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Effect of cream homogenization on textural characteristics of low-fat Iranian White cheese

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Abstract

The effects of cream homogenization of cheese making milk on textural and sensory characteristics of Iranian White cheese were studied. Cream was homogenized in a two-stage homogenizer at 6.0/2.5 or 9.0/2.5 MPa. Cheese samples were analyzed for rheological parameters (uniaxial compression and small amplitude oscillatory shear), meltability, microstructure, and sensory characteristics. Cream homogenization increased fat content leading to increased meltability. This effect increased as the homogenization pressure increased. The values of storage modulus, stress at fracture and Young's modulus of elasticity for cheeses from homogenized treatments were lower than those of unhomogenized cheese. Cream homogenization at 6.0/2.5 MPa effectively improved the textural, functional and sensory characteristics and enhanced the yield of low-fat Iranian White cheese. This cheese had the lowest values of storage modulus and stress at fracture, probably due to the high number of small, evenly dispersed fat globules in microstructure and especially its lower protein content. Cheeses with homogenized cream had improved texture, flavor and appearance.

Keywords: Iranian White cheese; Homogenization; Microstructure; Rheology; Low-fat

1. Introduction

The homogenization of milk or a fat emulsion can decrease the fat globule size to 1 μm or less (Darling & Butcher, 1978; Keenan, Moon, & Dylewski, 1983; Metzger & Mistry, 1995; Nair, Mistry, & Oommen, 2000), favoring even at low pressures a more uniform distribution of fat globules throughout the cheese curd (Peters, 1956). This provides some advantages in cheese making, such as higher cheese yield because of lower fat losses in whey (Green, Marshal, & Glover, 1983; Maxcy, Price, & Irvine, 1955; Peters, 1956; Rudan, Barbano, Yun, & Kindstedt, 1999; Tunick et al., 1993), higher moisture content of the cheese because of slower whey expulsion (Green et al., 1983; Peters, 1956; Tunick et al., 1993), lower free oil in cheese due to the increased degree of fat emulsification (Peters, 1956; Poduval & Mistry, 1999; Rudan et al., 1999; Tunick et al., 1993) and increased rate of lipid hydrolysis for certain types of cheese, e.g., Blue cheese (Rudan et al., 1999). Homogenization of milk adversely affects the protein network altering its basic structure (Nair et al., 2000), leading to retarded whey expulsion from curd, slower and less complete matting of curd (Peters, 1956), curd shattering (Tunick et al., 1993) and decreased elasticity and gel strength of curd (Green et al., 1983; Maxcy et al., 1955; Peters, 1956).

As most of the undesirable effects of homogenization on cheese making may be caused by the adverse affects of homogenization on milk proteins (Metzger & Mistry, 1994), the concept of homogenizing only the cream portion of cheese milk was studied. Rudan, Barbano, Guo, and Kindstedt (1998) reported that homogenization of milk or cream significantly improved the appearance of unmelted reduced-fat Mozzarella cheese. It did not however, have a large effect on unmelted textural properties of the cheese at

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10 °C. Poduval and Mistry (1999) found for reduced-fat Mozzarella cheese that homogenization of cream lowered free-oil but had no effect on the meltability of the cheese. There are reports (Metzger & Mistry, 1994, 1995), however, that body and texture of reduced-fat cheeses made from homogenized cream were improved.

Iranian White cheese is a close textured brined cheese, resembling Beyaz peynir (Turkish White cheese) and Feta but differs from Feta in the way it is made. It is, for example, manufactured without dry salting of curd and slime formation on the curd surface before brining (Madadlou, Khosrowshahi, Mousavi, & Emamdjome, 2006), which are essential for the development of the characteristic Feta flavor during ripening (Carić, 1993). It is widely consumed all over the country as a major item in the diet (Alizadeh, Hamedi, & Khosroshahi, 2005) and manufacturing of other domestic cheese varieties such as Jug cheese (Madadlou et al., 2006). At the industrial level, the ripening period is 40–90 days, but the cheeses made from raw milk in small rural production units may be ripened for 6–8 months (Azarnia, Ehsani, & Mirhadi, 1997). However, there are trends to reduce this time period for economic reasons (Alizadeh et al., 2005).

This study evaluated low-fat Iranian White cheese made by cream homogenization for microstructure, rheology, meltability, and sensory characteristics.

2. Materials and methods

2.1. Treatments, cultures, and rennet

Three treatments of cheese were made as follows: control low-fat cheese from unhomogenized cream (UHC), low-fat cheese from cream homogenized at first and second stage pressures of 6.0/2.5 MPa (HC8.5), and low-fat cheese from cream homogenized at first and second stage pressures of 9.0/2.5 MPa (HC11.5). Cheese batches were manufactured using 20 kg of standardized milk for each treatment. Cheeses were manufactured in triplicate, each replicate took two days. Two lyophilized direct-to-vat mixed cultures (R-704 and FRC-60, Chr, Hansens Dairy Cultures, Denmark) were used as starter. R-704 contained *Lactococcus lactis* subsp. *cremoris* and *L. lactis* subsp. *lactis*. FRC-60 contained *L. lactis* subsp. *cremoris, L. lactis* subsp. *lactis, Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*. As coagulant, chymosin derived by fermentation (Standard rennet, Chy-Max, Chr, Hansen Inc., Denmark: 183 International Milk Clotting Units (IMCU) mL^{-1} (International Dairy Federation, 1997)) was used at concentration of 4.5 IMCU kg^{-1} of milk. Rennet was diluted 30 fold with cold water then added to each 20 kg batch of milk.

2.2. Cheese making procedure

The cream (obtained from Pak Dairy Company, Tehran, Iran) of determined fat content (37%) was split into three batches, two of which homogenized at 57 °C in a two-stage Gaulin homogenizer (Gaulin Laboratory Homogenizer, APV, LAB. 60-10 TBS. Germany) at 6.0 or 9.0 MPa in the first stage pressures and 2.5 MPa in the second stage pressures. The third portion (control cream) was pumped through the homogenizer under no pressure. Raw skim milk obtained from the same company was standardized to 1.2% with either homogenized or unhomogenized cream, batch-pasteurized at 64 °C for 30 min in a stainless steel vat placed in a water bath, cooled to 35 °C and supplemented with 0.1 g of $CaCl_2$ (Scharlau Chemie S. A. La Jota-Barcelona, Spain) kg^{-1} of milk. The milk was inoculated by cultures and held at 35 °C for approximately 55 min for starter maturation before the addition of rennet. The curd was cut crossways in cubes of 2 cm^3 when firm (50 min after addition of rennet). After cutting, the curd was allowed to settle for 3–5 min and then gently agitated by a stainless steel hand peddle at a gradually increasing rate for 10 min to avoid fusion of freshly cut curd cubes and facilitate whey expulsion. This was followed by whey draining and wrapping the drained curd within cheesecloth. Next the curd was pressed for 2 h (under a gradually increasing pressure up to approximately 2200 Pa at the first 50 min.) to complete draining. After pressing, the curd was cut in blocks (4 cm × 9 cm × 9 cm). The blocks were stored at 23–25 °C for 19–20 h, then placed in 1.5 L airtight plastic containers, and covered with 13% brine (brine was pasteurized beforehand at 80 °C for 10 min, filtered through a clean cloth after rapid cooling and pH adjusted to 4.65 by addition of 99% lactic acid). After sealing, the containers were stored first at 23–25 °C for 48 h and then refrigerated at 5–6 °C for the ripening period of 8 weeks.

2.3. Chemical analysis, cheese yield, fat and protein recoveries

Titrable acidity of milk samples were determined by the Dohrnic method (James, 1995). The pH of milk and cheese samples was measured using a WTW digital pH-meter (model pH 525, Germany). Cheese was analyzed for moisture content by vacuum-oven method (AOAC (1997) method 926.08). The fat content of milk, cream and cheese were determined by the Gerber method (James, 1995). Total protein content of milk and cheese samples was determined by measuring total nitrogen using the Kjeldahl method (AOAC (1997) method 920.123) and converting it to protein content by multiplying by 6.38. Whey and milk total solids were determined by drying 8–11 g of milk or whey at 100 °C for 4 h. As an index of development of proteolysis, soluble nitrogen in 12% TCA was determined (Green, 1977) as described by Katsiari, Alichanidis, Voutsinas, and Roussis (2000). The soluble nitrogen in 12% TCA was expressed as percentage of total nitrogen (TCA-SN%TN). All chemical measurements were done in triplicate. Cheese samples were chemically analyzed during the 9th week of ripening. Yield was calculated as the weight of cheese before brining (after 19–20 h storage at 23–25 °C)