TOPIC 10

Other topics

10.1 EFFECT OF HOMOGENIZATION ON THE PROPERTIES OF LOW-FAT MOZZARELLA CHEESE*

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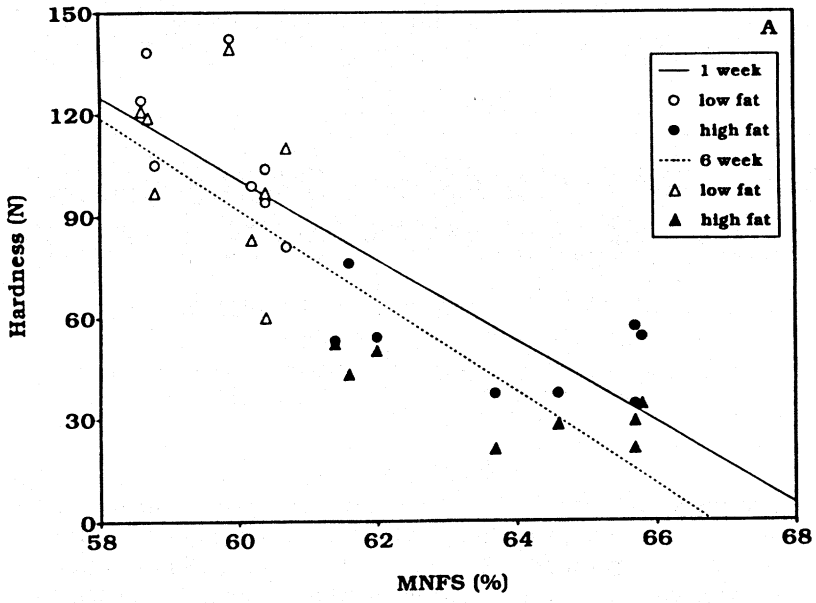
ABSTRACT

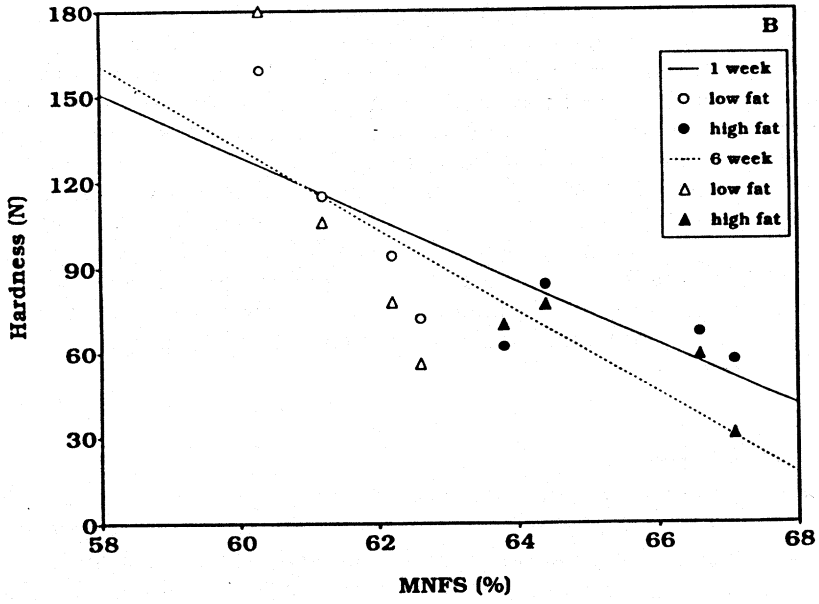
In response to consumer interest in lowering the fat content of the American diet, we have developed a low-fat Mozzarella cheese with texture and melting properties similar to those of a full-fat product. The improvements in texture and meltability appear to be related to increased proteolysis of α_{s1}-casein afforded by low cook temperature and storage at 4°C for 6 weeks. Because homogenization of cheese milk is required when ingredients other than fluid milk are used, the effects of homogenization on texture, melting, and proteolysis in low-fat and full-fat Mozzarella cheeses were investigated. Cheese milk homogenized at 17.2 MPa produced both low-fat and full-fat cheeses with reduced meltability and increased hardness. Proteolysis of α_{s1}-casein was 85% less than in control (non-homogenized) low-fat cheese and about half of that in control full-fat cheese. When homogenization pressure was reduced to 10.3 MPa, meltability and hardness were more favorable, although still not in the range of control cheeses. Proteolysis of α_{s1}-casein was similar to controls in low-fat Mozzarella but more like 17.2 MPa cheese in full-fat samples. With appropriate adjustment of homogenization pressures, manufacturing conditions and storage time, a low-fat Mozzarella cheese can be prepared with acceptable texture and meltability.

1 INTRODUCTION

To meet consumer demand for food products containing lower levels of cholesterol and fat, manufacture of reduced-fat cheeses has increased greatly in recent years in the United States. However, the resulting products usually have less than acceptable textural properties. To overcome these difficulties, we had previously

* *Mention of brand or firm names does not constitute an endorsement by the US Department of Agriculture over others of a similar nature not mentioned.*


A
1 week
low fat
high fat
6 week
low fat
high fat
Hardness (N)
150
120
90
60
30
0
58
60
62
64
66
68
MNFS (%)


B
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low fat
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6 week
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Hardness (N)
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MNFS (%)

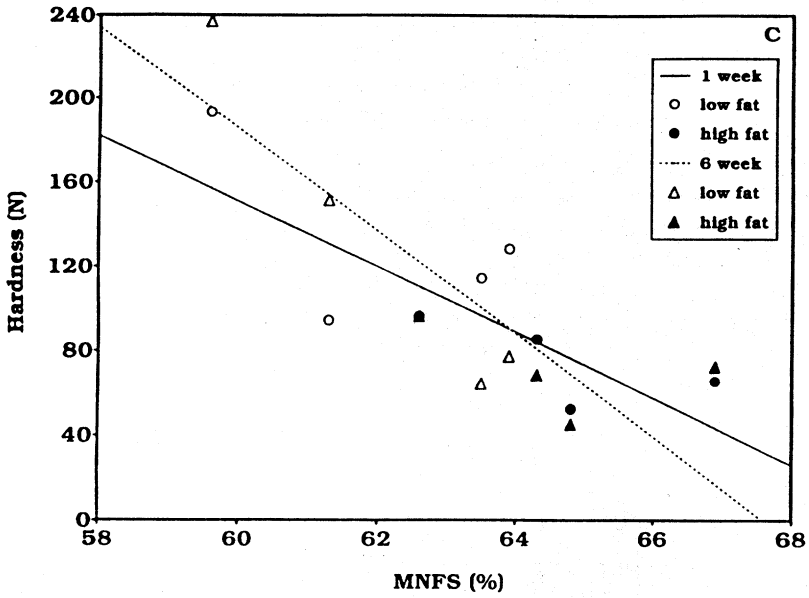

Figure 1: Correlation of hardness and moisture in non-fat substance (MNFS) in low- and full-fat Mozzarella cheeses after 4°C storage for 1 and 6 weeks. A, 0 MPa; B, 10.3 MPa; C, 17.2 MPa.

developed an experimental Mozzarella cheese with very low fat levels (<25% fat in dry matter) and high moisture content. After 6 weeks of storage at 4°C the textural qualities of this cheese were similar to those of fresh full-fat low-moisture Mozzarella [1-3]. The improved texture is believed to be due to increased degradation of the caseins.

In exploring the effects of additional processing options, homogenization of cheese milk was selected for further study since this procedure is often needed in some cheesemaking applications, for example, when recombined milk is used. The effects of homogenization on texture and proteolysis in cheese have been investigated only recently [3, 4]. This investigation deals with the effects of two homogenization pressures and two cooking temperatures on low- and full-fat Mozzarella cheeses.

2 MATERIALS AND METHODS

2.1 Preparation of experimental Mozzarella cheese

Low-fat and full-fat Mozzarella cheeses were prepared as described previously [4] using 50% *Lactobacillus bulgaricus* and 50% *Streptococcus thermophilus* (Marschall-Rhône Poulenc, Madison, WI, USA) as starter culture and single strength rennet (Chr. Hansen's Laboratory, Milwaukee, WI, USA). Cheese milk was homogenized in two stages for a total of 10.3 (1500 psi) or 17.2 MPa (2500 psi). Control cheeses were prepared from non-homogenized milk (0 MPa). Low-temperature

(high-moisture) cheese was held for 1.5 h after the curd was cut, drained in two stages, and then rinsed with water at 33°C. For high-temperature (low-moisture) cheese, the curd was cut and held 15 min, and then the temperature was increased to 45.9°C within 1 h, with stirring; when the curd was completely drained, it was rinsed with 40°C water. Samples were stored for 6 weeks at 4°C.

2.2 Analysis of Mozzarella cheese

Moisture content was determined by the forced-draft oven method [5] and fat content by the modified Babcock test [6]. Texture properties were analyzed at 1 and 6 weeks with an Instron Model 4201 Universal Testing Machine (Instron, Inc., Canton, MA, USA) for hardness, cohesiveness, and springiness; meltability was determined by measuring the increase in diameter of a disc of cheese (38 X 5 mm) after heating 5 min at 232°C (Schreiber test [6]).

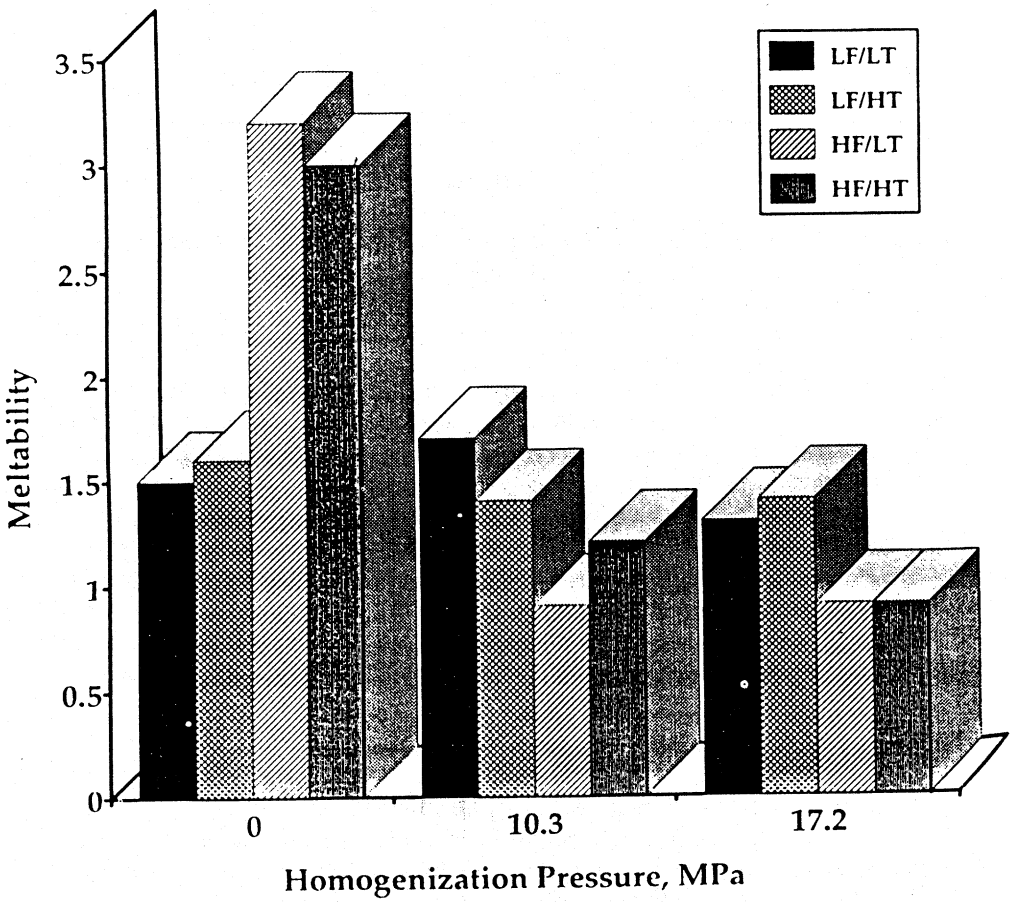

Figure 2: Effect of homogenization and cook temperature on meltability of Mozzarella cheeses after storage at 4°C for 6 weeks.
LF = low-fat, HF = full-fat; LT = low cook temperature, HT = high cook temperature.

Proteolysis of casein was followed with SDS-PAGE of cheese extracts at 1, 3, and 6 weeks on 20% homogeneous PhastGels (PhastSystem, Pharmacia-LKB, Piscataway, NJ, USA); gels were stained with Coomassie Blue. A Bio-Rad Model 620 Video Densitometer (Bio-Rad, Richmond, CA, USA) interfaced with a computer and Bio-Rad 1-D Analyst II software, version 3.10, were used to scan the gels and integrate peaks. The percentage of α_{s1}-casein remaining at 1, 3, and 6 weeks was calculated.

3 RESULTS

Correlation of hardness (Instron) and moisture in non-fat substance (MNFS) in low-fat and full-fat Mozzarella cheeses made from milk homogenized at 0, 10.3 and 17.2 MPa is shown in Figure 1A-C. Higher percentages of MNFS were required for low hardness values, especially with increasing homogenization pressure.

Meltability of low-fat and full-fat Mozzarella cheeses made from non-homogenized milk (0 MPa) was significantly different after 6-week storage at 4°C (Figure 2). However, these differences were reversed in full-fat Mozzarella cheeses made from milk homogenized at 10.3 and 17.2 MPa. Meltability values of the latter were lower than those of low-fat cheeses from non-homogenized milk.

The effects of homogenization and cook temperature on proteolysis of α_{s1}-casein are shown in Figure 3A and B. For both low-fat and full-fat cheeses cooked at low temperature (LF/LT and HF/LT, respectively) there was no difference after 6 weeks between 0 MPa (non-homogenized) and 10.3 MPa homogenized cheese. The percentage of α_{s1}-casein remaining in these samples after 6 weeks of storage at 4°C was about half of that present at 1 week. In contrast, homogenization at 17.2 MPa and high cook temperature (LF/HT and HF/HT) produced opposite effects – little or no proteolysis occurred.

4 CONCLUSIONS

Lower cook temperatures were directly related to higher values for MNFS, and these in turn appear to be responsible for increased proteolysis. Both the moisture content and the lower temperatures could increase survival of rennet, endogenous plasmin, and starter culture bacteria, the proteolytic enzymes of which also contribute to increased breakdown of caseins. Homogenization of cheese milk at 17.2 MPa retarded proteolysis, with the greatest effect occurring in full-fat Mozzarella cheeses and in cheeses made at higher cook temperatures.

Meltability, an important property of Mozzarella cheese, was significantly affected by homogenization. This result probably arises from the effects of shear on the fat globule membrane [7]. As fat globule size decreases and the number of fat globules increases, the membrane surrounding the globules is replaced by casein submicelles and fragments of the original membrane. The interaction between submicelles bound to the fat globules and the protein matrix of the cheese seems to retard heat transfer, resulting in poor melting characteristics. With appropriate adjustment of homogenization pressures, manufacturing conditions and storage time, a low-fat Mozzarella cheese can be prepared with acceptable texture and meltability.

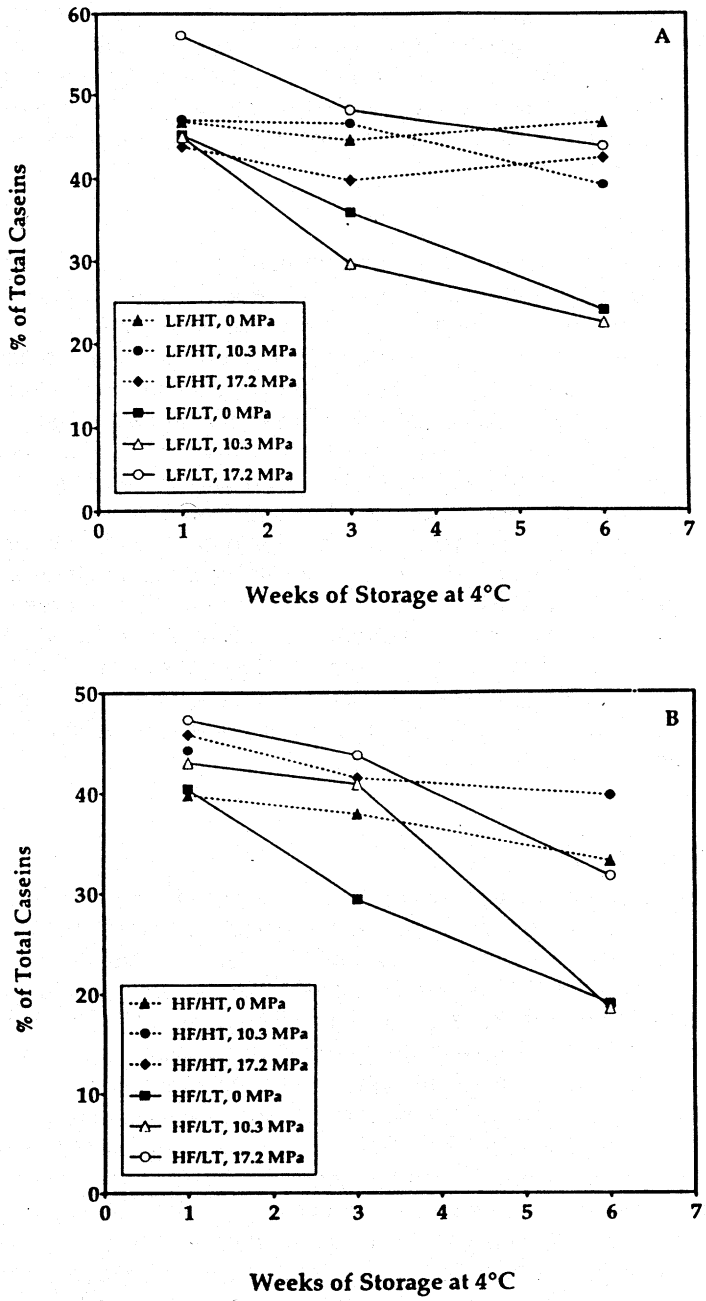

Figure 3: Effect of homogenization and cook temperature on percentage of α_{s1}-casein in Mozzarella cheeses after storage for 6 weeks at 4°C. A, low-fat; B, full-fat. LF = low-fat, HF = full-fat; LT = low cook temperature, HT = high cook temperature.

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