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Protein interactions in stirred yoghurt

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Introduction

Stirred yoghurt is obtained after pumping, cooling and packaging of set yoghurt at pH ≈ 4.6. The viscoelastic properties of the gel decrease on shearing, but re-increase on storage at 4°C. This phenomenon is known as "rebodying". The nature of bonds that are responsible for this rebodding was investigated.

Materials & Methods

Reconstituted heated milk (90°C-10 min) was inoculated with non ropy yoghurt cultures. The gel was stirred through a mesh of 350-400 μm-holes and then in a home food processor (Renan et al., 2008), and characterised by low amplitude dynamic oscillation for 24 h (short-term rebodding) and viscosity (long-term rebodding) during 28 d of storage at 4°C

- ① Set yoghurts were stirred at pH 4.4 to 5.0 and stored at 4 - 20°C for 24 h, with or without NaN₃ (using a Box-Benken design);
- ② A constant set yoghurt was stirred in different physicochemical conditions applied on stirring

Results & Discussion

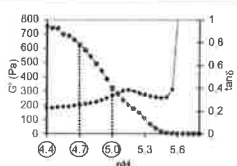


Fig.1: pH and G' of set acid gels versus pH

Set yoghurt stirred at lower pH values had a higher G' value (Fig.1). This led to a higher short rebodding (Fig.2) → electrostatic interactions involved.

No effect of the storage temperature of the stirred yoghurt during 24 h on short-term rebodding without over-acidification (Fig.2) → hydrophobic interactions were not involved in short-term rebodding.

Over-acidification took part in rebodding (Fig.2).

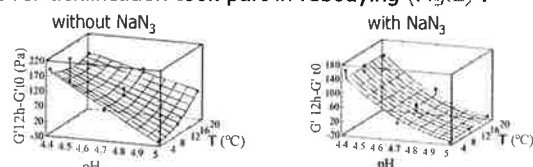


Fig.2: Short-term rebodding of stirred yoghurt as a function of the pH on stirring and the storage temperature of stirred yoghurt during 24 h (as the increase in G' during 12 h)

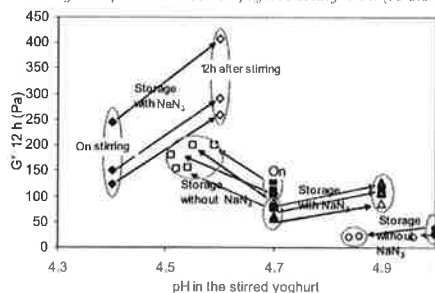


Fig.3: G' of stirred gels just after stirring and 12 h after stirring as a function of the pH in stirred yoghurt just after stirring and 24 h after stirring (the pH hardly decreased between 12 and 24 h)

With NaN₃ addition, the pH of the stirred gel increased by 0.2 unit on stirring.

Changes in G' during short-term rebodding were very complex (Fig.3), depending on the pH on stirring but also on its evolution during storage.

CaCl₂ (CA⁺) or Na-Citrate (CA⁻) addition on stirring:

CaCl₂ addition on stirring reduced the short-term rebodding (Fig.4). The same ionic strength increase with NaCl had no effect.

At 20 h:
tanδ_{CA⁻} > tanδ_{ctl} > tanδ_{CA⁺}

- CA⁺ gel
 - control gel
 - CA⁻ gel
- ↑ More solid-like gels

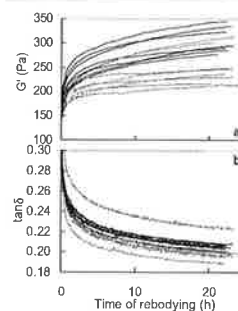


Fig.4: Short-term rebodding: control + CaCl₂ (+67 mmol.kg⁻¹) + Na-citrate 100 mmol.kg⁻¹

Very few significant effects on long-term rebodding:

+ NaCl → No long-term rebodding

+ Na-citrate stirred gel had the highest viscosity increase in 28 d (Fig.5).

Estimations of calcium partition (Mekmene et al., 2008) give a higher content in Pserine and carboxylic acid bound calcium with CaCl₂ addition and a lower one with Na-citrate addition.

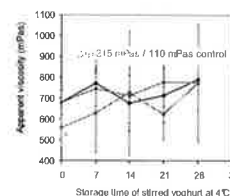


Fig.5: Long-term rebodding: control + CaCl₂ (+67mmol.kg⁻¹) + Na-citrate 100 mmol.kg⁻¹

Conclusions

Concerning the rebodding process, electrostatic interactions were suggested as seen from the effect of the pH on stirring on short term rebodding and the fact that NaCl addition prevented the long-term rebodding. Probably, hydrophobic interactions were of minor importance. Rebodding was partially explained by over-acidification. Calcium addition plays a negative specific role on the rebodding of stirred yoghurt. Calcium bridges between proteins likely formed, that could prevent protein rearrangements in the stirred gel.