Pressurization of milk by industrial size equipment: effect on whey protein denaturation

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INTRODUCTION

Milk proteins change their particle size and distribution under high-pressure. These changes depend on the pressure level, holding time, release rate and temperature. But also the equipment used to pressurize milk can influence those parameters. This work reports the rates of denaturation and distribution of different milk fractions obtained by pressurization of skim milk in industrial size equipment.

MATERIALS AND METHODS

Skimmed milk samples were collected from a local farm and pressurized to 250, 350, 450, 550 and 650 MPa using industrial size equipment from NCHyperbaric (Wave 6000/120 model). The samples were ultracentrifuged at 100.000 g or precipitated at pH 4.6 to obtain different soluble and non soluble protein fractions. The supernatants and pellets were analyzed by PAGE-SDS and Capillary Electrophoresis.

RESULTS

The soluble protein in the ultracentrifugation supernatant increased with pressure treatment, as casein micelle size decreased and become non-sedimentable (Figure 1). The more noticeable increase was seen in β-CN and α_{S1}-CN.

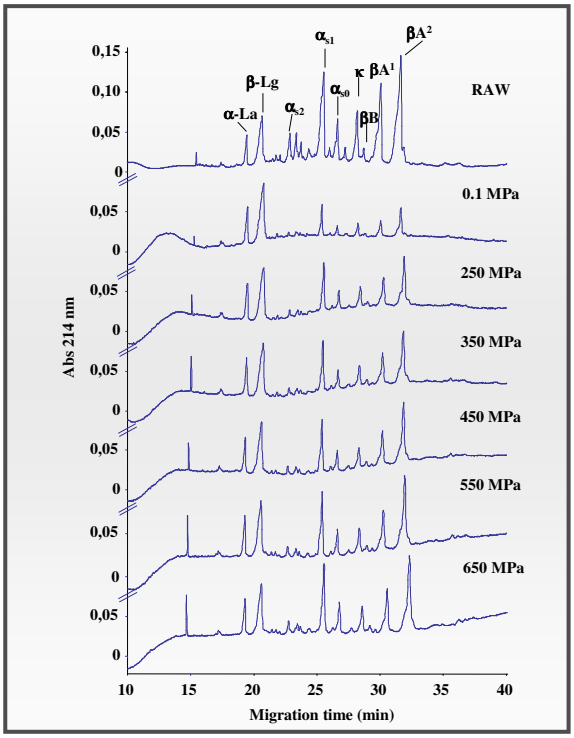

Figure 1. Electropherograms of a) raw skim milk and, b-g) soluble fraction of the supernatants after ultracentrifugation of pressurised samples at 0.1, 250, 350, 450, 550 and 650 MPa.

On the other hand, the protein content in the soluble fraction at pH 4.6 (whey proteins) diminishes as pressure treatment increase due to its progressive denaturation (Table 1). However, the decrease on solubility at pH 4.6 of the β-LG (irreversible denaturation) appears to be rather small (24.46, 46.37 and 59.19% for treatments at 450, 550 and 650 MPa respectively) than the data published before: >80 % of denaturation for this protein above 400 MPa.

Table 1. Area of peaks obtained by capilar electrophoresis of soluble fraction at pH 4.6 of skim milk pressurised at 0.1, 250, 350, 450, 550 and 650 MPa.

Soluble fraction at pH 4.6	α-La	β-Lg
0.1 MPa	8.05	24.28
250 MPa	8.20	24.86
350 MPa	8.17	20.79 (85.63)
450 MPa	7.94 (98.64)*	18.34 (75.54)
550 MPa	7.65 (95.04)	13.02 (53.63)
650 MPa	7.69 (92.31)	9.95 (40.81)

* The values in brackets represent the percentage values referred to the content in soluble proteins at pH 4.6 of the raw milk.

This difference might be caused by the decompression type in the equipment used for pressurization. In this work we have used an industrial size equipment in which the decompression is almost instantaneous, while previous works used small high pressure equipments needing one or two minutes to decompress.

CONCLUSION

Fast decompression of industrial high pressure may induce less denaturation on milk whey proteins, compared with pilot equipments.

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