DOI: 10.29050/harranziraat.1195205
Harran Tarım ve Gıda Bilimleri Derg. 2023, 27(2): 265-276

Research Article/Araştırma Makalesi

Some properties of semi-hard cheese made from cow's and goat's milk

İnek ve keçi sütünden yapılan yarı sert peynirin bazı özellikleri

Aslı ALBAYRAK KARAOĞLU[1*]

[1]Burdur Mehmet Akif Ersoy University, Dairy Products and Technologies Application and Research Center, Burdur.

[1]https://orcid.org/0000-0002-1636-148X

To cite this article:
Albayrak Karaoğlu, A. (2023). Some properties of semi-hard cheese made from cow's and goat's milk. Harran Tarım ve Gıda Bilimleri Dergisi, 27(2): 265-276.
DOI:10.29050/harranziraat.1195205

Address for Correspondence:
Aslı ALBAYRAK KARAOĞLU
e-mail:
aalbayrak@mehmetakif.edu.tr.

Received Date:
27.10.2022
Accepted Date:
23.03.2023

ABSTRACT

Goat's milk has been among the priority milk in consumer preferences, in recent years. It is an excellent food for children and adults due to its chemical composition and functional properties, and it can be easily consumed by individuals with cow's milk allergy. In the study, semi-hard type cheese was produced from cow's and goat's milk. Acidity, pH, fat, dry matter, ash, water activity, salt, color, protein, yield, organic acid and textural properties of cheeses were investigated. As a result of the analysis, it was determined that the titration acidity (% lactic acid), ash, total protein and value of cheese produced from goat's milk were higher. In terms of color, goat's cheese has a more matte appearance than cow's cheese, a* values are higher in semi-hard type cheese produced from goat's milk, and b* value is lower. The study determined that the firmness value of cheese produced from cow's milk was higher than that of goat cheese. In the study, 6 organic acids (oxalic acid, tartaric acid, formic acid, lactic acid, acetic acid and succinic acid) were determined. Formic, succinic and tartaric acid amounts were found higher in cheeses produced from goat milk. It was determined that the lactic acid level was designated the highest organic acid in cheese produced from both milk types. Cheeses produced from goat milk are more appreciated in terms of cross-sectional appearance and taste in sensory analysis. It is thought that semi-hard type cheeses can be produced from goat's milk can be an alternative to cheeses produced from cow's milk.

Key Words: Goat cheese, cow cheese, melting salt, texture, organic acid.

ÖZ

Keçi sütünün hem kimyasal bileşimi hem de fonksiyonel özelliği nedeniyle çocukların ve yetişkinlerin beslenmesinde mükemmel bir gıda olması ve inek sütü alerjisi olan bireylerce rahatlıkla tüketilebilmesi nedeniyle son yıllarda tüketici tercihlerinde öncelikli sütler arasında yer almaktadır. Çalışma da inek ve keçi sütünden yarı sert tip peynir üretilmiştir. Peynirin asitlik, pH, yağ, kurumadde, kül, su aktivitesi, tuz, renk, protein, randıman, organik asit ve tekstürel özellikleri incelenmiştir. Yapılan analiz sonucunda keçi sütünden üretilen peynirin titrasyon asitliği (% laktik asit), kül, toplam protein, değerinin daha yüksek olduğu tespit edilmiştir. Renk bakımından keçi sütü peyniri, inek sütü peynirine göre daha mat bir görünüme sahip olduğu, a* değerlerinin ise keçi sütünden üretilen yarı sert tip peynirde daha yüksek, b* değerinin ise daha düşük olduğu tespit edilmiştir. Yapılan çalışmada inek sütünden üretilen peynirin sıkılık değerinin keçi peynirine oranla daha yüksek olduğu tespit edilmiştir. Çalışmada 6 adet organik asit (okzalik asit, tartarik asit, formik asit, laktik asit, asetik asit ve süksinik asit) tespit edilmiştir. Formik, süksinik ve tartarik asit miktarlarının keçi sütünden üretilen peynirde daha yüksek olduğu tespit edilmiştir. Laktik asit düzeyinin peynirde de en yüksek oranda belirlenen organik asit olduğu belirlenmiştir. Duyusal analizlerde de kesit görünüş ve tat koku bakımından keçi sütünden üretilen peynirin daha çok beğeni aldığı görülmektedir. Yapılan analizler sonucunda keçi sütü kullanılarak yarı sert tip peynirin inek sütünden üretilen peynire alternatif olabileceği düşünülmektedir.

Anahtar Kelimeler: Keçi peyniri, inek peyniri, eritici tuzlar, tekstür, organik asit.

Introduction

Milk and its products are among the most important food groups that should be consumed in a healthy diet. Although cow's milk is preferred mostly, dairy products from goat, sheep and buffalo milk or their mixtures are also consumed widely. Goat's, sheep's and buffalo's kinds of milk are mostly used in local businesses or by the breeder by processing them into traditional products. According to TUIK (2021) data, 21370116 tons of cow's milk, 1143762 tons of sheep's milk, 622785 tons of goat's milk and 63643 tons of buffalo milk are produced in Turkey. The presence of goat milk comes right after cow and sheep milk. The amount of cheese produced is examined; 728777 tons of cheese from cow's milk, 1016 tons of cheese from sheep's milk, 236 tons of cheese from goat's milk and 159 tons of cheese from buffalo milk, and 24642 tons of cheese from a mixture of these milk. The soft type ones are produced the most among these cheeses. However, depending on the region, semi-soft, semi-hard, hard and extra-hard cheeses are also produced (Anonymous, 2021).

Cow and goat milk, which are the most produced and consumed in the world, constitute 85% and 12.3% of total milk production, respectively (Filipczak-Fiutak et al., 2021). Goat's milk has been among the priority milk in consumer preferences in recent years, so it is an excellent food for children and adults due to both its chemical composition and functional properties. It can be consumed by individuals with cow's milk allergy easily (Riberio and Riberio, 2010). Goat's milk products have an important place in providing product diversity due to their unique taste, smell, aroma and especially nutritional properties (Akan and Kınık, 2015).

The composition of products obtained from different types of milk also varies. Goat's milk contains more essential fatty acids, vitamins A and B, riboflavin, niacin, calcium, phosphorus, chlorine, magnesium, potassium and selenium than other milk. A significant buffering effect is observed in terms of high protein, non-protein nitrogen and phosphate (Metin, 2005; Şatır and Güzel Seydim 2010). Goat's milk of fat globule diameters are smaller (Metin, 2005). The amount of vitamin A is two or three times higher than other types of milk. The thyroid glands, which play a role in the conversion of carotene to vitamin A, work larger and faster in goats. For this reason, goat's milk and products are whiter (IDF 1986, Kosikowski and Mistry, 1997). Furthermore, it's low αs1-casein structure and easier digestibility of β-lactoglobulin, it is less allergenic than cow's milk (Güney and Kaymakçı, 1997). Goat milk is rich in the amino acids histidine, methionine, threonine and proline (Metin, 2005).

Technological processes affect product quality in the dairy industry significantly. When we examine goat milk technologically, goat's milk has a shorter fermentation time than other types of milk. (Metin, 2005). It contains high amount of β-casein, low amount of αs1-casein and high amount of non-protein nitrogen compounds. It is stated that this feature affects the ability to form clots. (Arslanbaş and Bodur, 2010). Goat's milk has a low cream binding ability. Because the fat globule diameters are very small, it prevents the separation of the fat. However, fat is easier to digest than other milk fats. Goat's milk is used in the production of special cheeses (Metin, 2005). In addition, goat's milk is a phosphate-rich form of milk. It will be an excellent source for removing the phosphate deficiency seen in people who do not consume meat or fish (Metin, 2005; Şatır and Güzel Seydim, 2010).

In recent years, researchers have evaluated it as a functional product due to its high nutritional value and importance in the nutrition of chronic patients (Riberio and Riberio, 2010). It is effective in the treatment of eczema, varicose veins, and asthma. (Kezer, 2013; Metin, 2005). In France, more than 90% of goat's milk is used in cheese production. Spain reports that it used to process goat, sheep, and cow's milk, but now only processes goat's milk (Güney, 2006).

In addition to soft type cheeses, semi-hard type goat cheese is processed in some private enterprises in our country. However, there is little information available about semi-hard cheeses produced industrially. For this reason, semi-hard type cheeses were produced from goat and cow milk with the help of melting salt suitable for industrial production. The chemical and textural properties and organic acid contents of these cheeses were investigated.

Material and methods

Material

Goat's milk and cow's milk were used to make two different kinds of semi-hard cheese. The milk was provided by the Dairy Processing facility affiliated with the Burdur Mehmet Akif Ersoy University Dairy Products and Technologies Application and Research Center, and the cheese was produced in the same facility. 2%(w/v) 40%(w/v) $CaCl_2$, lyophilized thermophilic starter cultures (Batch No: 022165, Italy) (*Lactococcus lactis subsp. lactis and Lactococcus lactis subsp. cremoris, Streptococcus thermophilus*), Chy-Max Plus 200 IMCU Rennet (1:15000), (Denmark), phosphate group melting salts (0,3% w/w) were used.

Methods

Semi-hard cheese making

The milk was heat treated at 68°C/15 minutes and cooled to 37-38°C. To make the milk suitable for industrial production, 2%(w/v) of 40%(w/v) $CaCl_2$ was added. Lyophilized thermophilic starter cultures were used in the study. Chy-Max Plus 200 IMCU Rennet (1:15000), (Denmark) was added to the milk in the amount determined by yeast strength analysis. The clot was cut into 2-3 cm^3 cubes using a cheese wire. The whey was separated from the clot after 15-20 minutes of waiting. The whey was then taken out with a coagulum press. The coagulum was heated to 40 °C until the acidity reached pH 5.80 and the serum was removed more quickly. The majority of the whey was then removed, and the curd's pH was reduced to 5.20.

After the curd reached the desired acidity level was crushed, was taken a kneading machine (İntermak, Türkiye), dry boiled process was applied by adding phosphate group melting salt into it (0.3 %w/w). The curd was transferred to mould which was 500 g by shaping, it was stored room temperature to yellow, was stored at +4°C for a night after removed from mould. Cheeses shaped were stored in polypropylene (PP) vacuum packaging.

Determination in both types of milk used in cheese production was designated by using Mettler Toledo (Switzerland) branded pH meter, %lactic acid amount titration method, fat analysis with Gerber principle, dry matter determination with gravimetric method, antibiotic determination (Anonymous, 2017).

The cheeses which were not ripened were analyzed after three days. The cheeses analyzed after three days were checked in terms of values. In order to determine values the following methods were used: pH determination of samples with Mettler Toledo (Switzerland) branded pH meter (Anonymous, 1983), % lactic acid amount titration method (Anonymous, 2000a), fat analysis with Gerber principle (Anonymous, 2000b), dry matter determination with gravimetric method (Anonymous, 2000a), salt determination (Anonymous, 2000c), ash determination (Anonymous, 1983), color determination using the Minolta CR-400 color device (Minolta Corp, Ramsey, NJ, USA), yield calculation (Van Slyke and Price, 1936; Mishra, 2006), determination of water activity values (aw) with a portable hygrometer (Novasina AG, CH 8853, Labswift aw, Lachen, Switzerland), Texture Profile Analysis with Stable Micro Systems Taxtplus C (UK) instrument.Texture analysis was performed using A/ECB Craft Knife and Fracture Wedge Set (A/WEG) probes in terms of firmness, hardness and brittleness parameters analyzed in hard-type cheeses. Protein determination was by using the Kjeldahl method according to the IDF method (Gripon et al.,1975). Sensory analysis was carried out with 10 panelists (Anonymous, 2016). Organic acids were determined according to Buffa et al. (2004). Five grams of sample was taken and then 25 ml of deionized water was mixed by ultraturrax for one minute. The tubes were left in the shaker at 250 rpm for 4 hours. After centrifuging the tubes at 1900 x g for 15 minutes, the samples were prepared for injection by passing them through a 0.45-micron filter. Organic acids were determined by using GL-7400 HPLC System, Column InertSustain C18(5 µm , 250x4,6mm I.D., Col., these parametres Temp. 40 °C, Detection UV 210nm (GL-PDA Detector), Injection Vol. 10 µl method (Tokyo, Japan). Statistical analysis data were analyzed using SPSS version 10.0 statistical program (SPSS, 1999). one-way analysis of variance was made using the ANOVA.

Result and discussion

Values of raw milk used in cheese production are given in Table 1.

Table 1. Some values of raw goat's and cow's milk used in cheese production

Parameters	Goat milk	Cow milk
pH	6.73±0,02	6.66±0,01
Titratable acidity (Lactic acid) %	0.17±0,01	0.18±0,01
Dry matter(%)	12.82±0,03	12.15±0,03
Fat (%)	3.90±0,01	3.70±0,01

Both types of milk were found to have a general average composition in terms of dry matter, fat, titration acidity, pH values, and the absence of antibiotics. The results were consistent with the Communiqué on Raw Milk and Heat Treated Drinking Milk (Anonymous, 2004).

Table 2 shows the chemical, biochemical, and yield values of semi-hard cheeses produced from goat's and cow's milk.

Table 2. Chemical, biochemical properties and yield ratios of cheese samples

Parameters	Goat's cheese	Cow's cheese
pH	5.49±0.01[a]	5.44±0.01[b]
Lactic acid %	1.04±0.05[a]	0.92±0.19[a]
Dry matter	57.72±0.53[a]	55.79±0.64[b]
Fat	22.75±1.41[b]	21.00±0.35[a]
Ash	3.90±0.06[a]	2.31±0.13[b]
Water activity	0.917±0.01[a]	0.915±0.01[a]
Salt	1.29±0.14[a]	1.35±0.12[a]
Protein	32.51±0.01[a]	28.57±0.01[b]
Yield calculation	10.38±0.01[a]	8.17±0.01[b]

a-b* Different letters indicate a significant difference in each line (p< 0.05).

It was determined that the statistical difference between the pH values of cheese varieties was significant ($p<0.05$). The titration acidity (% lactic acid) value of cheeses produced from goat's milk is higher. When the initial pH and lactic acid levels of the milk species were compared, the acidity development level was roughly the same in both types of milk. Salazar et al. (2018) determined the pH values of Gouda cheeses produced from raw and pasteurized cow's milk to be between 5.26 and 5.86, whereas the pH values of goat's milk cheeses were between 5.39 and 5.50. In the research conducted on Xinotyri cheese, the pH values of cheeses produced from raw and pasteurized goat milk were between 4.2-4.5 (Pappa et al., 2022). It was determined that the dry matter of semi-hard type cheeses produced from goat's milk was higher. Two cheese types produced from different kinds of milk were compared and there was a significant difference ($p<0.05$). According to Gambaro et al. (2017), the dry matter levels of 15 market goat cheeses range between 44.1 and 71.9 percent. According to a study that looked at the effect of carbon dioxide and oxygen gas permeability during the ripening of semi-hard type goat cheese, the dry matter values of the cheeses started at 53.96% and increased during storage (Darnay et al., 2019).

It has been determined that goat cheeses contain more fat. When the fat ratios of the milk used in the production of cheese were compared, it was determined that although the fat ratio of goat milk was high, the data of the two milk types did not show a statistically significant difference ($p>0.05$). The fat ratios of semi-hard cheese types produced from 100% goat and 100% cow milk range between 25.22% and 28.65%, with the lowest in cheese produced from 100% cow milk. In the study, the fat ratio of raw cow milk used to produce cheese was found to be between 3.59 and 3.82 percent, while it was between 3.27 and 3.28 percent for raw goat milk.(Shehan et al., 2009). According to our research, the fat rate in semi-hard type goat cheeses is higher due to the higher fat rate in raw goat milk. In addition, milk fat might vary depending on variables such as the type of animal, its nutrition, its age, and its lactation time (Metin, 2005). In a study that looked at the changes in ripening of Cheddar cheeses using different probiotic bacteria, the lowest fat value at the beginning of ripening was 31.71%, and the highest fat value at the end of ripening was 34.20%. There was no statistical difference between the fat ratios of the cheeses (Ong and Shah, 2009). According to a study on Maiorchino cheese, a semi-hard cheese produced from a mixture of goat and sheep milk, the fat level increased from 25.9% to 30.2% during the period of twenty-four months of storage (Conte et al., 2015).

Manuelian et al. (2020) searched at cheeses made from buffalo, goat, cow, and sheep's milk. The fat rate in soft goat cheeses was 17.12%, in hard sheep cheeses it was 31.42%, in semi-hard cow cheeses it was 27.31%, and in soft buffalo cheeses it was 22.59%. In the same study, Asiago cheese, a semi-hard type of cheese, had a fat ratio of 29.58%; Emmental cheese has a fat ratio of 24.5%; Fontina cheese has a fat ratio of 27.89%; Provolone cheese has a fat ratio of 28.94%; and Cheddar cheese has a fat ratio of 36.16%.

There was a statistically significant difference (p0.05) between these two cheeses. It is known that the salts that come naturally in milk and are added to the curd during production have a direct effect on the amount of ash in cheese. In a study that looked at the effects of storage conditions on semi-hard goat cheeses, the ash content of the cheeses ranged from 2.50% to 5.64% at the end of the 90th day of storage (Sumarmono et al., 2019). Analyses of Xinotyri Cheese, a hard cheese produced from both pasteurized and raw goat's milk, showed that the ash ratios in cheese made from raw goat milk started at 0.85% and reached 2.47% after 90 days of storage. After 90 days of storage, it was found to be 3.28% in cheese produced from pasteurized goat's milk. On the day it was made, it was 0.73% (Pappa et al., 2022).

There was no difference in salt rates because both types of cheese were made with the same salt types and amounts.

The total protein ratios of the cheeses were examined, and it was discovered that goat milk had 32.51% total protein and cow milk had 28.57% total protein. The distinction in total protein content between the cheeses was statistically significant ($p<0.05$). Emirmustafaoğlu and Coşkun (2012) found that the total protein values of Otlu cheeses made from a mixture of goat, cow, and both types of milk ranged between 18.46 and 22.74%, with goat cheese having the highest protein level. When the protein ratios of semi-hard type cheeses made from 100% cow, 100% goat milk, and mixed milk at different rates are examined, it is discovered that the protein ratio in cheese made from 100% goat milk is the highest (23.32%), and the protein ratio decreases as the cow's milk mixture ratio increases (Sheehan et al., 2009). The protein ratios of 15 different commercial semi-hard goat cheeses were found to be higher than other types of cheese, with values ranging from 21.4% to 32.1% (Gambaro et al., 2017).

According to Sumarmono et al. (2019), the protein content of goat cheeses was 15.98% at the start of ripening and 24.59% at the end of the 90 day storage period. Álvarez and Fresno(2021), looked at the physical and chemical properties of Palmero cheese made from goat's milk during the 90 day storage period. They found that the protein ratio changed from 26.98% to 31.37%. According to the researchers, this difference was statistically significant. Furthermore, it was stated that the β-casein/αs1-casein ratio in goat's milk is 70%/30% (Türkmen, 2017). The β-casein level in Xinotyri cheese, a hard type of goat cheese, was found to be higher than the αs1-casein level (Pappa et al., 2022).

The yield calculations of the semi-hard cheeses produced have been examined, and it has been determined that the yield rate of the goat milk cheese is higher. This distinction was also discovered to be statistically significant ($p<0.05$). There are two possible explanations for the high yield in cheese. A high fat-free dry matter ratio or casein ratio boosts yield (Matutinovi'c et al., 2021).

El-Zoughby (1998) determined the yield rates of Mozzarella cheese produced from various types of milk as follows: 11.62 kg/100 kg milk buffalo milk, 8.95 kg/100 kg milk cow's milk, 7.93 kg/100 kg milk goat milk, 10.50 kg/100 kg milk buffalo and cow's milk mix, 10.35 kg/ buffalo and goat milk. It was found to be 8.37 kg/100 kg of cow and goat milk in 100 kg of milk, and 9.15 kg/100 kg of buffalo, cow, and goat milk.

Zedan et al. (2014) said that the yield of fresh mozzarella cheese produced from a mix of buffalo and cow's milk (11.66 kg/100 kg milk) is higher than the yield of mozzarella cheese made from only cow's milk (10.66 kg/100 kg milk).The difference in yield was found to be caused by the fact that buffalo's milk has more fat, protein, and total dry matter than cow's milk.

In the study of Temizkan et al. (2014) found that the real and corrected yields of kashar cheese produced from sheep's milk were 13.77 kg/100 kg of milk and 12.31 kg/100 kg of milk, respectively. It has been determined that it is higher than the kashar cheese produced from cow's milk.

Facia et al. (2015) found that Fior di Latte cheese produced from a mixture of sheep and goat milk had a higher yield than cow's milk cheese.

Table 3. Color values of cheese samples

Sample name	Color Analysis		
	L*	a*	b*
Goat's cheese	82.76±0,01^{b}	0.24±0,01^{a}	10.82±0,01^{b}
Cow's cheese	85.42±0,01^{a}	0.17±0,01^{b}	11.36±0,01^{a}

a-b* Different letters indicate a significant difference ($p< 0.05$) in each column

The cheeses were color analyzed, and the CIE L*, a*, and b* values are shown in Table 3. Color in dairy products can be affected by the type of milk, fat and protein content, heat treatment, packaging material, and oxidation during storage.

The L* value represents the product's brightness level. The brightness of cow cheese was measured to be 85.42, and it was found that goat cheese was brighter. Cow's milk cheese was more clear than goat's milk cheese. In a color analysis of Panela cheese made from different concentrations of cow and goat's milk, it was found that the L* value went up as the cheese fully matured. This was because more goat's milk was used to make the cheese, which made the L* value go up. (Ram´ırez-L´opez and V´elez-Ruiz, 2018). According to Palmero goat's milk cheese, the L* value of 87.84 decreased during the ripening period, and the value decreased by 79.41 on the 90th day (Álvarez and Fresno, 2021).

a* values, which show the color change from red to green, were found to be higher in semi-hard goat's milk cheese. It is well known that dairy products made from goat milk have a higher a* value. This is attributed to free fatty acids, which differ in the structure of goat's milk (Egypto Queiroga et al., 2013).

Sheehan et al. (2009) found that goat's milk was linked to a higher a* value in cheeses made with only goat's milk or a certain amount of cow's milk.

Egypto Queiroga et al. (2013) conducted a color analysis of Coalho cheeses made from cow, goat, and their mixture milks, and discovered that goat milk cheese has the highest a* value. Sant'Ana et al. (2013) did a color analysis of Minas cheese made from goat's, cow's, and goat-cow mixed milk. They found that the cheese made from pure goat's milk had the highest a* value, followed by cheese made from a mix of both kinds of milk and cow's cheese.

It shows that the change in b* value, which shows the yellow-blue color scale, moves toward a yellowish color. The b* value in the milk of goats fed green feeds might be different. It has been said that the amount of carotene in milk changes depending on how it is fed, and that this has an effect on the product (Park, 2006; Lucas et al., 2008).

The fact that goat's milk contains more carotene than cow's milk is thought to influence the b* value. Furthermore, because the fat globule diameters in goat's milk are smaller and more evenly distributed, it reflects light more and creates the perception of a lighter color. This could explain why the b* value is lower than the value determined in cow cheese. The color analysis of Coalho cheese produced from a mixture of goat, cow, and both milk revealed that the cheese made from cow's milk had the highest b* value, while the cheese made from goat's milk had the lowest. The increase in these values has been attributed to proteolysis and the Maillard reaction (Egypto Queiroga et al.2013). Darnay et al. investigated the effects of different O^2/CO^2 permeability on the ripening of semi-hard cheeses (2019). The study determined the b* value to be 10.93, with the lowest value being 13.62.

Table 4. Texture analysis values of cheese samples

Parameters	Goat's Cheese	Cow's Cheese
Firmness	18.30±1.0^{a}	18.36.±148^{a}
Hardness	14.29±1.0^{a}	11.94±1.32^{b}
Brittleness	7.59±1.21^{b}	9.17±1.12^{a}

a-b* Different letters indicate a significant difference in each line (p< 0.05).

The chemical composition of the cheese, the size and distribution of the fat globule, the binding strength of the casein matrix, and the interactions in the protein matrix all effect the texture of the cheese (Hickey et al., 2015). The main factor was reported to be the heat treatment applied to the curd during the cheese making process. Cheeses heat-treated at high temperatures (45 °C) have a harder structure than cheeses produced at low temperatures (36 °C) (Aldalur et al., 2019). Cutting and penetration tests were performed on semi-hard cheeses produced from goat and cow milk. In penetration analysis, goat cheese was found to be harder in hardness values (Table 4).

According to Mallatou et al. (1994), brined white cheeses made from goat's milk are harder than those made from sheep's milk. The fact that the milk used to make cheese contains varying casein structures and varying fat ratios influences the rheological qualities of the cheese. According to reports, the difference in αs1-casein concentration between cow's milk and goat's milk also influences the acidity, storage, and protein aggregates of cheese (Ceballos et al., 2009).

Egypto Queiroga et al. (2013) discovered that the nutritional, textural, and sensory properties of Coalho cheeses produced from goat, cow, and their mixtures were higher in cheeses made from goat's milk.

In the study, the hardness value of cheese produced from cow's milk is higher than that of goat cheese. Miloradovic et al. (2018) examined the texture of cow and goat Quark cheeses produced using various heat treatments. It has been determined that goat milk cheeses are harder. This circumstance was discovered to be statistically significant ($p<0.05$). According to a study on Palmero cheese made from goat's milk, the hardness value began at 125 N and increased over the course of 90 days of ripening (Álvarez and Fresno, 2021).

The analysis determined that the fragility level of cow cheese was higher. The differences in fragility between cheeses were found to be statistically significant ($p<0.05$).

Statistically, there was no difference between goat cheese and cow cheese when it came to firmness. ($p<0.05$).

Organic acids play an important role in the composition and flavor of foods. Fermentation converts milk sugar (lactose) into organic acids (Öztek, 1985). Proteolysis, lipolysis, and glycolysis all have an impact on the taste and aroma of milk and its products. At the same time, some organic acids are recognized as indicators of starter culture development and bacterial control during cheese ripening (Park and Lee, 2006; Manolaki et al., 2006).

Table 5. Organic acid values of cheese samples

Organic acid (mg/L)	Retention time(minute)	Goat's cheese	Cow's cheese
Oxalic acid	2.687	11.43±0,39[b]	124.18±4.28[a]
Tartaric acid	2.985	233.58±8.06[a]	222.40±7.67[a]
Formic acid	3.274	957.75±33.04[a]	229.67±7.92[b]
Lactic acid	4.431	2040.03±70.37[a]	2278.67±78.60[a]
Acetic acid	4.871	79.45±2.74[b]	997.91±34.42[a]
Succinic acid	7.009	111.20±3.84[a]	63.48±2.19[b]

a-b* Different letters indicate a significant difference each line ($p < 0.05$).

In the study, 6 organic acids (oxalic acid, tartaric acid, formic acid, lactic acid, acetic acid and succinic acid) were determined. The amount of oxalic acid in goat cheese was discovered to be less than that in cow cheese. This distinction was discovered to be statistically significant ($p<0.05$).

The amount of tartaric acid in both cheeses was found to be approximately the same. The formic acid level in goat cheese was found to be higher, and the difference between cheeses was statistically significant ($p<0.05$). The lactic acid level was found to be higher in cow cheese, but it was not statistically significant ($p>0.05$). The amount of acetic acid in cow cheese was found to be higher than in goat cheese. It was found that this difference was statistically important ($p<0.05$). It was determined that the level of succinic acid was high in goat cheese. This difference was found statistically significant ($p<0.05$). The highest amount of lactic acid was found in cheeses made from both types of milk. The amount of formic acid and succinic acid in goat cheese was found to be much higher than in cow cheese.

Gambaro et al. (2017) looked at ripe and fresh goat cheeses and found that lactic acid had the highest level of organic acids. Park and Lee (2006) studied the impact of freezing on organic acids in plain soft Monterey Jack goat milk cheeses. The amount of lactic acid was at the highest level, followed by malic acid and tartaric acid. Furthermore, it can be stated that some organic acids are affected by storage time and temperature. Lactic acid is known to be an important flavor component in dairy products and is responsible for the sour/acidic taste (Chen et al., 2017).

In the study of Seçkin et al. (2011) different types of cheese produced from goat's milk were stored and examined the amount of organic acids. Lactic acid was found at the highest level, while pyruvic acid was found at the lowest level. It was observed that while citric and fumaric acid levels increased during storage, the amounts of malic, acetic, pyruvic and propionic acids decreased compared to the beginning of storage. Packaging methods and freezing process also reported that lactic acid levels were affected statistically.

In a study on Motal Tulum cheese, organic acid values of this cheese stored at different storage temperatures and in different packages were investigated (Andıç et al., 2010). It is stated that citric, lactic, formic, acetic and propionic acid contents, which increase during storage, are significantly affected ($p<0.05$). It is stated that organic acids other than butyric acid are significantly affected in terms of packaging parameters. Acetic acid can be produced from lactose, citrate and amino acids (Aston and Dulley, 1982).

Some bacteria use a fructose-6-phosphate to produce acetic and lactic acid from lactose. The fermentation pathway produces 3 moles of acetic acid and 2 moles of lactic acid for every 2 moles of glucose consumed (Scardovi and Trovatelli, 1965). According to some researchers, acetic acid causes a biting and sour taste in some cheeses as well as the vinegar smell (McSweeney and Sousa, 2000).

Tekin (2016) determined citric, pyruvic, uric, succinic, lactic, and formic acids in goat leather and canned Tulum cheeses. While lactic acid was found in the highest concentrations in cheeses, propionic, acetic, formic, citric, pyruvic, and uric acids were also found. Citric, succinic, and pyruvic acids decreased during storage while lactic, formic, acetic, propionic, and butanoic acids increased. On the 90th day of ripening, succinic acid increased twice as much in both Tulum cheeses as it did in fresh cheese.

Ong and Shah (2009) determined on Cheddar cheese, succinic and propionic acids after the 12th week. According to some other researchers, nonstarter lactic acid bacteria produce succinic and propionic acids (Ocando et al., 1993). It has been stated that succinic acid is formed from the breakdown of lactic acid, pyruvic acid, citric acid, isocitric acid and serine amino acid in cheeses. The amount of succinic acid in cheeses produced from milk with *Lactobacillus plantarum* added increased significantly when compared to cheeses made with *Lactobacillus paracasei* added. Furthermore, it was discovered that cheese storage and the total microflora of cheese affected the amount of succinic acid (Dudley and Steele, 2005; Skeie et al., 2008).

Formic acid levels in cheese have been found to rise during the ripening process. According to Tekin (2016), the level of formic acid in leather and tin Tulum cheese was similar, but it was detected at a slightly higher level in leather Tulum cheese, and the microbial activity in leather packaging was affected.

Gülcü (2008) said that grape juice has the most tartaric acid, which is often used to make things taste sour and sharp.

Lactate dehydrogenase can produce oxalic acid from pyruvate, and glycolate oxidase in plants can produce oxalic acid from glycolate. In his study on Sürk cheese, Güler (2014) determined the oxalic acid level to be 93.10 (mg/100g cheese). She speculated that oxalic acid could be derived from the plants used to produce cheese.

Table 6. Sensory analysis results of cheeses

Descriptive Analysis	Type of cheese	
	Goat's cheese	Cow's cheese
Section, appearance and Structure (18 points)	15.95±6,60	15.31±6,75
Color (7 points)	5.95±2,60	6.29±2,39
Taste and Smell (28 points)	25.91±10,60	26.20±10,88

Ten panelists assessed the sensory qualities of the cheeses. Goat cheese was found to have a higher structure and appearance score. It has been determined that goat cheeses are disliked because they are lighter in color. Goat cheeses have been found to be less appreciated in terms of taste and smell. It is believed that goat cheeses do not receive fewer points due to their strong aroma and the fact that the type of cheese produced is new.

Delgado et al. (2011) say that the flavor of cheese depends on several reactions, especially the metabolism of lactose and lactate, lipolysis, and proteolysis in the cheese matrix. Some researchers think that branched chain fatty acids could have a lot to do with the flavor of goat cheeses (such as 4-ethyl-octanoic and 4-methyloctanoic).

According to Morand-Fehr et al. (2004), fresh cheeses have a less pronounced caprine flavor, making them more appealing to most consumers. The same researchers emphasize that using hygienic practices during milking can reduce the development of disagreeable taste in goat's milk cheeses during storage due to a decrease in lipolysis caused by contaminating bacteria, specifically lipase producers.

Egypto Queiroga et al. (2013) found that cheeses produce with goat's milk were less appealing to the senses. Mixing goat's milk with cow's milk made the cheeses more appealing to the senses.

Conclusions

So, in this study, it was thought that semi-hard cheeses made with goat's milk could be a good alternative to cheeses made with cow's milk.

There are chemical, biochemical, sensory, and textural differences between cheeses made from cow's milk and cheeses made from goat's milk. At the end of the research, it was found that semi-hard cheeses made from goat's milk are better in terms of cross-section, appearance, taste, and smell than cheeses made from cow's milk. People think that goat milk can be a good raw material for making semi-hard cheeses, which are thought to be good in terms of how they work. So it will help the dairy industry make more cheeses from different kinds of milk, and more goat milk will be used as a raw material. It will add to what is known about how to take care of cheeses made from different kinds of milk.

Acknowledgments

I would like to thank Burdur Mehmet Akif Ersoy University, Dairy Products and Technologies Application and Research Center, where the laboratory infrastructure is used.

Conflict of interest: I declare that there is no conflict of interest.

Author Contributions: AAK designed the study, set up the trial, conducted the study, analyzed the data, and wrote the article.

References

Akalin, A.S., Gonc, S., & Akbas, Y. (2002). Variation in organic acids content during ripening of pickled white cheese. *J. Dairy Sci.,* 85, 1670–1676.

Akan, E., & Kınık, Ö. (2015). Keçi Sütü Kalitesinde Yeni Gelişmelere Bir Bakış. *Gıda ve Yem Bilimi - Teknolojisi Dergisi / Journal of Food and Feed Science - Technology*, 15, 34-45.

Aldalur, A., Ong, L., Bustamante, M. A., Gras, S. L. & Barron, L. J. R. (2019). Impact of processing conditions on microstructure texture and chemical properties of model cheese from sheep milk. *Food and Bioproducts Processing*, 116, 160-169.

Álvarez, S., & Fresno, M. (2021). Effect of the Ripening Period and Intravarietal Comparison on Chemical, Textural and Sensorial Characteristics of Palmero (PDO) Goat Cheese. *Animals,* 11, 58. DOI: https://doi.org/10.3390/ani11010058

Andiç, S., Tunçtürk, Y., & Gençcelep, H. (2010). Dondurarak Depolama Ve Vakum Ambalajlamanın Motal Peynirinde Lipoliz Ve Organik Asit Değişimi Üzerine Etkisi. *Gıda*, 36(6), 423-430.

Anonymous (1983). *Gıda maddeleri muayene ve analiz metotları.* TC Tarım, Orman ve Köyişleri Bakanlığı, Koruma ve Kontrol Genel Müdürlüğü, Ankara.

Anonymous (2000a). *AOAC Offical Method 926.124. Acidity of Cheese.* Titrimetric Method. Official Methods of analysis of AOAC International, Vol. 2, 17th ed., Gaithersburg, USA.

Anonymous (2000b). AOAC, *Official Methods of Analysis of AOAC International, vol. 2*, 17th edn., Association of Official Analytical Chemists, Maryland, USA, 2000.

Anonymous (2000c). *AOAC Official method 975. 20. Salt in cheese*. Official Methods of Analysis of AOAC International, Vol:2, 17th ed., Gaithersburg, USA. 163.

Anonymous (2004). *Türk Gıda Kodeksi Yönetmeliği Çiğ Süt Ve Isıl İşlem Görmüş İçme Sütleri Tebliği*. Tebliğ no: 2019/12, Ankara.

Anonymous (2016). *Kaşar peyniri standardı*, TS 3272, Türk Standartları Enstitüsü, Ankara.

Anonymous (2017). *Süt ve İşlem Görmüş Süt Ürünleri Standardı*, TS 1018, Türk Standartları Enstitüsü, Ankara.

Anonymous (2021). https://biruni.tuik.gov.tr/bolgeselistatistik/tabloOlustur.do#.

Arslanbaş, E., & Bodur, AE. (2010). Türkiye'de Süt Keçisi Yetifltiriciliği Ve Modern Süt Bilimi Bakış Açısıyla Keçi Sütünün Değerlendirilmesi. *Ulusal Keçicilik Kongresi*, (pp. 442, 24-26 Haziran), Çanakkale, Türkiye.

Aston, J.W., & Dulley, J. R. (1982). Cheddar cheese flavour. *Australian Journal of Dairy Technology*, 47, 59–64.

Bevilacqua, A.E., & Califano, A.N., (1989). Determination of organic acids in dairy products by high-performance liquid chromatography. *J. Food Sci*. 54, 1076–1079.

Buffa, M., Guamis, B., Saldo, J., Turijillo, A.J. (2004): Changes in organic acids during ripening of cheeses made from raw, pasteurised or high-pressure treated goats milk. *Lebensm. Wiss. Tech., 37*, 247-253.

Ceballos, L. S., Morales, E. R., Adarve, G. T. A., Castro, J. D., Martínez, L. P., & Sampelayo, M. R. S. (2009). Composition of goat and cow milk produced under similar conditions and analyzed by identical methodology. *Journal of Food Composition and Analysis*, 22, 322-329.

Chen, C., Zhao, S., Hao, G., Yu, H., Tian, H., & Zhao, G., (2017). Role of lactic acid bacteria on the yogurt flavour: A review. *International Journal of Food Properties*, 20, 316–330.

Conte, F., Ravidà, A., Mandanici, A., Ferrantelli, V., Chetta, M., & Verzera, A. (2015): Maiorchino cheese: physicochemical, hygienic and safety characteristics. *Italian Journal of Food Safety*, volume 4, 4532.

Darnay, L., Németh, A., Koncz, K., Monspart-Sényi, J., Pásztor-Huszár, K., Friedrich, L., & Laczay, P. (2019). Effect of different O^{2}/CO^{2} permeable foils on aging of semi-hard goat cheese. *International Dairy Journal*, 90, 114-118.

Delgado, F. J., González-Crespo, J., Cava, R., & Ramírez, R. (2011). Effect of high-pressure treatment on the volatile profile of a mature rawgoat milk cheese with paprika on rind. *Innovative Food Science and*

Emerging Technologies, 12, 98-103.

Dudley, E. G. & Steele, J. L., (2005). Succinate production and citrate catabolism by Cheddar cheese nonstarter lactobacilli. *Journal of Applied Microbiology*, 98, 14-23.

Egypto Queiroga, R.C., Santos, B.M., Gomes,A.M.P., Monteiro, M.J., Teixeira, S.M., Souza, E.L., Dias Pereira, C.J., & Estevez Pintado, M.M. (2013). Nutritional, textural and sensory properties of Coalho cheese made of goats', cows' milk and their mixture. *LWT - Food Science and Technology*,50, 538-544.

El-Zoghby, A.S. (1988). *Technological studies on hard cheese*. M.Sc Thesis. Fac, of Agric., Zagazig Univ., Egypt.

Emirmustafaoğlu, A., Coşkun, H. (2012). Keçi Sütü, Inek Sütü Ve Bu Sütlerin Karışımından Yapılan Otlu Peynirlerde Olgunlaşma Boyunca Meydana Gelen Değişmeler. *Gıda*, 37(4), 211-218.

Faccia, M., Trani, A., Gambacorta, G., Loizzo, P., Cassone, A., & Caponio, F. (2015). Production technology and characterization of Fior di latte cheeses made from sheep and goat milks. *J. Dairy Sci.* 98: 1402–1410. DOI:http://dx.doi.org/10.3168/jds.2014-7953

Filipczak-Fiutak, M., Pluta-Kubica, A., Domagała, J., Duda, I., & Migdał, W. (2021). Nutritional value and organoleptic assessment of traditionally smoked cheeses made from goat, sheep and cow's milk. *PLoS ONE*, 16(7), 1–16. DOI:https://doi.org/10.1371/journal.pone.0254431

Gambaro, A., Gonzalez, V., Jimenez, S., Arechavaleta, A., Irigaray, B., Callejas, N., Grompone, M., & Vieitez, I. (2017). Gambaro Chemical and sensory profiles of commercial goat cheeses. *International Dairy Journal*, 69, 1-8.

Gripon, J.C., Desmazeaud, M.J., Le Bars, D., & Bergere, J.L. (1975): Etude du rôle des micro-organismes et des enzymes au cours de la maturation des fromages II. - Influence De La Presure Commerciale. *Le Lait*, 548, 502-516.

Gülcü, M. (2008). *Durultmaya Yardımcı Maddelerin Üzüm Suyu Kalitesi Üzerindeki Etkileri.* Namık Kemal Üniversitesi, Fen Bilimleri Enstitüsü Gıda Müh. Anabilim Dalı, Tekirdağ.

Güler, Z. (2014). Profiles of Organic Acid and Volatile Compounds in Acid-Type Cheeses Containing Herbs and Spices (Surk Cheese). *International Journal of Food Properties*, 17:6, 1379-1392. DOI: 10.1080/10942912.2012.697957

Gün, İ. (2012). *Alternatif Kılıf Uygulamalarının Tulum peynirinin Bazı Nitelikleri Üzerine Etkileri.* Süleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü Gıda Mühendisliği Anabilim Dalı Doktora Tezi, Isparta.

Güney, O., & Kaymakçı, M. (1997). *Keçilerde Süt Üretimi*. Keçi Yetiştiriciliği, Kaymakçı M (baş editör), Bornova, İzmir, Türkiye, s. 83-92.

Güney, O. (2006). *Röportaj,* Hasad Hayvancılık, 255: 14-17.

Hickey, C. D., Auty, M. A. E., Wilkinson, M. G. & Sheehan, J. J. (2015). The influence of cheese manufacture parametres on cheese microstructure, microbial localisation and their interactions during ripening. A review. *Trends in Food Science & Technology*, 41, 35-148.

IDF (International Dairy Federation), (1986). Cheese and Processed Cheese Products. Determination of Fat Contents. IDF Standard 5B. Brussels. BE.

Kezer G., 2013. *İnek ve Keçi Sütü Karışımından Yapılan Kefirlerin Fizikokimyasal, Mikrobiyal ve Duyusal Özellikleri Üzerine Yağ İkame Maddelerinin Etkisi*.Yüksek Lisans Tezi, Ondokuz Mayıs Üniversitesi Fen Bilimleri Enstitüsü Gıda Mühendisliği Anabilim Dalı, Samsun.

Kosikowski, F.V., Mistry, V.V. (1997). *Cheese and Fermented Milk Foods*, Vol. 1. Westport CT 06880: F V Kosikowski LLC, 729.

Lucas, A., Rock, E., Agabriel, C., Chilliard, Y., & Coulon, J. B. (2008). Relationships between animal species (cow versus goat) and some nutritional constituents in raw milk farmhouse cheeses. *Small Ruminant Research*, 74, 243-248.

Mallatou H., Pappas CP., &Voutsinas LP (1994): Manufacture of feta cheese from sheep's milk, goats' milk or mixtures of these milks. *International Dairy Journal* Volume 4, Issue 7, p:641-664.

Manolaki, P., Katsiari, M.C., &Alichanidis, E. (2006). Effect of a commercial adjunct culture on organic acid contents of low-fat Feta-type cheese. *Food Chem*, 98, 658-663.

Manuelian, C.L, Currò, S., Penasa, M., Cassandro, M., & Marchi, M De. (2020). Characterization of major and trace minerals, fatty acid composition, and cholesterol content of Protected Designation of Origin cheeses. *Journal of Dairy Science Vol*. No. 5, 100:3384–3395. DOI: https://doi.org/10.3168/jds.2016-12059

Marsili, R.T. (1985). Monitoring chemical changes in Cheddar cheese during aging by high-performance liquid chromatography and gas chromatography techniques. J. *Dairy Sci.,* 68, 3155–3161.

Matutinovi´c, S., Rako, A., Tudor Kalit, M., & Kalit, S. (2021). Influence of the Ratio of Sheep and Cow Milk on the Composition and Yield Efficiency of Le´cevaˇcki Cheese. *Fermentation, 2021*, 7, 274. DOI: https://doi.org/10.3390/fermentation7040274

Morand-Fehr, P., Boutonnet, J. P., Devendra, C., Dubeuf, J. P., Haenlein, G. F. W., &Holst, P. (2004). Strategy for goat farming in the 21st century. *Small Ruminant Research*, 51, 175-183.

Metin, M. (2005). *Süt Teknolojisi-Sütün Bileşimi ve İşlenmesi*. Ege Üniv Mühendislik Fakültesi Yayınları, İzmir, Türkiye.

McSweeney, P. L. H. & Sousa, M. J., (2000). Biochemical pathways for the production of flavourcompounds in cheeses during ripening: A review. *Lait,* 80, 293-324.

Miloradovic, Z., Miocinovic, J., Kljajevic, N., Tomasevic, I., & Pudja, P. (2018). The influence of milk heat treatment on composition, texture, colour and sensory characteristics of cows' and goats' Quark-type cheeses. *Small Ruminant Research,* 169,154–159.

Mishra, R., (2006). *Study of Rheological, Physical and Microstructural Changes During Rennet- İnduced Gelation and Their İmpact on Cheese Yield and Texture*. University of Wisconsin-Madison, Doctor of Philosophy (Food Science), ABD, 270 s.: Umi number: 3234535.

Ocando, A. F., Granados, A., Basanta, Y., Gutierrez, B., & Cabrera, L. (1993). Organic acids of low molecular weight produced by lactobacilli and enterococci isolated from Palmita-type Venezuelan cheeses. *Food Microbiology*, 10(1), 1–7.

Ong, L., & Shah, N.P. (2009). Probiotic Cheddar cheese: Influence of ripening temperatures on survival of probiotic microorganisms, cheese composition and organic acid profiles. *Food Science and Technology, 42,* 1260–1268.

Öztek, L. (1985): Organik Asitlerin Önemi ve Peynirin Kalitesi Üzerine Etkileri. *Gıda, 1*0(4), 247-254.

Pappa, E.C., Bontinis, T.G., Samelis, J., Sotirakoglou, K. (2022). Assessment of the Microbiological Quality and Biochemical Parameters of Traditional Hard Xinotyri Cheese Made from Raw or Pasteurized Goat Milk. *Fermentation*, 8, 20. DOI: https://doi.org/10.3390/

Park, Y. W. (2006). Goat milk-chemistry and nutrition. In Y. W. Park, &G. F. W. Haenlein (Eds.), *Handbook of milks of non-bovine mammals (pp. 34-58).* Ames, IO, USA: Blackwell Publishing.

Park, Y.W., & Lee, J.H. (2006). Effect of freezing on organic acid contents and lipolytic index of plain soft and Monterey Jack goat milk cheeses. *Small Ruminant Res*, 63, 58–65.

Ram´ırez-L´opez, C., & V´elez-Ruiz, J.F. (2018). Effect of Goat and Cow Milk Ratios on the Physicochemical, Rheological, and Sensory Properties of a Fresh Panela Cheese. *Journal of Food Science,* Vol. 83, Iss. 7, 2018.

Riberio, A.C., & Riberio, S.D.A. (2010). Specialty products made from goat milk. *Small Ruminant Research,* 89(2-3), 225-233.

Salazar, J.K., Carstens, C.K, Ramachandran, P., Shazer., S.S, Narula., Reed, E., Ottesen, A., & Schill, K.M. (2018). Metagenomics of pasteurized and unpasteurized gouda cheese using targeted 16S rDNA sequencing. *BMC Microbiology*, 18,189. DOI:https://doi.org/10.1186/s12866-018-1323-4

Sant'Ana, A.M.S., Bezerril, F.F., Madruga, M.S., Batista, A.S.M., Magnani, M., Souza, EL., & Queiroga, R.C.R.E.V. (2013). Nutritional and sensory characteristics of Minas fresh cheese made with goat milk, cow milk, or a mixture of both. *J. Dairy Sci.,* 96, 7442–7453. DOI: http://dx.doi.org/ 10.3168/jds.2013-6915

Scardovi, V., & Trovatelli, L. D. (1965). The fructose-6-phosphate shunt as a peculiar pattern of hexose degradation in the genus Bifidobacterium. *Analytical Microbiology Enzymology,* 15, 19–27.

Seçkin, AK., Kizilirmak Esmer, Ö., Balkir, P., & Günç Ergönül, P. (2011). Effect of curd freezing and packaging methods on the organic acid contents of goat cheeses during storage. *Mljekarstvo*, 61 (3), 234-243.

Sheehan, J.J., Drake, M.A., & Mcsweenwy, P.L.H. (2009). Effect of partial or total substitution of bovine for caprine milk on the compositional, volatile, nonvolatile and sensory characteristics of semi-hard cheeses. *International Dairy Journal*, 19, 498-509.

Skeie, S., Kieronczyk, A., Naess, R. M., & Qstlie, M. (2008). Lactobacillus adjuncts in cheese: Their influence on the degradation ofcitrate and serine during ripening of a washed curd cheese. *International Dairy Journal*, 18, 158-168.

SPSS (1999). SPSS software, version 10.0, Chicago, IL.

Sumarmono, J., Setyawardani, T., & Santosa, S.A. (2019). Effect of Storage Conditions on the Characteristics and Composition of Fresh Goat Cheese Containing Probiotics. *Animal Production*, 21(1), 56-63.

Şatır, G., Güzel-Seydim, Z. (2010). Keçi Sütünün Fonksiyonel Bileşenleri. *Ulusal Keçicilik Kongresi, (pp. 442), 24-26 Haziran,* Çanakkale, Türkiye.

Tekin A (2016). *Keçi Derisi ve Bidonda Olgunlaştırılan Koyun (Karaman) Tulum Peynirlerinde Biyokimyasal ve Duyusal Nitelikler*. Yüksek Lisans Tezi, HMKÜ Fen Bil. Ens., Gıda Mühendisliği ABD, p:127.

Temizkan, R., Yasar, K., & Hayaloglu, A.A. (2014). Changes during ripening in chemical composition, proteolysis, volatile composition and texture in Kashar cheese made using raw bovine, ovine or caprine milk. Int. *J. Food Sci. Technol.*, 49, 2643–2649.

Türkmen, N. (2007). Nutritional Value and Health Benefits of Goat Milk Components. In Watson, R.R., R. Collier R.J. & Preedy, V.R. (Eds.), *Nutrients in Dairy and Their Implications for Health and Disease*. (pp.441-449). Academic Press, Issue number:1.

Van Slyke, L. L., & Price, W, V., (1936). *Cheese*. Orange Judd Publ. Co., Inc., New York, NY.

Zedan I.A, Abou-Shaloue Z., Zaky S.M., (2014). Quality evaluation of Mozzarella cheese from different milk types. *Alexandria Sci ExcJ*., 35, p:162–177.