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Cheese milk low homogenization enhanced early lipolysis and volatiles compounds production in hard cooked cheeses

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ABSTRACT

Homogenization applied to cheese milk has shown to increase lipolysis but its use is not spread as it can induce detrimental effects. The aim of this work was to assess the effect of low-pressure homogenization of the cream followed by pre-incubation of cheese milk on the composition, ripening index, lipolysis and volatile profiles of hard cooked cheeses. For that, control and experimental miniature Reggianito cheeses were made and analyzed during ripening (3, 45 and 90 days). Homogenization had no impact on composition and proteolysis. An acceleration of the lipolysis reaction was clearly noticed in cheeses made with homogenized milk at the beginning of ripening, while both type of cheeses reached similar levels at 90 days. We found the level of several compounds derived from fatty acid catabolism were noticeably influenced by the treatment applied: straight-chain aldehydes such as hexanal, heptanal and nonanal and methylketones from C_5 to C_9 were preferentially formed in experimental cheeses.

1. Introduction

Lipolysis is one of the main biochemical events that occurs during cheese ripening, and is caused by hydrolytic enzymes resulting in the hydrolysis of milk lipids to free fatty acids (FFA), partial glycerides and glycerol (McSweeney & Sousa, 2000). Further, FFA undergoes catabolic reactions that conduct to the formation of aroma compounds, such as esters, methylketones, lactones and secondary alcohols; moreover, short-chain fatty acids contribute themselves to cheese flavour. These compounds give characteristic aromatic/taste notes to some cheese varieties, being of great importance in mold and Grana cheeses (Collins, McSweeney, & Wilkinson, 2003). Inhard cooked cheeses as Reggianito, moderate to extensive lipolysis is an advantage for genuine flavour development. Reggianito cheese is an Argentinian product which manufacture has been inspired in Italian cheeses such as Parmigiano Reggiano and Grana Padano (Candioti et al., 2002; Vélez et al., 2011).

Enzymes responsible for liberation of FFA in cheese come from six main sources; the milk itself (mainly the indigenous lipoprotein lipase, LPL), rennet paste, starter bacteria, secondary organisms, non-starter lactic acid bacteria (NSLAB) and exogenous lipases (Collins et al., 2003). In milk, lipolysis does not occurs spontaneously, as the LPL is electrostatically associated to the casein micelle and the substrate is in the form of globules protected by the milk fat globule membrane (MFGM). However, physical treatments applied to milk prior to cheese making (agitation, pumping, homogenization) may decrease the protective action of the MFGM (Evers, 2004).

The basic principle of homogenization consists in the disruption of milk fat globules to smaller ones, achieved by forcing the milk at high pressure through small holes (Walstra, Geurts, Noomen, Jellema, & Boekel, 1999). During this process surface area of fat is considerable increased, which is stabilized by casein micelles and whey proteins. Thus, the homogenization would also favor the accessibility of lipolytic enzymes to fat (Kelly, Huppertz, & Sheehan, 2008). Indeed, homogenization is performed in cheeses where lipolysis is desired to enhance flavour (mainly in blue cheeses). On the other hand, it has also been used for reduced-fat cheese varieties in order to improve texture obtaining higher moisture and smoother or creamier bodied cheeses (Johnson, 2011). However, homogenization is not widespread in cheese making technologies, and no previous reports of this procedure applied in hard cooked cheeses is available. The aim of the present work was to assess the effect of low-pressure homogenization of the cream followed by a pre-incubation step of cheese milk on composition, proteolysis, lipolysis and the volatile profiles of Reggianito type cheeses.

2. Materials and methods

2.1. Pre-treatment of cheese milk

Fig. 1 shows the experimental scheme performed. A volume of 40 L of bulk raw milk (pH 6.7 ± 0.05) supplied by a nearby dairy plant (Milkaut S.A., Santa Fe, Argentine) was centrifuged (500 g, Alfa Laval, Lund, Sweden) at a flow of 40 L/h and at 40 °C, and skim milk (<0.5% of fat content) and cream (>40% fat content) were obtained. These fractions were mixed to obtain a cream with 20% fat which was split into two portions, unhomogenized and one-stage homogenized at 9 MPa

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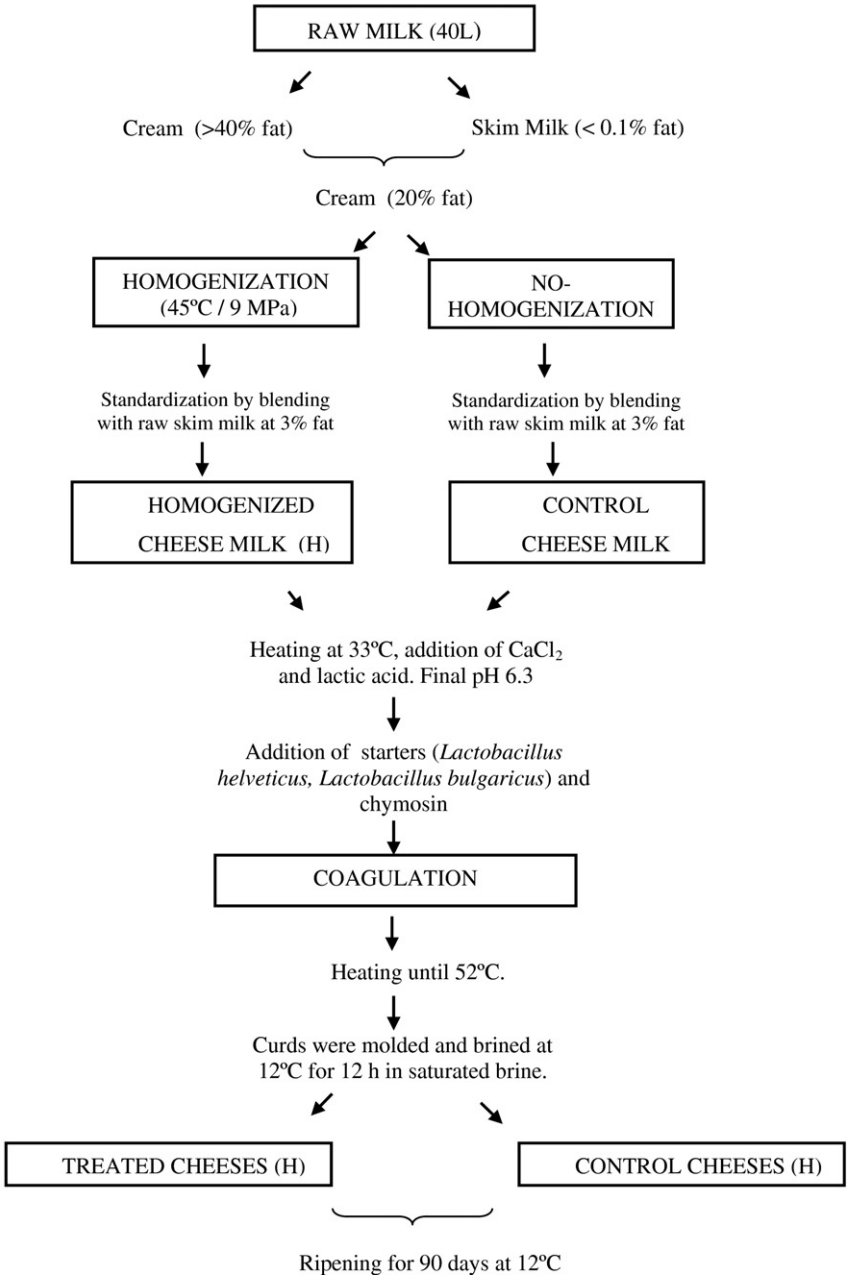

Fig. 1. Flow diagram depicting the process of manufacture of Reggianito cheeses, as well as the experimental treatment added (homogenization).

and 45 °C (Homogenizer 31 M-3TA, Gaulin Corporation, Boston, MA). Each portion was subsequently blended with raw skim milk to obtain cheese milk standardized at 3% fat content. Cheese milks were incubated for 12 h at 12 °C prior to cheese making day and destined to the manufacture of control (C) cheeses and cheeses made homogenized cream (H).

2.2. Total and free fat analysis

Total fat content of cream and skim milk samples were determined by Gerber method (Bradley et al., 1992). Free fat was analyzed on homogenized and unhomogenized cream samples (20% fat) to assess the damage of the MFGM. For that purpose, samples were centrifuged in standardized conditions (600 g 10 min 60 °C) and the layer of free fat was measured with a caliber (Vélez et al., 2011).

2.3. Phase contrast microscopy

Cream samples (20%) were viewed and photographed using a Contrast-phase Microscope (Jenned 2 - Carl Zeiss-Jena, Jena, Germany) attached to a camera (nit-AKS 24 × 36, automatic 2).

2.4. Cheese manufacture

Reggianito-type cheeses were made at laboratory scale (Fig. 1) using an equipment composed by 4 vats of 5 L each, operated in parallel (Vélez, Perotti, Wolf, Hynes, & Zalazar, 2010). C and H raw cheese milks were heated to 33 °C and $CaCl_2$ was added (Merck, Darmstadt, Germany) to final concentration of 0.14 g/L. Lactic acid (15 g/L) was added until milk reached a pH of 6.3–6.4. Then, two DVS commercial starters of *Lactobacillus helveticus* (LH-B02) and *Lactobacillus bulgaricus*