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DETERMINATION OF QUALITY PROPERTIES OF TRADITIONAL ADIYAMAN CHEESE PRODUCED FROM SHEEP MILK

Leyla EREN KARAHAN[1*], Aslı ÇELİKEL GÜNGÖR[2], Musa Serdar AKIN[3], Mutlu Buket AKIN[4], Huriye Gözde CEYLAN[5]

[1-5]Adıyaman Üniversitesi, Mühendislik Fakültesi, Gıda Mühendisliği Bölümü, Adıyaman, 02040, Türkiye
[2] Mardin Artuklu Üniversitesi, Turizm Fakültesi, Gastronomi ve Mutfak Sanatları Bölümü, Mardin, 47200,Türkiye
[3-4] Harran Üniversitesi, Mühendislik Fakültesi, Gıda Mühendisliği Bölümü, Şanlıurfa, 63050, Türkiye
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ABSTRACT

In this study, 60 fresh Adıyaman cheeses produced from sheep's milk by traditional method in Adıyaman were collected in April, May, June and July. Physicochemical, textural and microbiological properties of cheese samples were examined. Physicochemical and textural properties of Adıyaman cheeses showed a wide distribution in generally. Dry matter, fat, fat in dry matter, protein, protein in dry matter, hardness, gumminess, cohesiveness, and L^* values were 47.49±2.35%, 22.05±2.20%, 19.81±2.85%, 41.75±5.82%, 6047.83±5968.86 g, 5018.91±5151.70, 0.83±0.04, and 88.37±2.35 respectively and the difference between these values of the samples belonging to different months were found significant ($p<0.05$). The presence of yeast-mold, *Staphylococcus aureus*, coagulase positive *Staphylococcus aureus* (53.33%) and *Escherichia coli* (50%) were determined in Adıyaman cheese, while the presence of *Brucella* spp., *Salmonella* spp., and *Listeria monocytogenes* were not determined.

Keywords: *Adıyaman cheese; sheep milk; physicochemical properties; textural properties; microbiological properties*

KOYUN SÜTÜNDEN ÜRETİLMİŞ GELENEKSEL ADIYAMAN PEYNİRİNİN KALİTE ÖZELLİKLERİNİN BELİRLENMESİ

ÖZET

Bu çalışmada Adıyaman ilinde geleneksel yöntemle koyun sütünden üretilen 60 adet taze Adıyaman peyniri Nisan, Mayıs, Haziran ve Temmuz aylarında toplanmıştır. Peynir örneklerinin fizikokimyasal, tekstürel ve mikrobiyolojik özellikleri incelenmiştir. Adıyaman peynirlerinin fizikokimyasal ve tekstürel özellikleri genel olarak geniş bir dağılım göstermiştir. Kurumadde, yağ, kurumaddede yağ, protein, kurumaddede protein, sertlik, sakızımsılık, iç yapışkanlık ve L^* değerleri sırasıyla 47.49±2.35%, 22.05±2.20%, 19.81±2.85%, 41.75±5.82%, 6047.83±5968.86 g, 5018.91±5151.70, 0.83±0.04 ve 88.37±2.35 ve farklı aylara ait örneklerin kurumadde, yağ, kurumaddede yağ, protein, kurumaddede protein, sertlik, sakızımsılık, iç yapışkanlık ve L^* değerleri arasında görülen fark önemli bulunmuştur ($p<0,05$). Mikrobiyolojik analizlerde Adıyaman peynirinde maya-küf, *Staphylococcus aureus*, koagulaz pozitif *Staphylococcus aureus* (%53.33) ve *Escherichia coli* (%50) tespit edilirken *Brucella* spp., *Salmonella* spp. ve *Listeria monocytogenes* belirlenmemiştir.

Anahtar Kelimeler: *Adıyaman peynir; koyun sütü; fizikokimyasal özellik; tekstürel özellik; mikrobiyolojik özellik*

*e-posta[1] : lkarahan@adiyaman.edu.tr ORCID ID: https://orcid.org/0000-0003-0242-0167 (Sorumlu Yazar)
e-posta[2] : aslicelikel@artuklu.edu.tr ORCID ID: https://orcid.org/0000-0003-0583-295X
e-posta[3] : sakin@harran.edu.tr ORCID ID: https://orcid.org/0000-0001-7569-1983
e-posta[4] : mutluakin@harran.edu.tr ORCID ID: https://orcid.org/0000-0001-8307-8521
e-posta[5] : hgyildiz@adiyaman.edu.tr ORCID ID: https://orcid.org/0000-0001-7363-554X

1. Introduction

Adıyaman cheese, which is widely consumed especially in the Southeastern Anatolia region, has an important share among traditional cheeses. Raw sheep, cow, goat and/or mixed milks are generally used in the production of Adıyaman cheese, and the cheese curd is pressed on special strainers made of straw. Pressed cheeses are kept in boiled water or whey. Optionally, salt is added to the water or whey at this stage. Cheese can be consumed fresh, as well as matured by dry salting or brine method [1, 2].

Fresh raw sheep milk

↓

Addition of rennet (32-36°C)

↓

Coagulation (60-90 min) and curd cutting

↓

Straining the curd by taking it into a cloth bag

↓

Pressing the cloth bags by compressing them between the straws

↓

Boiling whey and obtaining curd

↓

Waiting of cheeses in boiling whey (shuji operation) (10 min)

↓

Second filtration on the straws

↓

Dry salting

↓

1-2 days drying

↓

Fresh consumption or ripening in brine

Figure 1. The flow chart of Adıyaman cheese production [2]

The production of Adıyaman cheese (figure 1) is carried out without a standard production method and a significant portion of it is carried out at homes. For this reason, it is important to determine the general composition, quality characteristics and conditions of standard product production of traditional Adıyaman cheese, which is consumed intensively in the region. In addition, the lack of hygienic conditions in the production and storage conditions may cause recontamination and create a risk in terms of public health. In this case, Adıyaman cheese is considered as a dairy product open to microbiological contamination due to its production method and storage conditions.

Traditional cheeses occupy a special place among traditional foods. For this reason, it is important to preserve the characteristic taste-aroma and texture etc. properties of traditional products, to bring

these products to the industry and to standardize their production. Traditional cheeses individually have their unique chemical and sensory qualities, particularly taste, texture and appearance [3]. In addition, seasonal conditions, race, nutrition and feed, which are effective in the composition of milk, affect the properties of cheese [4, 5]. For this reason, various studies have been carried out in recent years to determine the characteristics of traditional cheeses [2, 6, 7].

In our study, the physical, chemical and microbiological properties of Adıyaman cheese produced by the traditional method during the lactation period were investigated. It was aimed to determine the quality characteristics of Adıyaman cheese and to reveal the seasonal differences that may occur in production. Furthermore, it is needed to contribute to the transfer of cheese production to the industry by standardizing it, and to determine the level of good hygiene practice in production. The data obtained in the study is an important resource for industrial production operators, public health officials and other researchers.

2. Materials And Method

In our study, 60 fresh cheese samples produced traditionally from sheep's milk in Adıyaman province were used. Adıyaman cheese is sold fresh in markets without brine. In April, May, June and July, each sample was placed into 500 g sterile jars without brine and brought to the laboratory under cold chain on the same day. The samples taken were subjected to physical, chemical and microbiological analysis. In the study, considering the changes that may occur in the properties of the milk used in cheese production at the beginning and end of the lactation period, the months of March and August during the lactation period were excluded.

2.1. Physicochemical Analysis

The pH values of the cheese samples were determined by using a digital pH meter (Mettler Toledo – even Compact pH meter S210) and the titration acidity values were determined according to the alkali titration method [8], and the titration acidity results were expressed as % lactic acid. Total dry matter content of cheese samples was determined by International Dairy Federation (IDF) [9], ash content by AOAC (Association of Official Analytical Chemist) [10] method, fat content by gerber method [11] and the salt content was determined according to Mohr titration EN ISO 5943 [12]. The total nitrogen (TN) contents of the samples were determined according to the Dumas method [13]; The determined value was multiplied by 6.38 and the percentage of total protein content and the ratio of total protein in dry matter were calculated as % protein content in dry matter. The amount of water-soluble nitrogenous matter in cheese samples was prepared according to Kuchroo and Fox [14] and determined by the Dumas method [13]. The degree of maturation of the samples was determined according to the total nitrogen and the amount of water-soluble nitrogen content [15].

The color characteristics of the cheeses were determined using the Konica minolta (CR-400 chroma meter, Tokyo, Japan) model color analyzer and the CIE (International Comission on Illumination) color measurement system [16].

Texture profile analysis of cheeses using TA-XT2 (Stable Micro Systems Ltd., Surrey, UK) P/36R aluminum cylinder probe (36 mm diameter), load cell 30 kg, test speed 2 mm/sec, pre-test speed 1.0 mm/ sec, post-test speed was 5 mm/sec, the strain was 20%, trigger force was 5 g and waiting time was 5 sec. [17]. The hardness, springiness, gumminess, cohesiveness, adhesiveness, resilience and chewiness properties of the samples were determined.

2.2. Microbiological Analysis

After mixing the cheese sample taken according to TS EN ISO 707 [18], 10 g sample were diluted in 90 ml of 0.1% peptone water (Merck, Germany) for initial dilution, and subsequent decimal dilutions

up to 10^{-6} were prepared with the same diluent and appropriate dilutions were taken and inoculated petri plates prepared for the microorganisms to be investigated.

In order to determine the number of yeast-mold in cheeses, DG-18 agar medium (Merck 1.04092, Germany) was inoculated according to ISO 21527-1 spread plate method [19]. After 5-7 days of incubation at 25° C, the numbers of yeast and mold colonies were determined by counting on plates.

In order to search for *Staphylococcus aureus* in the samples, they were inoculated on Baird-Parker Agar (OXOID CM 0275, UK) by mixing 5% Egg Yolk-Tellurite Emulsion and incubated at 37°C for 24-48 hours under aerobic conditions [20]. After incubation, bright, black colored colonies (positive for tellurite reaction) without halos (atypical) and with a halo around them (positive for egg yolk or lecitinase reaction) were evaluated as (typical) *S. aureus*. Catalase and Microgen Staph Latex Agglitunation (Microgen Bioproducts, M43CE) tests were applied to the determined samples, and the number of coagulase positive *S. aureus* on the plates that gave positive results in these tests was determined [21].

The classical culture technique reported in ISO 6579-1 standard was used to search for *Salmonella* spp. in the samples examined in the research [22]. Suspicious colonies were confirmed using the Microgen GN A + B - ID assay kit.

The EN-ISO 11290-1 method was used for the determination and identification of *Listeria monocytogenes* [23]. Suspicious colonies were tested for confirmation using the Microgen Listeria ID Kit. *L. monocytogenes* ATCC 19118 was used as positive control.

The ISO 16649-2 method was used to search for *Escherichia coli* in the samples [24]. *E. coli* (ATCC 25922) for positive control and *S. aureus* (ATCC 25923) for negative control were used in the study.

The presence of *Brucella* spp. in cheese samples was determined using the Brucella coombs gel test along with their titer ratios [25]. Positive samples were identified with the Vitek II System (Vitek-2 Compact, Biomerieux, France).

2.3. Statistical analysis

All data were analyzed with the One-way ANOVA, followed by Tukey's HSD post hoc test using statistical package for social studies software “SPSS” version Statistics 21.0 (IBM SPSS Inc., U.S.A. Significance differences were determined at 95% significance level.

3. Results and Discussions

3.1. Physicochemical Properties

Physicochemical properties of traditional Adıyaman cheese were shown in Table 1. It was determined that the pH values of the cheese samples were between 5.07 and 7.10 and the titration acidity [lactic acid % (w/w)] values were between 0.05 and 0.69%. It is noted that a significant effect among pH and titration acidity values of the samples examined were not obtained statistically ($p>0.05$). Keskin and Çelik [26] determined that the pH and acidity values of traditional Leaf cheeses produced from sheep milk are 5.08 and 0.11% respectively. The dry matter content of Adıyaman cheese varied between 43.31% and 70.66%. It was determined that the dry matter content of the samples increased during the lactation period and the difference between the months examined in the study was statistically significant ($p<0.05$). It is thought that this change in the dry matter content of cheeses is due to the difference in the composition of sheep milk used in production and the lack of a standard production method in cheese production.

Table 1. Physical and chemical properties of Adıyaman cheese (n=15)

	April	**May**	**June**	**July**
	Minimum-maximum	Minimum-maximum	Minimum-maximum	Minimum-maximum
	Mean±std	**Mean±std**	**Mean±std**	**Mean±std**
pH	5.57-7.10	5.64-6.93	5.07-6.82	5.62-6.89
	6.12 ±0.39	**6.21±0.36**	**6.08±0.51**	**6.17±0.45**
Acidity (%LA.)	0.05-0.45	0.08-0.36	0.06-0.69	0.08-0.42
	0.17±0.11	**0.22±0.09**	**0.25±0.19**	**0.21±0.11**
Dry matter (%)	43.31-51.25	51.29-53.22	53.29-55.09	55.39-70.66
	47.49±2.35^{c}	**52.16±0.66^{b}**	**54.22±0.63^{b}**	**61.01±4.14^{a}**
Fat (%)	18.00-26.50	20.30-29.30	22.00-29.00	22.80-37.30
	22.05±2.20^{c}	**24.70±2.79^{bc}**	**26.25±2.03^{b}**	**30.57±3.77^{a}**
Fat in dry matter (%)	39.56-54.28	39.00-55.30	40.76-53.48	39.93-55.79
	46.42±4.24	**47.32±5.22**	**48.35±3.64**	**49.97±4.30**
Salt (%)	1.48-7.54	2.95-9.67	1.17-10.59	3.16-9.89
	5.10±2.01	**6.31±2.49**	**7.11±2.75**	**6.96±2.09**
Salt in dry matter (%)	3.21-15.91	5.61-18.85	2.20-19.87	5.46-16.50
	10.71±4.13	**12.12±4.83**	**13.12±5.10**	**11.41±3.45**
Ash (%)	1.80-8.05	3.37-10.10	1.61-11.03	3.64-10.81
	5.56±2.04	**6.84±2.53**	**7.64±2.78**	**7.49±2.14**
Total protein (%)	15.16-24.64	16.86-23.70	16.76-24.00	19.22-25.87
	19.81±2.85^{b}	**20.56±2.04^{ab}**	**20.25±2.13^{b}**	**22.78±2.25^{a}**
Total protein in dry matter (%)	32.76-50.42	32.66-45.69	30.89-43.62	30.40-43.48
	41.75±5.82^{a}	**39.40±3.76^{ab}**	**37.56±3.99^{b}**	**37.41±3.67^{b}**
Water soluble nitrogen (%)	0.04-0.10	0.05-0.09	0.03-0.18	0.04-0.26
	0.06±0.02	**0.06±0.01**	**0.07±0.04**	**0.08±0.06**
Ripening degree	1.30-4.24	1.41-3.06	1.05-6.00	1.20-6.82
	2.06±0.81	**1.96±0.51**	**2.17±1.17**	**2.28±1.74**

In studies on Adıyaman cheese, the dry matter amounts of cheese samples were determined as 41.98% and 70.20% in Adıyaman cheese [1, 27]. It was determined that the fat content of cheese samples was between 18.00% and 37.30% and the fat in dry matter content was between 39.00% and 55.79%. While the increase in the amount of fat in cheese samples examined in different months was statistically significant ($p<0.05$), the change between the amount of fat in dry matter was not significant ($p>0.05$). Keskin and Çelik [26] determined that the amount of fat and fat in dry matter of traditional leaf cheese produced from sheep milk was 23.14% and 40.73%. It was determined that the amounts of salt, salt in dry matter and ash in Adıyaman cheese samples were between 1.17%-10.59%, 2.20-19.87% and 1.61-11.03%, respectively, and the change in summer and spring months was not significance value statistically ($p>0.05$). It is thought that the difference in the amount of salt, salt in dry matter and ash in fresh cheese samples depends on the amount of salt added to the boiling water and used in dry salting in the production of Adıyaman cheese during production [1,28]. Özer et al. [29] determined that the amount of salt in dry matter in Urfa cheese was between 13.6 % and 21.1 % and the amount of ash was between 7.52 % and 10.14 %. Turkoglu et al. [30] determined that the salt content of Örgü cheeses was between 3.51 % and 7.31 %. It was determined that the protein and protein in dry matter amounts of Adıyaman cheese were between 15.16% and 25.87%, and 30.40% and 50.42%, and the change in protein and protein in dry matter amounts in summer and spring has significance value statistically ($p<0.05$). Turkoglu et al. [30] determined that the protein and protein in dry matter value of Urfa cheese was 17.36 % and 46.64 %. It was determined that the amount of water-soluble nitrogen and the degree of maturation of Adıyaman cheese were between 0.03% and 0.26%, and between 1.05 % and 6.82 %. The

changes in the water-soluble nitrogen and maturation degree of the samples in spring and summer were not statistically significant ($p>0.05$). This is thought to be since the cheeses are bought fresh from the enterprises. Özer et al. [29] reported that the ripening index of Urfa cheese produced from sheep milk was 9.5% at the beginning and 22.2% at the end of storage. Canözer and Köse [31] observed that the amount of water-soluble nitrogen in Diyarbakır Örgü cheese produced by traditional and industrial methods was 17.05% and 11.24%. The chemical properties of cheese differ depending on the composition of the raw material used in cheese production, production method, the chemical and microbiological activities occurring in the cheese during production and storage [32-34].

3.2. Cheese Color

It was determined that the L^*, a^* and b^* values of Adıyaman cheese (Table 2) were between 77.48 and 91.91, -9.52 and -0.28 and 13.04 and 40.01, respectively. The difference between the L^* values of cheese samples examined in different months was statistically significant ($p<0.05$), while the difference between a^* and b^* values was statistically insignificant ($p<0.05$). Kahyaoglu et al. [35] determined that the L^* and b^* values of Gaziantep cheeses produced in different oil ratios and boiling degrees were between 84.40-61.54 and 16.54-6.54. Atasoy et al. [36] determined that the L^*, a^* and b^* values of Urfa cheeses with different boiling temperatures and times were between 86.09 and 80.32, -1.50 and -1.11, and 16.23 and 12.35, respectively. Erbay et al. [37] determined that the L^*, a^* and b^* values of Hellim cheese were between 92.2 and 89.1, -0.2 and -3.6, and 20.9 and 15.3, respectively. Color characteristic of cheeses; it may differ depending on the milk used in production, the quality characteristics of the fat phase, the cheese production technique, and the biochemical changes during the ripening period [38, 39].

Table 2. Color charachteristics of Adıyaman cheese (n=15)

	April Minimum-maximum **Mean±std**	**May** Minimum-maximum **Mean±std**	**June** Minimum-maximum **Mean±std**	**July** Minimum-maximum **Mean±std**
L^*	83.69-91.91 **88.37±2.35^{a}**	82.26-91.64 **86.64±2.58^{ab}**	77.69-90.95 **86.75±3.60^{ab}**	77.48-89.61 **85.14±3.46^{b}**
a^*	-9.52 - -2.48 **-7.18±2.21**	-8.74 - -0.28 **-6.08±2.87**	-9.15 - -3.40 **-7.09±1.83**	-8.50 - -3.48 **-6.14±2.05**
b^*	13.04-30.56 **23.72±6.20**	13.21-32.70 **25.00±6.16**	18.07-33.21 **25.07±5.89**	13.56-40.01 **25.71±6.76**

3.3. Textural Features

The textural properties of the traditional Adıyaman cheese examined in our research are given in Table 3. It was determined that hardness, adhesiveness, resilience, cohesiveness, springiness, gumminess and chewiness values of Adıyaman cheese were between 574.42 g and 29457.80 g, -72.40 g sec. and 0.02 g sec, 0.35 and 0.84, 0.76 and 0.93, 0.87 and 3.57, 488.96 and 23346.58, and 460.36 and 35978.12, repectively. In the studies, it has been reported that hardness, adhesiveness, springiness, cohesiveness, gumminess and chewiness values of Diyarbakır Örgü cheese were 8964 N, -0.57 Ns, 0.82 cm, 0.70, 6333 N and 5246 mJ [40], hardness, resilience, cohesiveness, gumminess and chewiness values of Hellim cheese were between 12.5 kg and 45.2 kg, 0.84 and 0.91, 0.55 and 0.74, 7.9 kg and 30.7 kg, and 6.7 kg and 26.9 kg [37], and hardness, springiness, cohesiveness and gumminess were between 6.9 N and 20.0 N, between 0.78 and 0.98, between 0.73 and 0.96, and between 5.0 N and 19.1 N [35]. It was determined that the difference between hardness, cohesiveness, and gumminess values of Adıyaman cheese was statistically significant ($p<0.05$). It is thought that the change in the hardness

values of the cheeses is due to the difference in the dry matter, salt, and fat amounts of the samples and the different temperatures of curd processing during the production process [41, 42]. In addition, cheese textural properties varied on factors such as the amount of water in the cheese, the amount of calcium, the level of proteolysis, the pH value, the amount of fat, the size and distribution of fat droplets, casein-casein, casein-water, and casein-fat interactions [43-45].

Table 3. Textural properties of Adiyaman cheese (n=15)

	April	**May**	**June**	**July**
	Minimum-maximum	Minimum-maximum	Minimum-maximum	Minimum-maximum
	Mean±std	**Mean±std**	**Mean±std**	**Mean±std**
Hardness (g)	716.08-25398.52	596.46-8456.68	1699.76-9444.52	574.42-29457.80
	6047.83±5968.86^{ab}	**2693.80±1785.52^{b}**	**4213.29±2411.15^{ab}**	**5471.07±8798.31^{a}**
Adhesiveness (g.sec)	-72.40-0.02	-57.37 - -1.07	-20.42 - -0.14	-55.36- -0.18
	-16.22±18.58	**-13.41±16.60**	**-6.33±6.37**	**-6.95±15.14**
Resilience	0.35-0.71	0.38-0.67	0.36-0.71	0.37-0.84
	0.46±0.11	**0.56±0.09**	**0.54±0.11**	**0.56±0.12**
Cohesiveness	0.76-0.90	0.81-0.93	0.77-0.89	0.77-0.92
	0.83±0.04^{b}	**0.89±0.04^{a}**	**0.84±0.03^{b}**	**0.85±0.04^{b}**
Springiness	0.93-1.97	0.94-1.88	0.92-3.57	0.87-1.56
	1.38±0.40	**1.14±0.35**	**1.37±0.77**	**1.01±0.18**
Gumminess	653.85-21985.92	701.40-6859.86	1421.67-7563.18	488.96-23346.58
	5018.91±5151.70^{ab}	**2370.09±1415.36^{b}**	**3454.31±1945.42^{ab}**	**7418.91±7064.21^{a}**
Chewiness	641.15-33678.78	946.03-12887.43	1416.06-15538.95	460.36-35978.12
	7525.59±8223.98	**2845.85±2870.64**	**4558.51±3751.15**	**8557.88±10504.82**

3.4. Microbiological Properties

Microbiological properties of traditional Adıyaman cheese examined in our study are given in Table 4. It was determined that the number of yeast-molds in the examined cheese samples was between 3.30 log cfu/g and 7.98 log cfu/g, and the change between the yeast and mold numbers of the samples examined in different months were not statistically significant ($p>0.05$). In studies conducted on various cheeses, the yeast-mold count of cheeses were 3.16 log cfu/g in Hellim cheese [46], 2.63 log cfu/g in Diyarbakır Örgü Cheese [40], and 6.67 log cfu/g in Adıyaman cheese [1].

In the microbiological examination of the cheeses, it was determined that the count of *S. aureus* in the cheese samples was between <1.00 log cfu/g and 6.26 log cfu/g, and the change between *S. aureus* counts of the cheeses examined in different months was not statistically significant ($p>0.05$). Yalçın et al. [47] detected the presence of *S. aureus* in 20 of the Urfa cheese they examined in their study and reported that the amount was between <1.0 and 5.51 log cfu/g. In the microbiological analysis, coagulase-positive *S. aureus* was determined in 58 cheese samples, and the count of coagulase-positive *S. aureus* in the samples was found between 1.70 log cfu/g and 6.26 log cfu/g. The difference between the coagulase-positive *S. aureus* count of cheese samples analyzed in different periods was not significant ($p>0.05$). In the study, it was determined that the coagulase-positive *S. aureus* counts of 32 of the cheese samples were over 10^3 cfu/g. Gürbüz et al. [48] found that 25 of 106 cheese samples produced from raw milk had coagulase-positive *S. aureus*. It is thought that the use of raw milk in cheese production, the lack of attention to hygiene and sanitation rules by the producer and the seller, the lack of use of starter culture in production, and the dominant flora is not capable of preventing bacterial growth may cause the high count of *S. aureus* and coagulase-positive *S. aureus* in the samples [49].

Table 4. Microbiological analysis results of Adıyaman cheese

	April		**May**		**June**		**July**	
	n	Minimum-maximum **Mean±std**	**n**	Minimum-maximum **Mean±std**	**n**	Minimum-maximum **Mean±std**	**n**	Minimum-maximum **Mean±std**
Maya Küf (log cfu/g)	15	4.95-7.08 **6.14±0.68**	15	3.60-7.98 **6.20±1.20**	15	4.87-7.88 **6.44±0.87**	15	3.30-7.90 **6.15±1.35**
Staphylococcus aureus (log cfu/g)	15	1.85-5.18 **3.30±1.15**	15	<1.00-5.11 **3.15±1.34**	15	<1.00-4.72 **3.29±1.28**	15	1.70-6.26 **3.22±1.13**
Coagulas- positive Staphylococcus aureus (log cfu/g)	15	1.85-5.18 **3.30±1.15**	14	1.85-5.11 **3.37±1.06**	14	1.90-4.72 **3.52±0.94**	15	1.70-6.26 **3.22±1.13**
Escherichia coli (log cfu/g)	14	1.30-5.08 **3.20±1.09**	13	2.60-4.59 **3.59±0.79**	12	1.30-5.30 **3.38±1.19**	12	1.30-4.85 **3.13±0.97**
Salmonella spp.	15	-	15	-	15	-	15	-
Listeria monocytogenes	15	-	15	-	15	-	15	-
Brusella spp.	15	-	15	-	15	-	15	-

(-) : not detected

The presence of *E. coli* was detected in 85% of Adıyaman cheeses examined in the study. It was determined that the count of *E. coli* in Adıyaman cheeses was between 1.30 log cfu/g and 5.30 log cfu/g, and the count of *E. coli* in 30 of the cheese samples was above the limits specified in the regulation. In the cheeses examined in our study, the presence of *E. coli* was determined throughout the entire period, and the highest value was determined in June. Vural et al. [50] determined the presence of *E. coli* in 65.21% of the Örgü cheese samples, Costanzo et al. [51] in 8.16% of the cheeses produced from raw milk, and Soria-Herrera et al. [52] in 38.33% of the unpasteurized cheese samples. The number of *E. coli* detected in Adıyaman cheese is quite high compared to other studies and considering that the diseases that may be caused by *E. coli* pathogenic strains, Adıyaman cheese may pose a risk in terms of public health.

L. monocytogenes was not found in the cheese samples examined in our study. In the other studies, *L. monocytogenes* was detected in 15.6% of Irish farm cheese samples taken from different production stages [53] and in 1.4% of Norwegian cheese produced from raw milk [54]. Costanzo et al. [51] did not detect the presence of *L. monocytogenes* in 245 cheese samples produced from raw milk. In our study, the absence of *L. monocytogenes* in Adıyaman cheese is thought to be due to the endogenous microbiota of raw milk [55], which has an inhibitory effect on *L. monocytogenes* or applying a boiling process during production.

In the cheese samples examined in our study, *Salmonella* spp. was not detected. The result obtained from the study is similar to other studies on Urfa cheese [56], Örgü cheese [50] and Mozzarella cheese [57].

In our study, the presence of *Brucella* spp. was not detected in the cheese samples were examined. In other studies, the presence of brucellosis was detected in 22.93% of traditional cheeses produced from raw sheep and goat milk in Iran [58], while the presence of brucellosis was not detected in cheeses produced from raw sheep and goat milk in Niğde [59]. The development of pathogens in cheese production may depend on the acidification speed of the curd, the pH of the final product, the temperature and duration of the heat treatment applied to the curd, the presence of natural protection systems such as lactoperoxidase, lysozyme, and lactoferrin [60] and bacteriocins or bacteriocin-like compounds produced by lactic acid bacteria [61].

It is thought that the absence of pathogenic bacteria such as *Brucella* spp., *Salmonella* spp. and *L. monocytogenes* in our study may be due to the heat treatment applied to the curd in the cheese production technique [62, 57].

4. Conclusion

Although there are many traditional cheese types in Türkiye, the production of some of them in small businesses using non-standardized production techniques may cause the loss of the unique characteristics of traditional cheeses. In addition, in the Eastern and Southeastern Anatolia regions where small cattle breeding is common, the use of raw milk from sheep, goats, and cows in the production of traditional cheese poses a risk to public health. In our study, the physicochemical and textural properties of Adıyaman cheeses, which were examined in different months, showed a wide distribution in general and the difference between the dry matter, fat, fat in dry matter, protein, protein in dry matter, hardness, gumminess, cohesiveness, and L^* values of cheeses have significance value. This situation underlines the necessity of standardizing the production of Adıyaman cheese, which is among our traditional products and widely consumed. Yeast-mold, *S. aureus*, coagulase-positive *S. aureus* and *E. coli* amounts were found higher in Adıyaman cheese samples compared to other studies. Although pathogenic microorganisms such as *Brucella* spp., *Salmonella* spp. and *L. monocytogenes* were not detected in cheese in our study, the amount of coagulase-positive *S. aureus* in 53.33% and *E. coli* in 50% of the tested cheeses exceeded the limits set in the Microbiological Criteria Regulation of the Turkish Food Codex. Compared to other studies, the high microbial load in the studied cheese samples could be an indication that insufficient importance is given to the hygiene and sanitation practices required in food production. For this reason, heat treatment at appropriate time and temperature in the production of Adıyaman cheese produced from raw milk and attention to good hygiene practices in production are important in preventing the development of microorganisms that pose a threat to public health. Standardizing the production process of traditional Adıyaman cheese provides preserving the characteristic features of cheeses such as unique taste, smell, aroma, and texture, preventing risk factors for human health, and reducing economic losses. For this reason, studies should be carried out to awareness-raising of traditional producers on this issue. It is thought that the data obtained in our study will be a source for public health authorities, industrial food producers, and new studies to be done.

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Conflict Of Interest

The authors declare that they have no conflict of interest.

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