LWT - Food Science and Technology 50 (2013) 538–544

Contents lists available at SciVerse ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

Nutritional, textural and sensory properties of Coalho cheese made of goats', cows' milk and their mixture

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ARTICLE INFO

Article history:
Received 19 April 2012
Received in revised form
14 August 2012
Accepted 16 August 2012

Keywords:
Goat milk
Dairy products
Semi-hard cheese
Quality

ABSTRACT

This study assesses and compares the nutritional, textural and sensory characteristics of Coalho cheese made from goat's (CGM) or cow's milk (CCM) and their mixture (CCGM) during cold storage for 28 days. Among the assessed physiochemical parameters, the type of milk used during production only influenced ($P < 0.05$) the moisture, fat and salt contents of the cheeses. CGM and CCGM showed higher ($P < 0.05$) content of short- and medium-chain fatty acids, such as C6, C8 and C10 and C12, and long-chain polyunsaturated fatty acids C18:2n6c, and lower content of C16 and C16:1. All cheeses presented satisfactory sensory characteristics for most of the assessed parameters. However the addition of cow's milk to goat's milk improved sensory acceptability, mainly through the reduction of goat's milk odor and flavor. Coalho cheese made with the mixture of cow's and goat's milk maintained particular positive nutritional characteristics of goat's cheese, especially with respect to the fatty acids profile, with improved acceptability. All the cheeses maintained, in general, their properties throughout storage time.

1. Introduction

Coalho cheese is a typical Brazilian food that has been produced from raw or pasteurized milk in the Northeastern Region for over 150 years. This product possesses high commercial value due to the simple technology applied during its manufacture, high yield, and good acceptance by the consumers (Silva, Ramos, Moreno, & Moraes, 2010). Coalho cheese is a semi-hard cheese with medium to high moisture that is obtained after milk coagulation using animal rennet or other proper coagulating enzymes, sometimes complemented with selected lactic acid bacteria, and commonly marketed after 7 days of storage at 10 °C (Cavalcante et al., 2007). Even though it has been produced for over one century, Coalho cheese is still manufactured using unstandardized processes, causing variability in physicochemical, technological and sensory properties. Some sensory descriptive terminology commonly used to characterize Coalho cheeses marketed in Brazil includes leakage of whey for appearance, butter or milk flavor, butter taste and rubbery texture (Cavalcante et al., 2007).

Because of its peculiar taste and nutritional properties and its recognition as a healthy food, goat's milk has received special attention by researchers and dairy industry. Some properties of goat's milk are known to be advantageous compared with those of cow's milk, such as higher tolerance by allergic children, which is related to the amount of and structural differences in whey proteins (α-lactalbumin and β-lactalbumin) and the high proportion of small fat globules (1.5 μm), which provide better digestibility (Albenzio & Santillo, 2011; Haenlein, 2004; Raynal-Ljutovac, Gaborit, & Lauret, 2005; Sheehan, Drake, & Mcsweenwy, 2009). Furthermore, goat's milk has received special attention by researchers because of its recognition as a potential functional food since it holds potential as a natural source of lactose-derived oligosaccharides, present a healthier lipid composition with increased conjugated-linoleic acid and short fatty acids content and higher vitamin (A and complex B) and calcium content (Haenlein & Anke, 2011; Park, 2006; Silanokove, Leitner, Merin, & Prosser, 2010), which means that may provide a health benefit beyond its nutritional value.

Despite the availability of scientific information about the positive aspects of the consumption of goat's milk and goat dairy products, the production of this milk in some countries is scarce (such as in Brazil), limiting the production of goat dairy products. Nevertheless, the Northeastern Region of Brazil is the biggest goat's

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0023-6438
http://dx.doi.org/10.1016/j.lwt.2012.08.011

milk production region representing 75% of national production (highlighting the state of Paraíba with 18 million liter of milk per day) and its valorization in differentiated dairy products may contribute to the economical sustainability of the region, mainly of rural areas. However, the flavor of this milk is particular and stronger than cow's milk, which constrains its acceptability among several consumers, in particular Brazilian ones. In this context, the production of dairy products using mixtures of goat's milk and cow's milk could be an interesting and feasible opportunity for the dairy market and industry (Thompson, 2007) allowing the expansion of the dairy industry in many regions and strengthen the goat's milk production chain (Silanokove et al., 2010). Regarding this opportunity, the development of the appropriate technology for the production of Coalho cheese using a mixture of cow's and goat's milk to obtain a product with the proper characteristics and satisfactory acceptance by consumers is of particular interest. So, the aim of this study was to develop and assess the quality parameters and sensory acceptability of Coalho cheeses made from a mixture of goat's and cow's milk and compare the evaluated characteristics with those obtained for the Coalho cheeses made from plain goat's or cow's milk.

2. Material and methods

2.1. Cheese manufacture

Three different cheese types were made in duplicate in three different moments: CCM (cheese made from cow's milk), CGM (cheese made from goat's milk) and CCGM (cheese made from cow's milk and goat's milk, 1:1 ratio, L:L). The cheeses were manufactured following the traditional procedure proposed by Embrapa for traditional cow's Coalho cheese, which is a Brazilian agricultural research company (Laguna & Landim, 2003). Milk composition is presented in Fig. 1. Coalho cheeses were manufactured in 30-L vats from commercially pasteurized goat and/or cow milk heated to 90 ± 1 °C for 10 min, followed by direct acidification with 0.25 mL/L lactic acid. Calcium chloride (0.5 mL/L) and a commercial coagulating agent (0.9 mL/L, Ha-La®) and starter of mesophilic lactic cultures (R-704 *Lactococcus lactis* subsp. *cremoris* and *L. lactis* subsp. *lactis*) available from Christian Hansen Brazil (Valinhos, Minas Gerais, Brazil) were also added to the vats. The vats were incubated at 36 °C until a firm curd was formed (approximately 40 min). The obtained gel was gently cut into cubes, allowed to drain, salted in brine (12 g/L NaCl), placed in perforated rectangular containers (approximate capacity of 250 g) and maintained at 10 °C under pressure for 4 h and vacuum packaged. The cheese obtained after storage at 10 °C for 24 h was regarded as the final product. The cheeses were then stored at 4 °C for 28 days to simulate the common shelf-life.

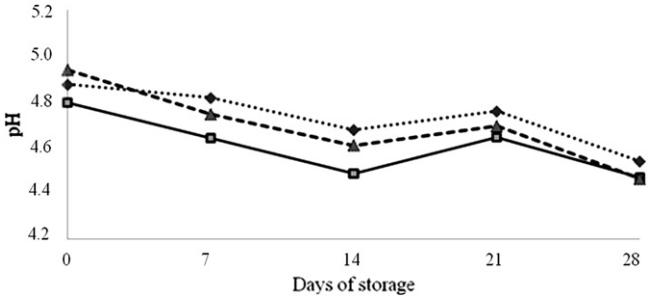

Fig. 1. Mean values for pH of Coalho cheese made from cow's, goat's milk and their mixtures during storage at 10 °C for 28 days. CCM (⋯◆⋯): cheese made from cow's milk; CCGM (—□—): cheese made from mixture of the two; and CGM (- -▲- -): cheese made from goat's milk.

2.2. Analysis

Cheeses from each treatment (*n*: 6) were used for physicochemical and technological analysis of the final product (day 1) and after 7, 14, 21 and 28 days of storage. For fatty acids profile and sensory analysis, the cheeses were evaluated after 14 and 28 days of storage. Each day, three cheeses from the same batch and trial were unpacked and immediately used for physicochemical, fatty acids profile, textural and sensory analysis.

2.3. Physicochemical analysis

The pH values of the cheeses were determined using a combined pH glass electrode connected to a pH-meter MicropH 2001 Crison potentiometer (MicropH 2001, Barcelona, Spain). The moisture content from the samples was determined following the international standard method (IDF, 1958), and protein, fat and salt (sodium chloride – NaCl) contents were measured using a Lacto-Scope Filter C4 apparatus (Delta Instruments, The Netherlands) according to Madureira, Pintado, Gomes, Pintado, and Malcata (2011).

2.4. Extraction and chromatographic analysis of fatty acids

Lipid extraction was performed according to Hara and Radin (1978) and transesterification of the FA according to Christie (1982). The FA methyl esters (FAME) in hexane were then injected (1 μL) into a gas chromatograph (PerkinElmer – Clarus 500B, The Netherlands) equipped with a flame ionization detector (FID) and a PTV injection port used in the split mode with a split vent flow of 100 mL/min and a split ratio of 1/25. The oven temperature program was initially set at 100 °C for the first minute, then increased at a rate of 2.5 °C/min to 240 °C (remaining for 20 min). Hydrogen was the carrier gas at flow rate of 45 mL/min, injector temperature of 245 °C and detector temperature of 270 °C. The separation of the FAME was performed with a WCOT fused-silica CPWAX 58 capillary column (Varian Middelburg, The Netherlands) with a length of 50 m, inner diameter of 0.25 mm and film thickness of 0.20 μm.

The identification of the FA was performed by comparing the retention indexes of the FAME with those of BCR-CRM 164 (Anhydrous Milk-Fat Producer: BCR Institute for Reference Materials and Measurements, Belgium) and Supelco TM (Component FAME Mix, cat 18919 Supelco, Bellefonte, PA) methyl ester standards, and the data were expressed as relative values. The FA composition was converted to g/100 g using the software *Chromquest 4.1* (Thermo Electron, Italy).

2.5. Instrumental texture

The textural properties of the cheeses were evaluated with a TA-XT2 Texture Analyzer™ (Stable Micro Systems, Haslemere, England) using a two-bite compression of cylindrical samples (diameter of 5.0 cm and height of 2.0 cm). The employed compression force was 5 g, initial height 1 cm, and test speed 5 mm/s. The following parameters were measured: hardness, chewiness and cohesiveness. For the texture analysis, Texture Expert software for Windows (version 1.20; Stable Micro Systems) was used.

2.6. Color analysis

A CR-300 colorimeter® (Minolta Co., Osaka, Japan) was used for instrumental color evaluation. The CIELab color scale ($L^*a^*b^*$) was used with a D^{65} illuminant (standard daylight) and measuring