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Characterization of goat milk from Lebanese Baladi breed and his suitability for setting up a ripened cheese using a selected starter culture

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ABSTRACT

In this work the hygiene and quality parameters of goat milk from Baladi breeds were assess in order to evaluate his suitability for setting up a ripened cheese. Experimental cheese trials were performed on local Lebanese dairy farm using a selected culture starter. Evolution of physicochemical and microbiological features of experimental cheese during ripening were evaluated. Raw milk showed a good microbiological quality meeting the hygiene criteria given by European law on the hygiene of foodstuffs. Mesophilic lactobacilli were found to predominate during cheese fermentation while thermophilic cocci gradually grown and were preponderant during all ripening stage. Non-protein nitrogen and water soluble nitrogen fractions increased gradually over the ripening highlighting good casein primary proteolysis. The Free Fatty Acids (FFA) content increased through the ripening period reaching 7340 mg/100 g. Palmitic and oleic acids were the most representative long-chain FFAs at 210 days whereas capric acid was found as a major short-chain FFA. Cheese ripened 90 days, revealed high score for the flavor and taste attributes and good globally acceptance.

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1. Introduction

Small ruminants in Lebanon contribute to 25% of milk production. Lebanese goat population counts 403.800 animals (Lebanese Ministry of Agriculture, 2010) which most of it (96.8%) is Baladi breed. It is a strong and sturdy breed, well adapted to survive in a harsh environment and in the specific ecologic conditions of the Mediterranean east coast; it tolerates poor nutritional conditions in ranching, prevailing diseases in the region, and drought. The goat milk sector in Lebanon continues to improve since several years. Although the biological, sanitary and socio-economic constraints milk production increased from 21.2 (2008) to 34 (2010) thousand tons (Lebanese Ministry of Agriculture, 2010). It is mainly intended for direct consumption; but it is also processed only into traditional and local dairy product with very short shelf-life as Laban (Tamime and Robinson, 1999), Darfiyeh (Serhan et al., 2009) and Labneh (Aloğlu and Önerb, 2013). These products are much appreciated among Lebanese consumers even though their marketing is limited to small distribution channels and for a limited period of the year. The cheese-making of this milk into ripened cheese could represent an innovation and the qualitative development could have a positive impact on the economic and social development of agricultural regions. In other words, helping the farmer by transferring a technical improvement of the quality of goat cheese and allowing him to offer, all year, a popular cheese will help him meet the ongoing needs of the market and certainly encourage his attachment to his land and village.

The healthy properties of goat milk and dairy products (Slačanac et al., 2010; Yangilar, 2013) as well as the importance of the use of lactic acid bacteria (LAB) in the process, and their optimal technological properties as potential starter cultures in dairy making, are well established (Alonso-Calleja et al., 2002; González and Zárate, 2012; Mangia et al., 2014). In particular, in cheese making from sheep milk, *Streptococcus thermophilus* and *Lactococcus lactis* subsp. *lactis* strains showed good growth and acidification activity whereas *Lactobacillus casei* subsp. *casei* strains showed a good proteolytic activity (Madrau et al., 2006; Mangia et al., 2013). Therefore, this study is aimed to produce ripened cheese from Bal-

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adi breed goat milk using a selected *Streptococcus thermophilus* SPS1, *Lactococcus lactis* subsp. *lactis* LPS31 and *Lactobacillus casei* subsp. *casei* 3PS103 strains, assuming that LAB strains have a similar behavior in goat and sheep milks than in cow milk (Pappa et al., 2007). This strategy will allow the evaluation of the hygiene and quality parameters of raw milk from Baladi breed. Moreover, on the cheese obtained sthe microbial and physicochemical parameters during ripening cheese will be evaluated, in particular proteolysis index and free fatty acids content will be analysed. High levels of hygienic and sanitary standards will be applied in order to provide elevate cheese quality.

2. Material and methods

Baladi goats raised on extensive grazing systems in a farm located at medium altitude (500–900 m) in the Achkout region (Lebanon) where used.

This area is characterized by typical Mediterranean vegetation composed mainly by *Quercus calliprinos* Webb., *Rosa* spp., *Poterium spinosum* L., *Calycotome villosa* (Poir.) and *Amygdalus* L. species, where natural grasses and other erbaceous species cover the soil. Goats grazed for 8 h daily and were milked from April to August twice a day, with a milk yield of about 100–120 L/goat in 150 days of lactation.

Bulk milk sample was collected three times with 5-day intervals from the morning milking during the spring and transported in the laboratory where analysis and experimental cheese-making (n = 3) using 100 L of milk in each one, were performed.

2.1. Starter culture and experimental cheese manufacturing

For starter culture preparation, lactobacilli were grown overnight in MRS (Himedia, Mumbia, India) broth and streptococci in M17 (Himedia) and centrifuged at 10,000*g* for 20 min. The pellets were re-suspended in 10 mL of pasteurized goat milk and incubated at 37 °C for 12 h before use. Lactic streptococci and lactobacilli were then added to the milk to achieve 10^7 and 10^6 CFU/g, respectively.

Raw milk was pasteurized to 72 ° C for 15 s and then cooled to 40 °C and inoculated with 1% of the selected starter culture. Coagulation was done using 3–4 mL of commercial liquid calf rennet (Chr. Hansen, Denmark; strength 1:10.000) for 100 L of milk. When gel firmness was judged to be adequate (by empirical evaluation), the curd was cut into grains of about 0.5 cm so that it retains greater amount of serum and cooked to about 42 °C for 10 min. The product was transported into molds and reversed every 30 min for 3, 4 times. Salting was performed after 5 h of molding and cheese samples were left to dry for 1 h before conservation. Cheese molds were reversed 2 times a day for 3, 4 days and left in a cold room at a constant temperature of 10 °C and a constant relative humidity of 85% for ripening.

2.2. Sampling and microbiological analysis

Milk samples were analysed before pasteurization, while cheese samples at 1, 30, 60, 90 days of ripening. Both milk (10 mL) and cheese (10 g) samples were diluted in 90 mL of physiological sterile Ringer's solution (Himedia, Mumbia, India) for 2 min in a Stomacher Lab Blender 80 (PBI, Milan, Italy). Samples were 10-fold diluted in Ringer's solution and plated on the specific media of different microbial groups.

Total mesophilic count was counted on Plate Count agar (PCA, Himedia) plates after 48 h of incubation at 32 °C, while coliforms were counted on MacConkey agar (MC, Himedia) after 48 h at 30 °C. Coagulase positive staphylococci (CPS) were counted on Baird Parker agar (BP, Himedia) supplemented with Egg Yolk Tellurite Emulsion (Himedia) after 48 h at 37 °C and typical colonies were assayed for coagulase activity using the Staphylase test (Himedia). Lactobacilli counts were done on MRS agar (Himedia) after 48 h of incubation at 22 °C and mesophilic and thermophilic cocci were counted on M17 agar (Himedia) after incubation of 48 h at 22 °C and 42 °C respectively.

Milk samples were also subject of *Brucella* control using the Milk Ring test (MRT) (Cadmus et al., 2008), *Salmonella* spp. was determined using a Salmonella Rapid Test Salmonella tests (Oxoid, Milan, Italy).

2.3. Physicochemical analysis

On milk and cheese samples at different ripening time the most important physicochemical parameters were determined: pH value was measured using a pH meter (Thermo Orion 3 Star pH Benchtop) directly after sampling; titratable acidity determination was carried out in 10 g of milk/cheese titrated with 0.l N NaOH, phenolphthalein was used as indicator and acidity was expressed as percentage of lactic acid; lactose, was quantified using enzymatic assays (Boehringer Mannheim, R-Biopharm, Germany); total solids (IDF, 1982), ash (IDF, 1964) and fat (IDF, 1986) were determined following the IDF Standard Methods. Total nitrogen (TN), non-casein nitrogen (NCN), non-protein nitrogen (NPN) and water soluble nitrogen (WSN) amounts were calculated following the Kjeldahl method according to Bütikofer et al. (1993). Based on the data generated, two "proteolytic indexes" were calculated as ratios WSN/TN and NPN/TN. Free fatty acids (FFAs) were extracted from cheeses and determined by gas chromatography according to the method of de Jong and Badings (1990) with some minor modifications reported by Mangia et al. (2013).

2.4. Acceptance test

Assuming that the ripened cheese produced from Baladi goat milk is a new product for the Lebanese market, we decided to make a preliminary acceptance test to provide essential information of the "Baladi ripened cheese". A nine-point structured hedonic scale (1 = disliked and 9 = liked extremely), was used for the evaluation of the appearance, flavor, taste and global acceptability. In addition, each assessor should indicate buying intention using a 5-point hedonic scale (1 = certainly would not buy and 5 = certainly would buy).

The test was conducted by regular cheese consumers (n = 52) of both sexes, students and staff of the University.

2.5. Data analysis

For each cheese-making trial (n = 3) all the microbial and physicochemical determinations were carried out in triplicate on each sample. The results are expressed as mean values ± standard deviation.

3. Results and discussion

3.1. Composition of raw goat milk from Baladi breed

Mean values of the physicochemical parameters of raw goat milk used in the cheese making trials were the following: pH 6.65 ± 0.20; fat 4.31 ± 0.18; protein 4.00 ± 0.06; lactose 4.05 ± 0.24; total solids 14.08 ± 0.21; ash 0.72 ± 0.04. Goat milk showed higher fat and protein content than that reported for Saanen (Nudda et al., 2013), Damascus (Keskün et al., 2004) and Alpine (Costa et al., 2014) as well as other goat breeds (Tamime et al., 2011; Park et al., 2007). Similar fat content in Baladi goat raised in comparable system was reported (Argov-Argaman et al., 2016). Instead, similar overall composition was reported by Güler (2007).

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