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Infusion pasteurization of milk: Influence on viscosity and casein micelle size

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Introduction

Heat treatment of milk is applied in practice to obtain a microbiologically safe product with longer shelf life as compared to raw milk. A standard treatment for fresh milk is HTST pasteurization (72°C x 15 s). Any applied heat treatment will affect the intrinsic as well as the functional properties of the milk. It is of interest to develop technologies for as gentle heat treatments of milk as possible. One possibility is infusion pasteurization, characterized by very short heating, holding and cooling times. This may result in less damage of the intrinsic attributes of milk, ensure the necessary bacterial inactivation and inactivate alkaline phosphatase (AP) as demanded by regulation.

The objective of this study was to investigate the effects of infusion pasteurization in different time-temperature combinations on the size of the casein micelles and the viscosity of the treated milk.

Materials and methods

Infusion pasteurization was performed on raw milk with two holding times (0.1s and 0.7s) combined with three different temperatures (80°C, 100°C, and 120°C). All samples were cooled overnight and skimmed by centrifugation after 24 h. The infusion pasteurized samples were compared to untreated raw milk (control) and standard HTST pasteurization (reference). The size of the casein micelles were analyzed in skim milk using dynamic light scattering and the viscosity of skim milk was determined using a glass capillary viscometer.

Results

The infusion pasteurization treatments affected the viscosity of the milk (Figure 1), possibly as a result of changed interactions between casein micelles due to associated whey protein (Jeurnik & de Kruif, 1993).

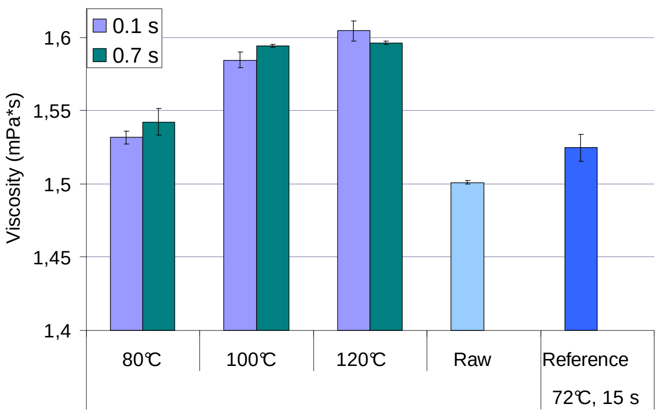

Figure 1. Viscosity of milk samples, infusion pasteurized at 80°C, 100°C and 120°C with holding times 0.1s and 0.7s, raw milk and reference samples.

The raw skim milk had lower viscosity than all heat treated samples. No clear distinction was seen between the reference and the infusion treatment at 80°C, whereas infusion temperatures of 100°C and 120°C increased the viscosity. Change in holding time influenced the viscosity less than change in temperature.

Figure 2 shows that there was no obvious differences in the size distributions of casein micelles in raw milk and the infusion treated samples at 80°C, whereas the size distributions exhibited a broader span at higher micelle diameters for the samples treated at 120°C as compared to the raw milk. The samples infusion pasteurized at 100°C (not shown) also had a broader span, though not as pronounced as the samples treated at 120°C. There were no differences according to holding time.

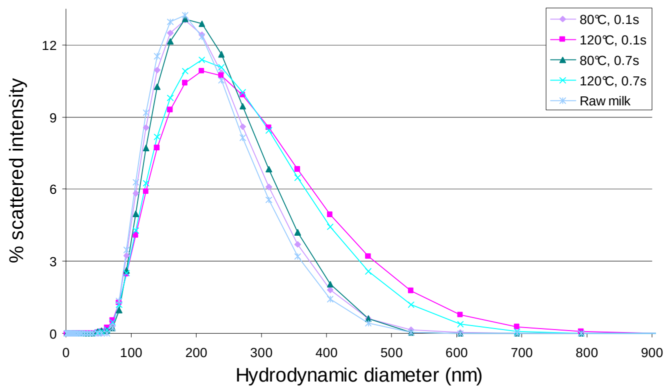

Figure 2. Size distributions of casein micelles samples infusion pasteurized at 80°C and 120°C for 0.1s and 0.7s and raw milk.

The Z-average hydrodynamic diameter increased with increasing treatment temperature (Figure 3). Heat treatment may cause an increase in casein micelle size as a result of interactions between denaturated whey proteins, in particular β-lactoglobulin, and κ-casein on the surface of the micelles (Anema & Li, 2003).

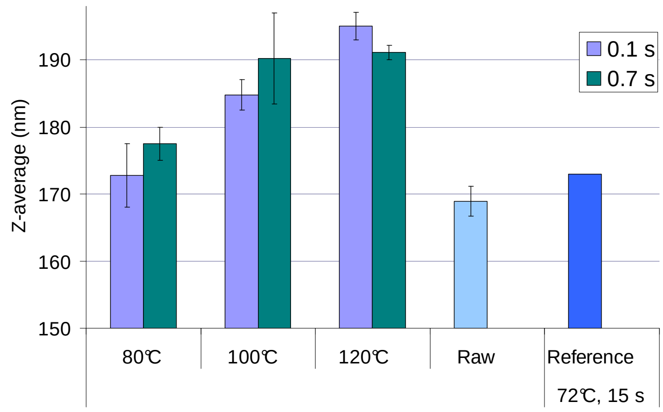

Figure 3. Z-average hydrodynamic diameter of casein micelles in samples infusion pasteurized at 80°C, 100°C and 120°C along with control and reference samples.

Conclusions

Infusion pasteurization of whole milk may induce an increase in the size of the casein micelles and an increase in viscosity of the skim milk fraction. Both effects are temperature dependent showing higher increases at higher temperatures when compared to raw milk or HTST pasteurization. Holding time has little or no effect in the range used in this experiment.

References
Anema, S.G. & Li, Y., (2003) *Journal of Dairy Research*, 70, 73-83
Jeurnik, T.J.M & de Kruif, K.G., (1993) *Journal of Dairy Resarch*, 60, 139-150

Financed by DARCOF