Rebodying of stirred yoghurt: protein interactions

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Introduction

Stirred yoghurt is obtained by pumping and cooling of set yoghurt at pH 4.6 followed by filling. During storage, the texture of the stirred yoghurt improved, with a large increase in viscosity or viscoelastic properties, which is known as rebodying. We studied the nature of bonds established between protein particles after stirring that are responsible for this rebodying.

Materials & Methods

Set yoghurt was obtained from heated reconstituted milk with non-ropy yoghurt culture at 38°C until pH 4.6 and was then stirred in 2 steps: a- pumping thought a 350-400 µm mesh; b- mixing in a home processor. Ionic strength increase from 166 to 334 mM (IS^+) $CaCl_2$ (66.6 mmol.kg^{-1}) (CA^+), citrate (100 mmol.kg-1)(CA^-), N-ethylmaleimide additions (5 mmol.kg^{-1})(NEM^+) were performed in the home processor. The decrease in IS to 118 mM (IS-) was performed by centrifuging 200 g set yoghurt, replacing 50 g supernatant by 50 g lactose solution, mixing pellet and aqueous phase and processing from first step. Short-term and long-term rebodying were determined by low amplitude dynamic oscillation for 20 h and viscosity measurements for 28 d, respectively. Set yoghurt was stored for 7 d storage before stirring to test the role of ionic equilibrium (ST^+).

Results & Discussion

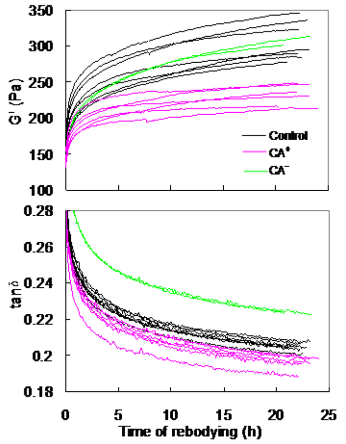

Fig.1. Short-term rebodying: viscoelastic properties for 20 h after stirring

Short-term rebodying

Same results for control, IS^+, IS^-, ST^+ and NEM^+ samples.

CA^+ sample had a lower short-term rebodying than control ($\Delta G'_{20h}$=60 % of control) (Fig.1).

Final tanδ significantly different: CA^- > control> CA^+ (Fig.1).

Calculations of Ca partition (Mekmene et al. 2008) show that CA^+ samples had more Ca_{sol}, CA^{++}, Pser and carboxylic acid bound Ca, though the binding of Ca to the colloidal phase was not evidenced by measurements of (Ca_{tot}-Ca_{sol}) in yoghurt samples.

Same microstructure of control and CA^+ samples at day 0 and day 1 (Fig.2).

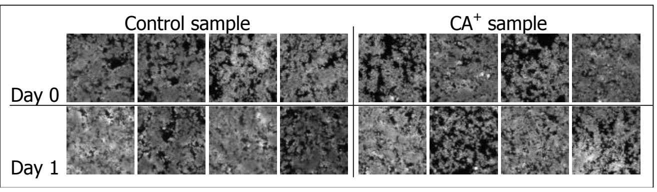

Fig.2. Stirred yoghurt microstructure as observed in confocal microscopy

Long-term rebodying and pH

pH IS^-<pH control<pH IS^+ (due to contents in buffering compounds) (Fig.3a).

Less over-acidification with NEM^+ sample (Fig.3a).

IS^+ sample: $\Delta\eta_{28\,d} < 0 \Rightarrow$ no long-term rebodying (Fig.3b).

CA+ sample: $\Delta\eta$ seemed higher than control (though not significantly different) (Fig.3b).

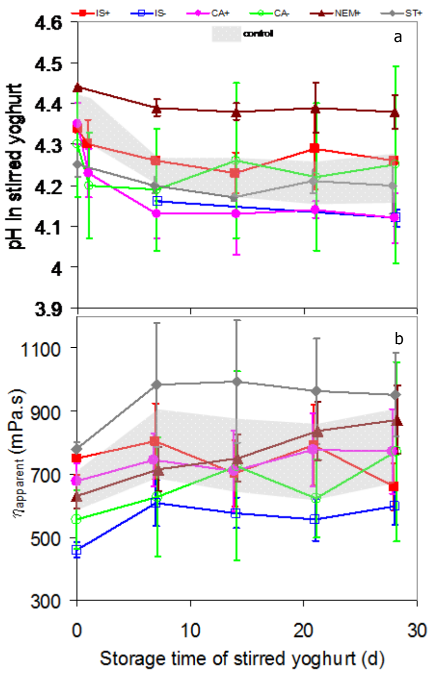

Fig.3. pH (a) and viscosity (b) in stirred yoghurt for 28 days

Conclusions

Addition of calcium reinforced the solid-like behaviour of stirred yoghurt and reduced its rebodying, while the same increase in IS this NaCl did not. Calcium interacted with phosphoserine and carboxylic acids, as estimated by calculations, though not experimentally evidenced, restrained the motion of protein chains and prevented spatial rearrangements between gel particles.

Increasing IS increased the pH in stirred yoghurt and prevented long-term rebodying. This was due to a higher pH, a higher IS and a lower apparent pK values resulting in yoghurt particles carrying a residual negative charge.

The most probable interactions in stirred yoghurt could not be salt bridges, electrostatic attractive and disulfide bonds. Completion of ionic equilibrium during and after stirring was of minor contribution. As Renan et al. (2008) rejected hydrophobic interactions, we conclude that repulsive electrostatic and hydrogen interactions played a major role in the structure and the rebodying of stirred yoghurt.

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