Comparison of set or stirred acid gels fermented at 42°C and 30°C

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Introduction

It is well known that fermentation of heat-treated milk with a thermophilic yoghurt culture at 30 or 42°C leads to different acidification rates and pH of gelation. The objective of this study was to show the effect of temperature during fermentation on rheological properties of set and stirred acid gels and to understand the determinant of quality of stirred yoghurt.

Materials & Methods

Reconstituted milk at 120 g.kg^{-1} dry matter was heat-treated 90°C for 5 min. Non ropy *Lactobacillus bulgaricus* (LB340) and *Streptococcus thermophilus* (TA060) were added at 0.02 unit.L^{-1} at 42 and 30°C to reach pH 4.6. Low amplitude dynamic oscillation (LADO), penetrometry and confocal microscopy were performed to monitor gel formation and microstructure. The set gels were stirred through a buchner funnel and characterised by pH measurements, penetrometry, LADO and viscosity (η) the day of stirring (J0) and during 8 days of storage 4°C (at J+4 & J+8).

Results & Discussion

Set gels

Fig.1 shows the higher pH of gelation at 42°C than at 30°C, 5.39±0.04 and 5.17±0.03, respectively, but the same viscoelastic properties at pH 4.6. At high strain (penetrometry), the gel formed at 42°C appeared firmer (fig.2). The gel microstructures were almost alike (fig.3), although the gel formed at 42°C was a little more heterogeneous: the strands were better defined and the pores a little more larger.

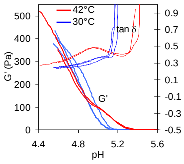

Fig.1. Viscoelastic properties of heat treated milk during acidification by LADO (coaxial cylinders-0.1% strain-1 Hz)

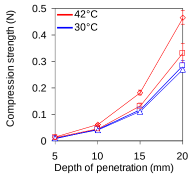

Fig.2. Hardness of the set acid gel by penetrometry (cone 60 degres-30 mm/min)

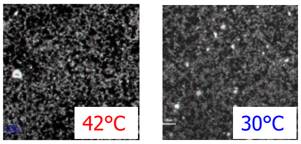

Fig.3. Confocal scanning laser microscopy of acid gels at pH 4.6. Rhodamine β-isothiocianate (20 mg/l) was added before fer-mentation (λ_{exc}=543 nm)

Stirred gels

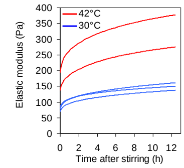

Fig.4. Rebodying of the gels at pH 4.6 with time by LADO (cone-plate-20°C-0.1% strain-0.16 Hz)

Fig.4 shows a much higher rebodying after stirring of the acid gels formed at 42°C than the one formed at 30°C.

The pH of stirred gels decreased and the hardness measured by penetrometry increased during storage for 8 days at 4°C (fig.5). The changes were more pronounced between J+1 and J+4 and for the gels formed at 42°C than for the one formed at 30°C.

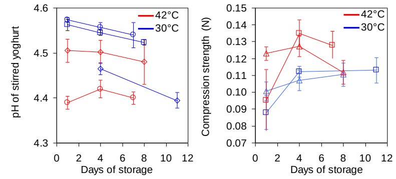

Fig.5. pH and compression strength at 20 mm penetration of stirred acid gels

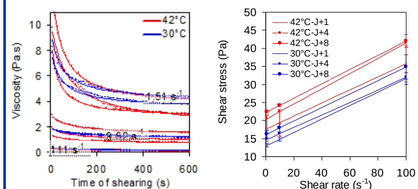

Fig.6. viscosity at J0 and mean shear stress of stirred gel (cone-plate-10°C)

Stirred acid gels are shear thinning, thixotropic and plastic (Fig.6): viscosity increased during the 8 days of storage at 4°C. The fig.6 shows that it is mainly the yield stress that increased during storage (significantly different at P=1%), with no changes in the plastic viscosity (not significantly different at P=1%). The yield stress is higher for gels formed at 42°C

Conclusions

Set acid gels formed at 42°C were firmer than the one built at 30°C, although same viscoelastic properties were shown at low amplitude oscillation and same microstructures. After stirring, gels built at 42°C had higher firmness and viscosity than gels built at 30°C. This could be explained by higher rebodying capacities of the stirred gel. At 42°C, casein particles gelled at a higher pH value than at 30°C. At the gel time, particles could be less destructurated/demineralised at 42°C than at 30°C and the stirred gel could be more heterogeneous. After stirring, gels built at 42°C could underwent more re-organisation of the structures than gels built at 30°C, by increasing homogeneity and relaxing structures that could led to the construction of more interactions between the grains of gel. This led to a higher yield stress for gels formed at 42°C than at 30°C, the day of stirring and even during storage at 4°C

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