

Cheese quality, characteristics and technology of Bulgarian artisanal white brined cheese from raw sheep milk

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Abstract. The study aims to evaluate the potential for producing traditional artisanal cheese from raw sheep's milk. The physicochemical composition of the raw milk was determined, with dry matter at 20.75%, fat at 8.17%, protein at 6.55%, and carbohydrates at 4.94%. The total bacterial count was found to be relatively low (1.4×10^6 cfu/ml), while the proportion of saturated fatty acids (74.73%) was approximately three times higher than that of unsaturated fatty acids (24.66%). The composition and quality parameters of the traditional artisanal cheese produced from raw sheep's milk were also examined during a 60-day ripening period. Over this period, a consistent increase in dry matter (from 47.02% to 49.50%) and protein content (from 16.23% to 16.79%) was observed, along with a decrease in water content (from 53.03% to 50.57%), while the fat in dry matter (FDM) remained relatively stable until the end of ripening. The non-protein nitrogen/total nitrogen (NPN/TN) ratio did not change significantly during ripening ($P > 0.05$). Among the free amino acids in the cheese, leucine (Leu), glutamic acid (Glu), phenylalanine (Phe), lysine (Lys), and valine (Val) accounted for up to 71.81% of the total amino acid content.

1 Introduction

Milk and dairy products are widely consumed worldwide due to their high nutritional value. The specific composition of sheep's milk varies throughout the lactation period and is influenced by genetic, physiological, and environmental factors [1]. Therefore, understanding both the composition of milk and the technology of dairy production is essential for obtaining high-quality products with desirable characteristics. Sheep's milk and its derived products are known for their exceptional nutritional and biological value, attributed to their high content of proteins, fats, minerals, vitamins, and other phytonutrients.

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Sheep's milk is a traditional raw material for producing various dairy products in Balkan countries. Despite its seasonal nature, it is highly valued for making typical traditional dairy products due to its higher density, viscosity, titratable acidity, and lower freezing point compared to goat and cow milk. Its use is closely linked to the ethno-cultural dietary habits of local communities [2], as well as to sensory preferences and cultural traditions. The lactation period of sheep is seasonal, lasting between 105 and 150 days depending on breed and productivity. Consequently, its composition varies significantly: dry matter content ranges from 16.89 to 19.15%, milk fat from 6.08 to 8.37%, total protein from 5.20 to 6.50%, lactose from 4.11 to 5.31%, and acidity from 0.21 to 0.26% [3].

The qualitative and quantitative composition of proteins and fats in milk plays a key role in determining the consistency and sensory profile of the final product. The fatty acid profile of sheep's milk is primarily influenced by the genetic characteristics of the breed [3], with a higher proportion of saturated fatty acids of short and medium chains. These fatty acids contribute to both the nutritional value and the biologically active profile of food products, creating the aroma and flavor attributes typical of artisanal products. High levels of lauric (C_{12:0}), myristic (C_{14:0}), and palmitic (C_{16:0}) fatty acids are associated with increased cholesterol isomers, whereas stearic acid (C_{18:0}) has a neutral effect on blood lipid levels. Conversely, butyric acid (C_{4:0}), oleic acid (C_{18:1}), and n-3 and n-6 fatty acids have preventive effects on cardiovascular diseases. Sheep's milk also contains higher levels of conjugated linoleic acid compared to goat's milk under similar grazing conditions [3-5].

In recent years, there has been growing consumer interest in traditional Bulgarian dairy products made from sheep's milk. Marketing efforts emphasize terms such as "traditional," "local," "healthy," and "functional," highlighting artisanal products produced from milk of indigenous breeds using traditional technologies. A major challenge for artisanal cheese producers is preserving the diversity and identity of the native microflora, which provides unique metabolic properties. The production of dairy products based on traditional artisanal methods is expanding across Balkan countries.

Currently, quality and safety management systems in the dairy industry prioritize obtaining raw milk of high quality with minimal microbial contamination. The microbiological quality of raw milk remains a subject of ongoing research and industrial focus. For artisanal cheese producers, adhering to high hygiene standards is essential to creating unique products with distinct flavors that have no equivalent on the market.

Therefore, the aim of the present study is to investigate the chemical and microbial composition of sheep's milk and to evaluate the quality characteristics of traditional artisanal white brined sheep's cheese.

2 Materials and methods

Raw bulk milk samples were collected from small-scale dairy farms from the region of Sliven (42.65°N 26.433333 °E), Bulgaria. Sheep's milk is obtained from autochthonous breeds of sheep - "Karakachan breed" from morning manual milking of 30 sheep. The animals are fed entirely on pasture, in the land of the settlement. The samples were taken in the month of May 2025, and the animals were on the 90th day of the lactation period. The average age of the sheep is between 3 and 4 years.

Chemical analysis of milk samples. The milk fat, dry matter, solids-non-fat (SNF) protein, lactose, density, and solids content of the studied samples were measured by using the Lactoscan SFP Options Milk Analyzer. Titratable acidity determined by titration method. The values of pH were measured by a pH meter (with a pH meter under standard test conditions), a test to detect antibiotics in milk (Twin Sensor is a competitive test involving specific receptors with high affinity for Betalactams and tetracycline molecules, received from Biokom Trendafilov LTD).

Microbiological analysis of milk samples. Total viable count (TVC) was determined by using Plate Count Agar medium.

Fatty acid composition of lipid fraction: The total fatty acid composition of the lipid fraction was determined using gas chromatography (GC) after transmethylation of the respective sample with 2% H₂SO₄ in absolute CH₃OH at 50°C. The analysis was conducted as according to the standard method. To determine the fatty acid methyl esters (FAMES), a HP 5890 gas chromatograph was used, equipped with a 75 m x 0.18 mm x 25 µm (film thickness) capillary Supelco column and a flame ionization detector. It was programmed as follows: the column temperature changed from 140 °C (hold 5 min), at 4 °C/min to 240 °C (hold 3 min); the temperatures of the injector and detector were set at 250°C. Identification was performed by comparison of the retention times with those of a standard mixture of FAME subjected to GC under identical experimental conditions.

Traditional artisanal cheese making process. The raw sheep's milk was obtained while manual milked, then purified through a filter cloth. The milk is curdled at a temperature of 32.0±1.0°C, and commercial rennet enzyme (Biokom Trendafilov LTD) is added in the amount of 0.05 %. Coagulation process takes about 25.0-30.0 min. Then a coagulum is cut into prisms, after that left to stand to release some of its whey. About 3.0-5.0 % potable water with a temperature of 12.0±2.0 °C is added to the cut cheese cubes. Thus, the cheese mass stands for about 10-12 min, then it is stirred. The mixture of cheese and whey is then placed in a filter cloth bag which is suspended in a horizontal position. The cheese is drained for a period of about 1.0 hour, and the separated whey is collected in a container (used for making brine solution). The cheese is placed in a perforated wooden mould and pressure is applied to press and form it. The pressing process continues for 3.0-4.0 hour, after which the filtering cloth bag is removed and the cheese pieces are shaped. After that salted with sea salt and placed in a refrigerator at a temperature of 6.0°C for 24 hours. The preparation of the brine solution: the separated whey is heated to a temperature of 90.0-95.0°C; 2.5% crystal sea salt is added. Because of this temperature, denaturation of whey proteins occurs. The deproteinization process of whey lasts 5.0 to 7.0 min, after which the proteins are separated. Then the brine is cooled to a temperature of 3.0-4.0°C and filtered. The fresh cheese is stacked tightly in wooden barrels, the brine is added, pressed with a wooden grate and the barrels are tightly closed. Periodically, every 2-3 days, it is necessary to fill up the barrels with brine. The cheese is maturing at a temperature of 10.0±3.0°C for a period of 40-60 days.

Chemical analysis of cheese samples. Dry matter content of artisanal cheese was determined: the amount of sodium chloride; the levels of fat content; the content of total protein and nitrogen; and the values of active acidity were determined potentiometrically by using a pH meter.

Microbiological analysis of cheese samples. The microbiological analysis was carried out during the ripening period (40/60 days). Total count of lactobacilli, total count of lactococci, psychrophilic microorganisms, and the presence of molds and yeasts were evaluated.

Statistical analysis. Computer processing of the results was performed using the program Microsoft Excel 2010. All determinations were carried out in triplicate, and data were presented as mean value ± SD (n=3).

3 Materials and methods

Physicochemical and microbiological analysis of raw sheep milk samples. The results of the physicochemical and microbiological analyses of the raw sheep's milk used for producing traditional artisanal cheese are presented in Table I. The data indicate that the chemical parameters of the milk collected in May fall within the average range reported for the Karakachan breed of sheep [6]. The dry matter content of the raw sheep's milk (20.75%) is higher than previously reported in the literature [6-8], where values for milk from the same

breed range between 19.13% and 19.22%. The higher dry matter content in fresh sheep's milk from autochthonous breeds may be attributed to multiple factors, including phyto- and water intake, lactation stage, animal age, climatic and genetic characteristics, and udder health. The solids-not-fat (SNF) content (12.52%) in this study was higher than previously reported values (11.45%) for the Travniški breed of sheep [6], while in the Bulgarian White Dairy breed, the average SNF content is approximately 10.63% [1, 6].

Table 1. Chemical and microbiological characteristics of raw sheep milk used for the production of traditional artisanal cheese samples.

| Properties | Composition of sheep milk |
|-----------------------|---------------------------|
| Dry matter, % | 20.75±0.01 |
| SNF*, % | 12.52±0.21 |
| Fats, % | 8.17±0.15 |
| Proteins, % | 6.55±0.06 |
| Carbohydrates, % | 4.94±0.90 |
| Solids, % | 1.21±0.02 |
| Density, g/ml | 1.03±1.13 |
| Titatable acidity, °T | 20.01±0.11 |
| pH | 6.80±0.02 |
| Inhibitors | n.d |
| TBC, cfu/ml | 1.4.10 ⁶ |

*SNF- Solids-Not-Fat; TBC-total bacterial count; n.d - not detected; *Average value ±SD (n=3)

The elevated SNF values observed in Karakachan sheep are likely due to their lower milk yield [8], as well as differences in the vegetation consumed, which strongly influences milk composition.

The fat content (8.17%) was comparable to previously reported values for sheep's milk from Karakachan sheep (7.29–7.32%) and Bulgarian White Dairy sheep [2, 9]. The lipid fraction was 7.34%, a value consistent with those reported in earlier studies [2]. According to various authors [10, 11], variations in fat content can result from factors such as stress during milking, inadequate or unbalanced feeding, and seasonal climatic fluctuations. Sudden temperature changes and variations in pasture composition can significantly affect the fatty acid profile [7]. The composition and structure of fatty acids in sheep's milk are considered key factors influencing the production of artisanal dairy products with distinctive sensory characteristics [8, 9].

The carbohydrate content (4.94%) of the analyzed milk aligns with previously reported values by Kawęcka and Pasternak [10]. Due to the specific anatomical features of the Karakachan breed, including hairiness in the abdominal area, the milk may be prone to physical and biological contaminants, which can act as carriers of microorganisms. However,

microbiological analysis showed low total viable counts (1.4×10^6 cfu/ml), indicating good livestock management practices and strict sanitary conditions during manual milking. Thus, the relatively low bacterial contamination supports the potential use of raw milk for artisanal product production, though further research is needed to confirm microbial purity.

Previous studies on the fatty acid composition of sheep's milk have identified the predominant fatty acids as C_{10:0}, C_{14:0}, C_{16:0}, C_{18:0}, and C_{18:1}c9. The higher levels of saturated fatty acids, particularly palmitic (C_{16:0} – 39.70%) and myristic (C_{14:0} – 15.10%), are characteristic of sheep's milk [8]. Changes in pasture vegetation also influence milk composition [7-9]. In the present study, saturated fatty acids (74.73%) were higher than unsaturated fatty acids (25.47%), consistent with previous findings on different sheep breeds [2, 3]. Notably, elevated levels of monounsaturated fatty acids, particularly the oleic acid isomer C_{18:1} (22.5%), were observed, while the levels of other oleic isomers, C_{18:2} (0.5%) and C_{18:3} (0.11%), were relatively lower (Fig. 1).

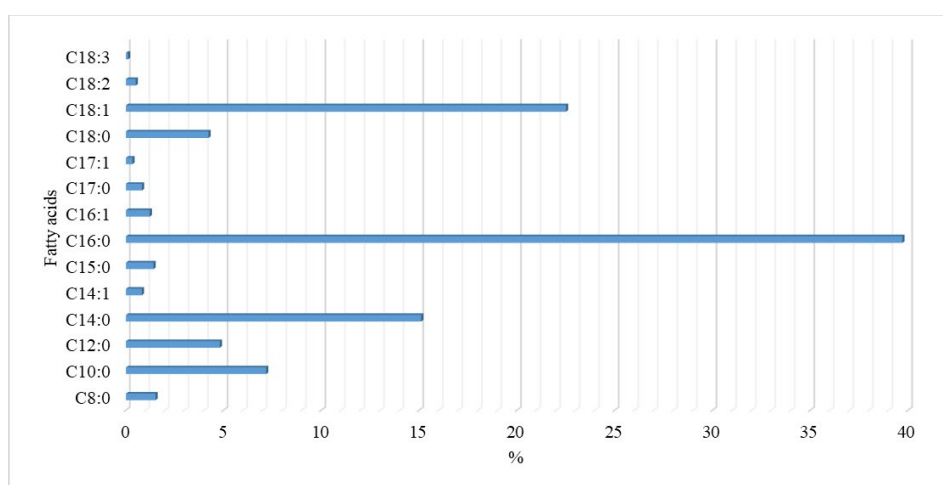


Fig. 1. Fatty acid composition of raw sheep milk.

The levels of medium-chain fatty acids (MCFAs) - C_{8:0} – 1.51%; C_{10:0} – 7.17%; long-chain fatty acids (LCFAs) - C_{12:0} – 4.8%; C_{14:0} – 15.1%; C_{14:1} – 0.81% are consistent with the values previously reported by other authors [32, 34]. The concentration of LCFAs (C_{15:0} – 1.41%; C_{16:0} – 39.7%; C_{16:1} – 1.22%; C_{17:0} – 0.82%; C_{17:1} – 0.33%) is also comparable to those reported for sheep's milk from the same breed and lactation period by Mihaylova [5]. It is important to consider variations arising from climatic conditions, as well as stress during milking, which can affect the fatty acid profile.

A trend toward a reduction in saturated fatty acids and an increase in unsaturated fatty acids toward the end of lactation has been noted by other researchers [10]. Changes in the composition of forage, particularly an increase in cellulosic substances and a decrease in protein content, lead to reduced levels of C_{18:3}. Variations in phytointake also influence microbial activity in the rumen, which in turn affects the fatty acid composition of milk [11].

Quality composition of artisan cheese from raw sheep's milk. According to variations in homemade and technological approaches, differences in certain physical and chemical parameters have been reported for artisanal cheeses [12]. In this study, the average values of chemical parameters during the ripening of artisanal sheep's cheese made from raw milk were monitored throughout the maturation process. The research aimed to provide comprehensive information on the changes in cheese composition and their influence on the quality characteristics of the final product.

The determination of dry matter is particularly important for assessing both the shelf life and the nutritional value of artisanal cheese. Between the 1st and the 60th day of ripening, an increase of more than 2% in dry matter content was observed. A similar trend of increasing dry matter during ripening has also been reported by other authors [5, 12]. The most significant increase in dry matter occurred around the 20th day of ripening, whereas comparatively smaller changes (approximately 0.01%) were observed between the 40th and 60th days of ripening (Table 2).

Table 2. Physicochemical composition of traditional artisanal cheese during the ripening period.

| Properties | Traditional artisanal cheese sample | | | |
|----------------------------|-------------------------------------|-------------|-------------|-------------|
| | Ripening period, days | | | |
| | 1 | 20 | 40 | 60 |
| Dry matter, % | 47.02±1.05 | 48.63±1.13 | 49.04±1.01 | 49.50±1.02 |
| Proteins, % | 16.23±0.07 | 16.39±0.12 | 16.44±0.06 | 16.79±0.21 |
| Water content, % | 53.03±1.31 | 51.41±0.55 | 51.05±1.05 | 50.57±1.01 |
| NaCl, % | 4.12 ± 0.44 | 4.08 ± 0.44 | 3.80 ± 0.05 | 3.77 ± 0.01 |
| Total fats, % | 30.01±1.07 | 31.00±1.09 | 31.09±1.11 | 32.03±1.07 |
| Fat in Dry Matter (FDM), % | 64.05±1.00 | 64.07±1.11 | 64.08±0.55 | 64.04±1.02 |
| Titrate acidity, °T | 128.00±1.29 | 144.00±1.00 | 185.00±1.41 | 221.00±1.33 |
| pH | 4.82 ± 0.77 | 4.69 ± 0.44 | 4.42 ± 0.06 | 4.30 ± 0.01 |

*average value ±SD (n=3)

The dry matter content of artisanal cheese can also be influenced by the concentration of dry matter in the brine solution. As the dry matter content of the cheese increases, a corresponding decrease in water content is observed. Protein content showed a slight increase during the ripening period, with a more pronounced rise of 0.35% recorded between the 40th and 60th days of ripening. The average protein content was approximately 16.46%, which is comparable to values reported by other authors [5, 12].

A reduction in water content between the 1st and 20th day of ripening (from 53.03% to 51.41%) was found to correlate with the salting stage of the cheese. It was observed that higher salt levels (above 3%) led to less pronounced proteolytic processes compared to cheese with lower salt content (below 2.2%). Moreover, reduced salt content in artisanal cheeses can affect texture by increasing softness, lowering acidity, and even contributing to the development of a slight bitter aftertaste.

Regarding lipolysis, no significant correlation was identified between salt content and changes in fatty acid composition [12, 13]. The fat in dry matter (FDM) content of the samples remained relatively stable, averaging around 64.0%, while total fat levels increased by approximately 2.0% over the ripening period (from 30.01% on day 1 to 32.03% on day 60). The pH of the artisanal cheese decreased from 4.82 on the 1st day to 4.30 by the 60th day of ripening.

Nitrogen Fractions. The investigation of changes in nitrogen fractions during ripening, presented in Fig. 2, reflects the proteolytic processes occurring in the cheese.

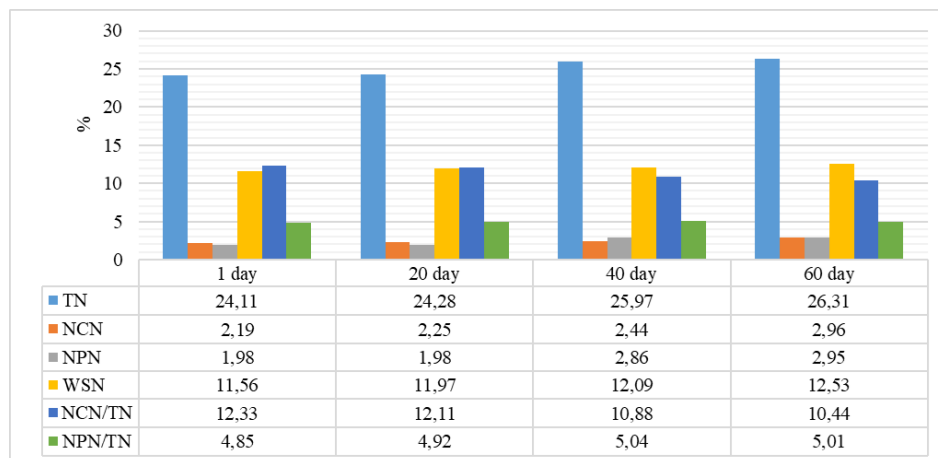


Fig. 2. Nitrogen fractions in traditional artisan cheese during the ripening period: TN – total nitrogen; NCN - non-casein nitrogen; NPN – non-protein nitrogen; WSN – water-soluble nitrogen.

The results indicate that total nitrogen (TN) content increased by approximately 2%, rising from 24.11% on day 1 to 26.31% by the 60th day of ripening. The water-soluble nitrogen (WSN) fraction ranged from 11.56% on day 1 to 12.53% at the end of the ripening period. The observed increase in WSN values, accompanied by a decrease in pH, aligns with previously reported findings for ripened sheep's cheese made from raw milk [13]. During ripening, WSN levels increased by approximately 1.2%. Meanwhile, the NCN/TN ratio decreased from 13.33% to 10.44% over the 60 days, indicating a limited degree of proteolysis and minimal hydrolytic changes in the casein structure. The NPN/TN values showed no significant changes throughout the ripening process ($P > 0.05$).

Higher NCN/TN values were observed on day 1 compared to day 60, indicating that the proteolysis process in the cheese was modified throughout ripening. Proteolysis was more pronounced during the initial stages but became limited as ripening progressed, while the amino acid content increased significantly during this period. The modified proteolysis process can be attributed, on the one hand, to the absence of added starter microflora and, on the other hand, to the low ripening temperature. Despite the observed changes in nitrogen fractions, the overall degree of proteolysis can be considered low. For more substantial changes in nitrogen fractions, other authors have reported ripening periods of 200–240 days [12, 13]. At the end of ripening, the NPN content reached 2.95%, which is higher than the initial level of 1.98%. The formation of NPN fractions is primarily associated with enzyme complexes produced by various microbial species that hydrolyze long peptides.

Free Amino Acids. In the present study, 14 free amino acids were identified in artisanal sheep's cheese at day 60 of ripening (Table 3).

At the end of the ripening period, the amino acids with the highest concentrations were leucine (Leu), glutamic acid (Glu), phenylalanine (Phe), lysine (Lys), and valine (Val), which together accounted for 71.81% of the total identified amino acids. Between the 1st and 20th day of ripening, significant increases were recorded for several amino acids: tyrosine (62.75%), lysine (59.72%), serine (47%), aspartic acid (38.09%), and isoleucine (31%). The increase in free amino acids during ripening is largely attributed to proteolysis, which leads to the formation of aroma-active compounds that shape the flavor profile of cheese [13].

Table 3. Changes in the free amino acids of traditional artisanal cheese during the ripening period.

| Amino acids, mg/g dw | Traditional artisan cheese | | | |
|---------------------------------|----------------------------|-----------|-----------|-----------|
| | Ripening period, days | | | |
| | 1 | 20 | 40 | 60 |
| <i>Essential amino acid</i> | | | | |
| Alanine | 0.32±0.02 | 0.45±0.03 | 0.67±0.00 | 0.89±0.01 |
| Glycine | 0.11±0.01 | 0.19±0.05 | 0.45±0.54 | 0.39±0.01 |
| Proline | 0.24±0.01 | 0.39±0.77 | 0.57±0.45 | 0.79±0.02 |
| Serine | 0.45±0.06 | 0.31±0.14 | 0.62±0.66 | 0.52±0.01 |
| Aspartic acid | 0.54±0.03 | 0.52±0.01 | 0.56±0.05 | 0.87±0.01 |
| Glutamic acid | 1.12±0.02 | 1.23±0.84 | 3.18±0.04 | 4.11±0.01 |
| Tyrosine | 0.45±0.94 | 0.47±0.02 | 0.91±0.24 | 1.45±0.07 |
| <i>Nonessential amino acids</i> | | | | |
| Valine | 0.31±0.01 | 0.44±0.02 | 1.29±0.29 | 1.61±0.02 |
| Leucine | 1.02±0.02 | 1.33±0.39 | 3.24±0.13 | 4.73±0.01 |
| Isoleucine | 0.35±0.01 | 0.57±0.13 | 0.28±0.01 | 0.84±0.01 |
| Threonine | tr.* | 0.45±0.66 | 0.51±0.80 | 0.60±0.02 |
| Methionine | 0.57±0.01 | 0.47±0.23 | 0.71±0.07 | 0.73±0.01 |
| Phenylalanine | 1.55±0.05 | 1.67±0.61 | 2.29±0.59 | 3.05±0.01 |
| Lysine | 1.44±0.09 | 1.86±0.35 | 1.70±0.08 | 2.04±0.01 |

* tr.- trace; **average value ±SD (n=3)

During the same period, the highest increases were observed for glutamic acid (91.05%), leucine (76.69%), alanine (71.11%), valine (70.45%), and proline (61.53%). On the 20th day of ripening, threonine (0.45 mg/g dw) was also identified. According to Lepecka et al. [14], hydrolysis of α s1-casein occurs at bonds Phe23-Val24 and Leu149-Phe150, which are particularly sensitive to chymosin and lactococcal proteinases, leading to alterations in the amino acid composition.

Further increases were observed throughout the ripening process: phenylalanine (50.81%), alanine (35.95%), proline (30.37%), glycine (28.20%), glutamic acid (27.25%), and valine (19.25%). The total concentration of free amino acids serves as a key indicator of the ripening stage of cheese. Data from this study indicate that the proportion of free amino

acids in artisanal sheep's cheese increased most significantly between the 40th day (16.52 mg/g dw) and the 60th day of ripening (21.64 mg/g dw), representing an overall increase of approximately 46% during the 60-day ripening period.

The rise in free amino acid levels between days 40 and 60 may be attributed to a slight reduction in sodium chloride content (from 3.80% to 3.77%) and the activity of non-starter lactic acid bacteria (NSLAB) with strong proteolytic activity.

Microbiological analysis. The variety of microorganisms present in raw sheep's milk, and their incorporation into the microflora of artisanal cheese, is associated with both positive and negative effects. Artisanal cheeses are characterized by spontaneous fermentation, where interactions occur between desirable microorganisms and non-starter bacterial populations. The microbiological safety of the final product is fundamental to its overall quality. According to local traditions and consumer expectations, each type of artisanal cheese should possess a distinct color, aroma, flavor, and texture [14].

The results of the microbial evaluation of the artisanal sheep's cheese during the 40th to 60th day of ripening revealed variations in the counts of total lactobacilli and total lactococci (Table 4).

Table 4. Changes in the total viable count of traditional artisan cheese during the ripening period.

| Total viable count, cfu/g | Traditional artisanal cheese | |
|---------------------------|------------------------------|-------------------|
| | Ripening period, days | |
| | 40 | 60 |
| Total lactobacillus | 2.1×10^4 | 1.1×10^3 |
| Total lactococcus | 1.4×10^7 | 1.2×10^5 |
| Psychrotrophic | 1.2×10^2 | 1.7×10^3 |
| Yeast and moulds | <100 | n.d* |

* n.d - not detected

The data indicate that up to the 40th day of ripening, the total number of lactococci (1.4×10^7 cfu/g) is higher than that of lactobacilli (2.1×10^4 cfu/g). During the ripening process, the number of mesophilic microorganisms decreases, and by the 60th day, lactobacilli become the predominant microflora (1.2×10^5 cfu/g). Similar observations have been reported for cheeses made with pasteurized milk [14]. According to Tilocca et al. [15], for artisanal cheeses produced on small local farms—where milk is used immediately after milking and no starter cultures are added—it is crucial to carefully monitor the subsequent technological processes. This involves maintaining high hygiene standards in production facilities, equipment, and handling practices.

The presence of molds and yeasts in artisanal cheeses can be attributed to their natural occurrence during milking. A decrease in mold and yeast counts between the 40th and 60th day of ripening may be linked to the reduction of lactose levels (0.41 mg/g dw) and the persistence of lactic acid bacteria in the medium [15]. In this study, no viable mold or yeast cells were detected by day 60. The presence of lactic acid is also associated with the metabolic activity of some mold and yeast species. The variation in mold and yeast levels in artisanal raw sheep's milk cheeses depends on factors such as salt concentration, temperature, moisture, and overall production conditions. The low microbial contamination observed in

the artisanal cheese samples can be attributed to strict hygiene measures during raw milk handling and throughout the technological processing. Using raw sheep's milk immediately after milking ($32 \pm 1^\circ\text{C}$) provides a bactericidal environment, which promotes the presence of bacteriocinogenic isolates (e.g., *Lactobacillus spp.*, *L. brevis*, *L. plantarum*, *L. casei*, and *L. buchneri*) exhibiting antimicrobial activity against strains such as *Escherichia coli* ATCC 25922, *Listeria innocua* ATCC 33090, and *Staphylococcus aureus* ATCC 25923 [14]. However, it remains essential to monitor specific microbiological indicators throughout the production process, as well as the technological parameters of the production environment.

4 Conclusion

A detailed analysis of the composition of milk, covering its chemical and microbial characteristics, along with the metabolites they produce, can provide valuable insights into the unique aroma and taste components that define the quality of traditional artisanal dairy products. Traditional artisanal sheep's cheese has the potential to become a product of guaranteed quality, serving as both a cultural and culinary identity marker with strong prospects for broader market accessibility. Future research will focus on optimizing technological parameters, selecting functional microbial cultures, and further improving the overall quality of the product.

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