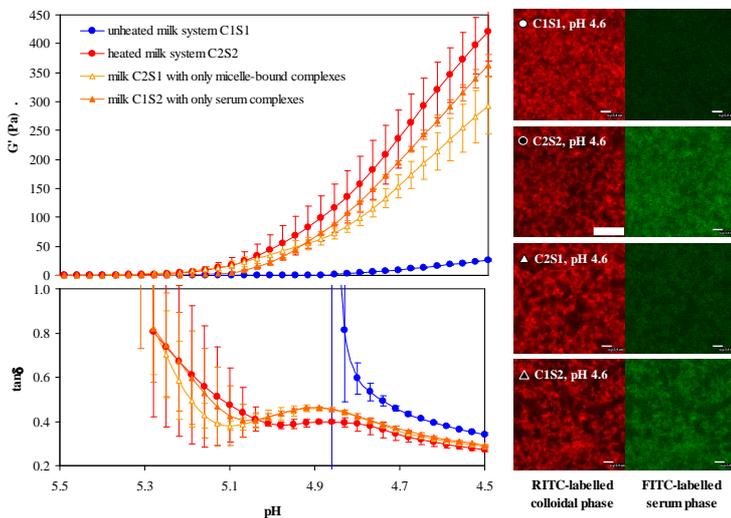
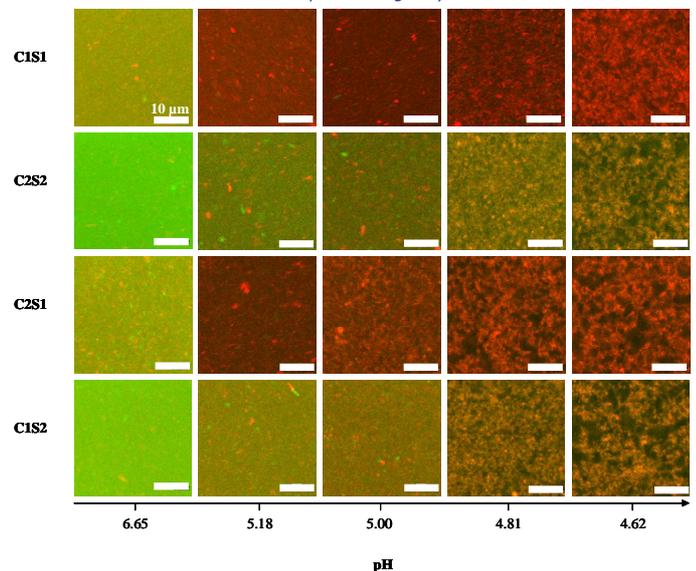


Fig.2: FITC/RITC overlay images of the systems (RITC on colloidal components in red and FITC fixed on soluble components in green)



Conclusions

Confirmation that the heat-induced complexes were responsible for the earlier destabilisation of milk system at pH \sim 5.2 and for enhanced G'

Heat-induced complexes located in the serum or the colloidal phase or both
 \rightarrow same rheological and microstructural changes of acid gels
 + co-location of SC and casein micelles in the gels

Casein micelles = the building material of the gel with SC attached to their surface

suggested that SC interacted with the casein micelles before gelation
Possibly C1S2 = C2S1 = C2S2 at the gel time

SC provide casein micelles with new gelation functionality