Production technology and characterization of Fior di latte cheeses made from sheep and goat milks

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ABSTRACT

Innovation in the small ruminant dairy sector faces structural challenges because dairies are often involved in breeding and produce cheeses that appeal essentially to local markets using traditional technologies and facilities. An investigation was carried out to produce Fior di latte, a traditional, soft *pasta filata* cheese, from sheep and goat milks at the farm level. Fior di latte is an Italian high-moisture, round mozzarella currently produced from cow and water buffalo milks; it is very popular in Europe. Cheesemaking trials were performed and the most appropriate technology proved to be a combination of direct acidification and lactic fermentation, with some modifications to the milk coagulation phase. The gross composition of the experimental cheeses was similar to that of bovine Fior di latte, and the overall hygienic quality was satisfactory even though the milk had not been pasteurized. The new cheeses were similar in appearance to the bovine type, but some specific features were detected. Besides the typical “goaty” and “sheepy” flavors, some novel and distinctive descriptors of odor, flavor, and texture were noted. Our experiment showed that good quality Fior di latte cheese that complies with microbiological requirements of the European legislation can be obtained from sheep and goat milks by appropriately modifying the cheesemaking technology.

Key words: caprine Fior di latte, ovine Fior di latte, innovative cheese

INTRODUCTION

Breeding of dairy goats and sheep is typical in marginal and less favorable (e.g., in terms of economy and climate) areas of the world. In Europe, dairy goats and sheep are concentrated in the countries bordering the Mediterranean Sea, where milk is used to produce cheese, mostly in small dairies using local and traditional methods (Scintu and Piredda, 2007). The small dairies

are often involved in breeding activities, have simple and traditional facilities, and process small amounts of milk a day. Hence, little process and product innovation has occurred in this dairy sector, even though information is available in the literature about the production of “innovative versions” of traditional sheep and goat cheeses (Kilic et al., 2009; Albenzio et al., 2010; Comunian et al., 2010). Among the Italian traditional dairy products are *pasta filata* cheeses, which are mainly made from cow and water buffalo milks. Some *pasta filata* cheeses are also made from goat and sheep milks but few reports are available in the literature about them, because they are considered minor dairy products. These products include semi-hard types such as Balkan Kashkaval (Milanović et al., 1998; Carić, 1999), and the Italian Scamorza and Vastedda (Mucchetti et al., 2008; Albenzio et al., 2013a,b), whereas soft types such as mozzarella, are not yet produced using goat and sheep milks. Bovine high-moisture mozzarella, known as Fior di latte, is very much in demand in Italy and is rapidly becoming popular throughout Europe. It is widely used as a table cheese or as an ingredient for traditional pasta dishes in restaurants, fast-food outlets, and at home. It is marketed in water or saline solutions and has a very short shelf life (from a few days to 2 wk) because of its high moisture content, which ranges from 60 to 67% (de Candia et al., 2007; Faccia et al., 2012; Minervini et al., 2012). Attempts have been made to prepare Fior di latte from sheep and goat milks, but the characteristics of the cheeses obtained are similar to those of low-moisture mozzarella (Shaker et al., 2012).

The purposes of our study were to (1) find a suitable technology to produce a cheese prototype from goat and sheep milks having the same characteristics as bovine Fior di latte in terms of composition and appearance; and (2) assess the main chemical, microbiological, and sensory features of the product.

MATERIALS AND METHODS

Cheesemaking

Milk for cheesemaking was taken from 2 farms in the Apulia region of southern Italy where sheep of differ-

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ent breeds (Sarda, Leccese, and Comisana) and Jonica goats were reared. The farms were officially free of brucellosis. The milk was collected after morning milking at $4 \pm 2^\circ\text{C}$ and transported to our laboratory in 50-L stainless steel tanks. Milk temperature upon arrival was $6 \pm 1^\circ\text{C}$ and the milk was not pasteurized. To assess the most suitable processing method, cheesemaking trials were performed using 3 different technologies: direct acidification (**DA**) of milk with citric acid, acidification of the curd by lactic fermentation (**LA**) with selected starters, and mixed acidification (direct acidification + lactic fermentation, **DLA**). Each trial was run in duplicate in a laboratory dairy plant consisting of 30-L vats indirectly heated by steam; curd was cut with fixed-size nylon networks and stretched manually. Temperature and pH during processing were continuously controlled by a combined pH meter/thermometer apparatus (Crison, Barcelona, Spain). Food-grade citric acid (monohydrated) was supplied by Tecnomilk S.r.l. (Gioia del Colle, Italy); single-strength liquid calf rennet (1:10,000, 80% chymosin, 20% pepsin) was from Chr. Hansen (Milwaukee, WI). For DA cheesemaking, a milk “stretching trial” was performed as described in a previous paper (Faccia et al., 2009) to establish an appropriate level of acidification. A 10% citric acid solution was then added to the cool milk and, after mixing by stirring, the temperature was increased for coagulation. For the LA trials, milk was heated at 38°C and inoculated with a selected strain of *Streptococcus thermophilus* as a starter (freeze-dried culture for direct vat inoculation; CSL, Zelo Buon Persico, Italy); after 30 min, rennet was added to induce coagulation. For the DLA trials, cool milk was partially acidified with citric acid, the temperature was increased to 38°C , and the starter (the same strain as in the LA trial) was inoculated. The cheeses obtained from all the trials were immediately cooled after stretching by immersion in chilled water until the core temperature reached 8°C . Then, the cheeses were salted for 10 min in a 12% brine kept at 8°C , packaged in plastic bags, using water as governing liquid (in which the cheese is stored), and stored under refrigeration. The yields (kg of cheese/100 kg of milk) were calculated by weighing the cheeses 24 h after cooling.

Sensory screening was performed on the experimental cheeses obtained in the trials, and the technology providing the best sensory properties was chosen to produce the final prototypes from goat and sheep milks at a semi-industrial dairy plant available at one of the farms. Two batches of Fior di latte prototypes, spherical in shape and each weighing about 200 g, were obtained and subjected to chemical, microbiological, and sensory analyses 24 h after manufacture.

Chemical Analyses

Milk fat and total protein were determined by the Gerber (IDF, 1981) and Kjeldahl methods (IDF, 1993), and an electrode (Crison) was immersed to measure pH. Cheese moisture and pH were determined as reported by the International Dairy Federation (IDF, 1986, 1989), fat by the Soxhlet method, total protein by the Kjeldahl method, and sodium chloride by the Volhard method (AOAC International, 2000; method 935.43). The protein fractions of the milks and cheeses were characterized by electrophoresis. Samples were dissolved in 9 M urea and loaded onto a discontinuous polyacrylamide gel in the presence of urea (urea-PAGE) as reported by Andrews (1983). The gel was stained with blue silver (Candiano et al., 2004) and, after destaining in water, it was scanned and subjected to densitometric analysis by using Quantity One software (BioRad, Hercules, CA). The lipid fraction was characterized by determining the total FA profile after extraction by the Folch method (Folch et al., 1957). Total FA analysis was performed by GC as reported by Trani et al. (2010). Briefly, the FAME were obtained by trans-esterification of about 25 mg of each lipid sample, which had been previously dissolved in 2 mL of petroleum ether, and using 2 mL of boron trifluoride-methanol reagent (Morrison and Smith 1964). Samples were injected into a Fisons model MFC800 gas chromatograph (Fisons, Milan, Italy) equipped with a 60 m $\times$ 0.32 mm i.d. and 0.5 μm film thickness fused-silica capillary column (Stabilwax, Restek, Bellefonte, PA). The following conditions were applied: (1) oven—5 min at 170°C , followed by heating ($1^\circ\text{C}/\text{min}$) to 220°C , and held at 220°C for 30 min; (2) carrier—helium 20 cm/s at 170°C ; (3) injector— 250°C , 1 μL ; split 40:1; (4) detector—flame-ionization detector, 250°C . All analyses were run in triplicate, and the means of the results were compared by Student's *t*-test at a 5% level of significance.

Microbiological Analyses

Milks and cheeses were analyzed to evaluate the parameters according to European Union requirements. Somatic cell counts of milks were determined by a Fossomatic counter (Foss Electric, Hillerød, Denmark); presence of *Listeria monocytogenes* and *Salmonella* spp. was evaluated according to the International Organizations for Standardization (ISO) methods 11290 (ISO, 1996) and 6579 (ISO, 2002); β -glucuronidase-positive *Escherichia coli*, and coagulase-positive staphylococci were counted according to ISO methods 16649 (ISO, 2001) and 6888 (ISO, 1999). For viable counts of milk and cheese, representative samples (20 mL or 20 g,

Table 1. Average characteristics (SD in parentheses) of sheep and goat milks used for the cheesemaking trials

Milk	pH	Fat (%)	Protein (%)	DM (%)	SCC (cells/mL)	Total mesophilic bacteria (cfu/mL)
Sheep	6.62 (0.02)	6.2 (0.1)	5.3 (0.1)	17.6 (0.3)	$5.9 (0.5) \times 10^5$	$110 (40) \times 10^3$
Goat	6.72 (0.03)	4.2 (0.1)	3.8 (0.1)	14.1 (0.2)	$8.1 (1.1) \times 10^5$	$2.0 (1.4) \times 10^3$

respectively) were diluted in 180 mL of 2% (wt/vol) sodium citrate solution and homogenized in a Waring blender (Waring Commercial, Torrington, CT). Serial dilutions were made in quarter-strength Ringer's solution and plated on specific media (Oxoid, Basingstoke, UK): total mesophilic bacteria were counted on plate count agar incubated at 30°C for 48 h (Gammariello et al., 2009); lactobacilli on de Man, Rogosa, and Sharpe (MRS) agar at 37°C for 48 h under anaerobiosis (Gammariello et al., 2009); streptococci and lactococci in M17 agar at 37°C for 48 h (Morea et al., 1999); yeasts and molds on yeast extract dextrose chloramphenicol agar at 30°C for 48 h (Romano et al., 2001); total coliforms on violet red bile lactose agar at 37°C for 24h (Gammariello et al., 2009); enterococci on Slanetz and Bartley medium at 45°C for 48 h (Altieri et al., 2005); and *Pseudomonas* spp. in *Pseudomonas* agar base with CFC *Pseudomonas* selective supplement and 10 mL/L of glycerol at 30°C for 48 h (Gammariello et al., 2009). Analyses were repeated 3 times for each sample.

Sensory Analyses

Sensory analyses were conducted by a panel consisting of 8 trained evaluators. The panelists (5 women and 3 men from our Food Science team) were very familiar with bovine *pasta filata* cheeses and had been selected based on international standards ISO 8586-1: (ISO, 1993) and ISO 8586-2 (ISO, 1994). Their task was to (1) screen the experimental cheeses for acceptability of taste and body/structure; and (2) evaluate in detail the sensory properties of the final prototypes versus a commercial sample of bovine Fior di latte produced using similar technology. Using a slightly modified version of the protocol reported by Minervini et al. (2012),

the panelists rated hardness (1 = soft; 4 = very hard) and creaminess (1 = not creamy, 4 = very creamy) for body/structure, and sourness (1 = not sour, 4 = very sour) and flavor (1 = barely perceivable, 4 = very intense) for taste. The descriptor list reported by Pagliarini et al. (1997) was used for detailed assessment of sensory properties. Preliminarily, the panelists participated in 6 training sessions to become familiar with the descriptors using the same standard materials proposed by Pagliarini et al. (1997). Then, a reference value was established for each descriptor on a commercial bovine Fior di latte taken from a dairy that used DLA technology. The panelists were asked to rate the intensity of each attribute by assigning a score of 1 (absence of the sensation) to 5 (extremely intense). After the training period, the panel assessed the samples of sheep and goat milk Fior di latte in 6 sessions, 3 for sheep and 3 for goat milk samples. In addition to rating the descriptors in the list, the panelists discussed the novel characteristics perceived and suggested some new descriptors. Data were tested for normality distribution by Kolmogorov-Smirnov's test, whereas Levene's test was used to verify the homogeneity of variance. The significant differences were tested by ANOVA with Tukey's honestly significant difference (HSD) test post hoc, for multiple comparison. All analyses were performed using software SPSS v.19 (SPSS/IBM, Armonk, NY).

RESULTS AND DISCUSSION

Cheesemaking

The microbiological and chemical parameters of milk are summarized in Table 1: SCC and TMB counts

Table 2. Results of the cheesemaking trials

Item ¹	Amount of acid (g/L)	Coagulation temperature (°C)	Rennet dose (mL/L)	Fermentation time (h)	pH at stretching	Temperature at stretching (°C)
Sheep						
DA	2.51	33	0.10	—	5.43	53
LA	—	33	0.12	8.7	4.83	54
DLA	1.43	33	0.10	6.3	5.05	53
Goat						
DA	1.71	34	0.14	—	5.67	51
LA	—	34	0.22	6.5	5.09	52
DLA	0.97	34	0.14	4.9	5.18	51

¹DA = direct acidification; LA = lactic fermentation; DLA = direct acidification + lactic fermentation.

Table 3. Technological parameters for the production of sheep and goat Fior di latte prototypes by the direct acidification plus lactic fermentation method

Item	Sheep	Goat
Acidification phase		
Temperature of milk on adding acid (°C)	8	8
Amount of acid used (g/L)	1.46	0.94
pH after acid adjunct	5.99	6.02
Temperature at starter inoculation (°C)	38	38
Starter inoculation to rennet addition (min)	40	40
pH at rennet addition	5.91	5.94
Coagulation/fermentation phase		
Rennet dose (mL/L)	0.10	0.14
Temperature for milk coagulation (°C)	33	34
Time for milk coagulation ¹ (min)	8	12
Rennet addition to partial drain time (min)	43	48
Partial to final drain time (min)	297	202
Total drain time (min)	340	250
Final drain to stretching time (min)	25	22
Rennet addition to stretching time (h)	6.08	4.53
Stretching phase		
pH at stretching	5.06	5.15
Temperature at stretching (°C)	55	52

¹Empirical evaluation of curd firmness.

were within the limits indicated by European Union regulations. The fat:protein ratio, which is of pivotal importance in *pasta filata* cheese processing, was 1.17 for sheep milk and 1.11 for goat milk. The values were close to those normally found in cow milk; therefore, the cheese milks did not require standardization. However, the high protein concentration called for some modifi-

cations in the coagulation process: a lower temperature and a smaller dose of rennet were used to avoid excessive hardening of the curd. The 3 cheesemaking methods yielded different results in terms of processing times and sensory characteristics of the cheeses (Table 2 and Figure 1) but in all 3, curd stretching behavior differed from that of cheeses made from cow milk. Although our experimental design was not set up to specifically investigate rheological properties, the curd paste was more malleable and had shorter fibers than is usually observed in cow milk Fior di latte processing. The LA method required a long time to reach a suitable pH for stretching and produced an unacceptable structure of the cheese paste, which proved to be excessively hard and rubbery, probably because of excessive syneresis during the long fermentation phase. The DA method required a very short processing time but the sensory characteristics of the resultant cheeses were very poor. Although structure received a good rating, taste was compromised by an unpleasant sour perception, a defect caused by the excessive amount of citric acid used, which was based on the preliminary stretching trials (1.71 g/L, corresponding to pH 5.43 for sheep milk and 2.51 g/L, corresponding to pH 5.67 for goat milk, much higher than normally used for cow milk cheeses). We had anticipated the need for higher acidification levels because the pH of the stretching point is closely related to the protein content of milk, but we did not anticipate the occurrence of the sour defect. In the

Figure 1. Sensory evaluation (on a scale from 1.00 to 4.00) of the sheep and goat cheeses obtained from the experimental trials using 3 methods: DA = direct acidification; LA = lactic fermentation; DLA = direct acidification + lactic fermentation.

Table 4. Proximate composition (SD in parentheses) of sheep and goat Fior di latte cheeses

Item	pH	Fat (g/kg)	Protein (g/kg)	DM (g/kg)	NaCl (g/kg)
Sheep	5.16 (0.01)	207.3 (13.2)	186.0 (9.9)	419.2 (7.1)	5.6 (0.5)
Goat	5.30 (0.02)	195.6 (9.3)	189.7 (5.5)	408.4 (9.1)	6.0 (0.3)

sheep cheeses, the sour taste was unacceptable. The DLA technology yielded the best results, with short processing times and good sensory characteristics, and was thus deemed the most suitable of the 3 methods. It was used to produce the final prototypes of Fior di latte throughout the semi-industrial cheesemaking trials. Details are given in Table 3: cold milk was pre-acidified to pH 6.0, and the temperature was increased to 38°C for starter addition. After 40 min, the temperature was adjusted at 33 (sheep) or 34°C (goat) and rennet was added for coagulation. When gel firmness was judged to be satisfactory (by empirical evaluation), the coagulum was cut; the average diameter of the grains was 2 cm for goat and 3 cm for sheep. The greater dimension of the sheep curd grains was necessary to counterbalance the tendency to hardening. The curd, after sedimentation in the bottom of the vat, was kept in the whey for fermentation, and the temperature was maintained at 34 to 35°C by adding small amounts of warm whey when necessary. When pH decreased below 5.8, a first drainage was performed and fermentation continued in about one half of the whey. After the pH reached 5.35, drainage was completed, and the last step of the curd fermentation took place at room temperature. Stretch-

ing was carried out by mixing the minced curd and hot water (80°C) in the ratio of about 1:1 (wt:vol). No change of water was done, because the curd elongated very easily. The final pH of the cheeses, controlled at molding, was 5.06 and 5.15 for sheep and goat, respectively.

Unlike cow milk Fior di latte, which is salted during stretching, the prototypes were salted by immersion in 12% brine for 10 min at 8°C. This modification was necessary because the curd fibers broke during stretching when using salted water (1.5% NaCl) or adding salt to the milled curd before stretching (30 g of NaCl/kg of curd). The use of 12% brine was established after unsuccessful trials in 22% brine at 10°C; under the latter salting condition, the surface of the products hardened and cracked after a few minutes. This was probably due to softness of the cheese paste. The same problem is observed for water buffalo mozzarella, which is traditionally salted in dilute brine (10–18%). Reusing the 12% brine could pose microbiological risks, whereas preparing fresh brine for every batch of cheese could be expensive and time consuming. In our study, we prepared 12% brine by diluting the concentrated brine available at the dairy.

Figure 2. Fatty acid groups (%) in sheep and goat Fior di latte cheeses. UN = unsaturated, LC = long-chain, MC = medium-chain, SC = short-chain FA.

Table 5. Fatty acids profile (g/100 g of total FA) of sheep and goat Fior di latte cheeses

FA	Sheep	Goat
C4:0	1.32 ^a	0.65 ^b
C6:0	1.23	1.35
C8:0	2.33	2.83
C10:0	5.87 ^a	9.93 ^b
C12:0	3.98	4.93
C13:0	0.09	0.12
C14:0	11.75	11.13
C14:1	0.23	0.16
C15:0	1.39	0.89
C16:0	26.50	29.04
C16:1	0.60 ^a	0.35 ^b
C17:0	0.04	0.03
C17:1	0.03	0.02
C18:0	12.43	11.88
C18:1	30.01 ^a	25.61 ^b
C18:2	0.54 ^a	0.21 ^b
C18:3	1.33	0.71
C20:0	0.34	0.16

^{a,b}Means in the same row bearing different superscripts differ ($P < 0.05$).

Table 6. Microbiological profile¹ of sheep and goat milks (log₁₀ cfu/mL) and Fior di latte cheeses (log₁₀ cfu/g; SD in parentheses)

Item	LB	LC	TC	EC	Y&M	TMB	Pseud
Sheep milk	3.86 (0.14)	4.61 (0.04)	2.48 (0.06)	2.30 (0.03)	3.18 (0.03)	5.04 (0.24)	3.65 (0.09)
Sheep cheese	5.04 (0.08)	9.46 (0.31)	<2	3.74 (0.18)	<2	5.80 (0.17)	3.79 (0.31)
Goat milk	3.88 (0.10)	4.15 (0.11)	2.48 (0.08)	<2	<2	3.30 (0.15)	3.83 (0.05)
Goat cheese	4.83 (0.19)	9.40 (0.54)	3.04 (0.03)	3.70 (0.04)	2.51 (0.04)	5.41 (0.22)	3.28 (0.37)

¹LB = lactobacilli; LC = streptococci and lactococci; TC = total coliforms; EC = enterococci; Y&M = yeasts and molds; TMB = total mesophilic bacteria; Pseud = *Pseudomonas* spp.

Chemical and Microbiological Characteristics of Cheeses

The composition of the cheeses is summarized in Table 4. The gross composition was relatively similar to that reported in the literature for bovine Fior di latte; the fat:protein ratio was >1 and the moisture content was close to 60% (Faccia et al., 2012; Minervini et al., 2012). The yields of cheese (kg of cheese/100 kg of milk) were greater than those typical for cow milk: 25.2 for sheep and 17.5 for goat, compared with 13.5 to 14 kg of cheese/100 kg of milk for CM. The mean FA composition of the cheeses is shown in Table 5 and Figure 2. The FA found in greater quantities were oleic and palmitic acids, followed by myristic and stearic acids. The main differences between sheep and goat cheeses were in the short-chain group (C4 to C10) and the unsaturated group, with short-chain FA being higher in the goat cheese and unsaturated FA greater in sheep cheese. In detail, higher percentages of butyric (C4:0), oleic (C18:1), and linoleic acids (C18:2) were detected in sheep cheese ($P < 0.05$), whereas a higher percentage of capric acid (C10:0) was found in goat cheese ($P < 0.05$). These particular FA differences found in cheese are not commonly found in milk (Park et al., 2007). Comparison with bovine Fior di latte is not feasible because no information is present in the literature, but a comparison can be made with low-moisture mozzarella (Hauff and Vetter, 2009). The same 4 FA have been reported to be the most abundant in low-moisture mozzarella, with oleic acid being second in relative quantity after palmitic acid; the ratios among the FA groups in bovine low-moisture mozzarella are different with respect to those found in the present study. The urea-PAGE patterns of caseins of milks and cheeses 1 d after production are shown in Figure 3. The patterns of the caseins of milk and cheese for each species were similar, and bands different from caseins were only slightly detectable in cheese, indicating that no primary proteolysis could be detected 1 d after production. This finding may be due to the small amount of rennet added to milk and retained in the Fior di latte paste and to partial thermal denaturation during curd stretching. As expected, the electrophoretic mobility of sheep and goat α_{S1} -caseins was different (Veloso et al., 2002). The

resolution of the casein bands was better than that described in the literature, suggesting that urea-PAGE could be used for control purposes in similar cheeses to detect and quantify mixes of goat and sheep milks, not only mixes with bovine milk (Molina et al., 2002; Veloso et al., 2002; Mallatou et al., 2004). The microbiological profiles of the prototype cheeses are shown in Tables 6 and 7. The hygienic quality was satisfactory, as none

Figure 3. Urea-PAGE patterns of caseins in goat and sheep milks and Fior di latte (FdL; 1 d after production).

Table 7. Pathogen testing of sheep and goat Fior di latte, according to the European Union regulations¹

Cheese	<i>L. monocytogenes</i>	<i>Salmonella</i> spp.	CPS (cfu/g)	<i>E. coli</i> , (cfu/g)
Sheep	—	—	400	<10
Goat	—	—	<100	<10

¹*Listeria monocytogenes* and *Salmonella* spp. were absent in 25 g of cheese; actual counts of coagulase-positive staphylococci (CPS) and β -glucuronidase-positive *Escherichia coli* are shown.

the pathogens listed in the European Union regulations was found in 25-g samples of cheese, and total coliform counts were low, as were the counts of total mesophilic bacteria and yeasts and molds. These findings may be ascribed to the good microbiological quality of the raw milk and the thermal effect of the stretching process. Nevertheless, pasteurization is recommended. No differences were found between goat and sheep Fior di latte, and as expected, the microbiota in both cheeses consisted mainly of the lactic acid bacteria added during cheesemaking. *Pseudomonas* spp. counts were similar to those commonly found in bovine high-moisture mozzarella (Sinigaglia et al., 2008; Faccia et al., 2013). It is essential to control the growth of these microorganisms during cheese storage to prolong shelf life, because they are important causes of quality alteration (Sinigaglia et al., 2008; Mastromatteo et al., 2014).

Cheese Sensory Evaluation

Appearance of the prototype cheeses was similar to that of cow milk Fior di latte, as can be seen in Table 8. Perception of the white color, although not statistically significant, was more evident in the novel cheeses due to the low carotene concentration in goat and sheep milk (Park et al., 2007). A whiter color could be an advantage, because pure white is a basic requirement of mozzarella cheese (Jana and Mandal, 2011). The panelists provided a distinctive appearance descriptor for the 2 new types of Fior di latte—the term “porcelain,” which described a shiny surface. As for the other groups of descriptors, the new cheeses were less similar to cow milk Fior di latte. In particular, characteristic “goaty” and “sheepy” odor and flavor were perceived at a high level of significance ($P < 0.01$) in goat and sheep milk

Table 8. Sensory evaluation of cow, goat, and sheep milk Fior di latte (hedonic scale 1–5)

Attribute	Cow	Goat	Sheep
External appearance			
White	4	5	5
Translucent	4	4	4
Fibrous	2	2	2
Smooth paste	5	5	5
Odor			
Milk odor	1	2**	2**
Butter odor	1	1	2
Yogurt odor	2	2	2
Flavor during chewing			
Acid	2	2	2
Bitter	1	1	1
Sweet	1	1	1
Salty	2	1*	1*
Milk flavor	1	3**	3**
Cream flavor	1	2	2
Texture during chewing			
Firm	2	2	2
Elastic	4	2*	2*
Cohesive	2	2	2
Rubbery	2	1*	1*
Juicy	2	2	2
Slippery	0	0	1*
Flaky	2	2	2
Peculiar characteristics			
External appearance	Not shiny	Porcelain	Porcelain
Odor	—	Goaty	Sheepy
Flavor	—	Almond milk	Walnuts
Texture	Elastic	Plastic	Plastic

* $P < 0.05$; ** $P < 0.01$.

cheeses, respectively. A more intense cream flavor and, for sheep milk cheese, a more distinct butter odor were perceived, but this result was not significant ($P > 0.5$). Differences in the score for “salty flavor while chewing” indicated lower perception in sheep and goat cheeses than in cow milk cheese. This could be due to the different salting procedure because the concentration of NaCl was not very different from that normally found in bovine Fior di latte (Minervini et al., 2012). Brine salting causes an uneven distribution of sodium chloride in the cheese paste, with the outer portion being more salted than the inner portion, which might explain the less salty flavor perceived by the panel. Distinctive flavor descriptors were “almond milk” (for goat cheese), and “walnuts” (for sheep cheese). Compared with cow milk Fior di latte, 3 texture descriptors—elastic, rubbery, and, for the sheep cheese, slippery—had lower or higher scores ($P < 0.05$). These differences are in line with the different behavior of the curds during stretching, which gave rise to a distinctive texture characteristic that the panelists described as “plastic.”

CONCLUSIONS

The purpose of this study was to produce a prototypical Fior di latte cheese from sheep and goat milks. Not all processing technologies typically used to make cow milk Fior di latte mozzarella are suitable for sheep and goat milks because the latter milks have a higher protein content than cow milk. Although they were very similar in appearance to bovine Fior di latte, the cheeses obtained had some unique characteristics, displaying a specific identity in terms of flavor and texture. Given their characteristics and high cheesemaking yields, the new cheeses appear to have a promising market outlook and, if accepted by the consumers, they could offer interesting prospects for the small ruminant sector. Further investigations are underway to assess the shelf life of the new cheeses and to evaluate consumer acceptance.

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