

DETERMINATION OF SOME CHEMICAL, TEXTURAL AND MICROBIOLOGICAL PROPERTIES OF KARGI TULUM CHEESE

KARGI TULUM PEYNİRİNİN BAZI KİMYASAL, TEKSTÜREL VE MİKROBİYOLOJİK ÖZELLİKLERİNİN BELİRLENMESİ

Assist. Prof. Dr. Çağım Akbulut Çakır 

Harran University, Faculty of Engineering, Department of Food Engineering, Şanlıurfa/Türkiye

Dr. Tuba Büyüksırt Bedir 

Hitit University, Faculty of Engineering, Department of Food Engineering, Çorum/Türkiye

Dr. Özlem İstanbullu Paksoy 

Department of Quality Management/Biogenetics, Kocaeli Food Control Laboratory Directorate, Kocaeli/Türkiye

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ÖZET

Kargı Tulum peyniri, Çorum'un Kargı ilçesinde koyun, keçi, inek ve manda sütü ve bunların karışımlarından yaz mevsiminde yaylalarda üretilen ve sonbaharda piyasaya sunulan bir peynir çeşididir. Özellikle Çorum, Kastamonu, Samsun ve Ankara illerinde tüketilmektedir. Peynirlerin pazarlanması için koyun ve kuzu derisinden yapılan tulumlar temizlenip küçük parçalara ayrılarak dikilir. Peynirler, peynir altı suyu süzildükten sonra dikilir ve hazırlanan tulumların içine hava boşluğu kalmayacak şekilde sıkıştırılarak preslenir. Kargı Tulum peynirinde hala geleneksel üretim ve satış yöntemleri kullanılmaktadır, bu nedenle her üretimde standart ürün elde edilememektedir. Bu nedenle geleneksel peynir üretiminde yer alan aşamalar ve olgunlaşma için kullanılan ambalaj malzemesi, ürünün kimyasal ve tekstürel özelliklerini, mikrobiyal yükünü ve dolayısıyla kalitesini etkiler. Kargı Tulum peyniri ile ilgili az sayıda çalışma bulunmakta ve tekstür ve reolojik özelliklerini inceleyen kapsamlı bir çalışma bulunmamaktadır. Peynirde tekstür; bileşim, mikrobiyolojik yük, olgunlaşma koşulları ve proteoliz gibi birçok faktörden etkilenir; bu nedenle peynirin tekstür özellikleri kimyasal ve hijyenik parametrelerle birlikte değerlendirilmelidir. Bu çalışmada 3 tekerrürlü olarak geleneksel üretimi gerçekleştirilmiş olan Kargı Tulum peynirlerinin bazı kimyasal (pH, titrasyon asitliği, toplam kuru madde, yağ), tekstürel (Tekstürprofil analizi) ve mikrobiyolojik karakteristikleri (toplam mezofilik bakteri sayımı, küf maya sayımı, koliform) belirlenmiştir. Kargı Tulum peynirlerine ait nem içeriği % 43.45, yağ içeriği % 25.5, pH 4.55, titrasyonasitliği (% laktik asit) 2.55 bulunmuştur. Türk Standartları Enstitüsü TS 3001 Tulum Peyniri Standardına göre Kargı Tulum peyniri örneklerimiz tam yağlı peynir sınıfındadır ve kimyasal analiz sonuçlarımız bu standarda uygundur. Tekstür profil analizi sonucunda peynir örnekleri arasında çiğnenebilirlik dışındaki tüm tekstür parametreleri arasında (sertlik, yapışkanlık, kohesiflik, elastikiyet, sakızımsı yapı, dayanım) istatistiksel olarak önemli fark bulunmuştur ($P<0.05$). Tulum peynirinde ortalama toplam mezofilik aerobik bakteri sayısı $6.40 \log \text{ kob.g}^{-1}$; ortalama küf ve maya sayısı $1.07 \log \text{ kob.g}^{-1}$ olarak bulunmuştur. Analizi yapılan örneklerde koliform grup bakteriye rastlanmamıştır. Mikrobiyolojik sonuçlar istatistiksel olarak karşılaştırıldığında peynir örnekleri arasında önemli bir fark olmadığı tespit edilmiştir.

Anahtar Kelimeler: Kargı Tulum peyniri, geleneksel peynirler, tekstür, mikrobiyoloji

ABSTRACT

Kargı Tulum cheese is a type of cheese produced in the highlands in summer seasons from sheep, goat, cow and buffalo milk and their mixtures in certain proportions in the Kargı district of Çorum and put on the market in autumn. It is particularly consumed in Çorum, Kastamonu, Samsun and Ankara provinces. For the marketing of cheeses, tulum made of sheep and lamb skins are cleaned

and cut into small pieces and sewn. Cheese curds, after the whey draining, are pressed into the prepared tulum by being compressed so that there is no airgap in them. Traditional production and sales methods are still used in Kargı Tulum cheese, therefore standardized products cannot be obtained in every production. For this reason, the stages involved in the traditional cheese production and the packaging material used for ripening affect the chemical and textural properties, microbial load and therefore, quality of the product. There are few number of studies on Kargı Tulum cheese and no extensive study examined the texture and rheological characteristics of it. Cheese texture is influenced by many factors, such as composition, microbiological load, ripening conditions and proteolysis; therefore texture properties should be evaluated together with the chemical and hygienic parameters. In this study, some chemical (pH, titration acidity, total solids, fat), textural (TPA) and microbiological characteristics (total mesophilic count, mold and yeast counts, coliform) of tulum cheese samples produced according to the traditional method with three replicates were determined. Moisture content of the Kargı Tulum cheese samples were 43.45%, fat content was found % 25.5, pH was 4.55, acidity (lactic acid %) was 2.55. According to TS 3001 Tulum Cheese Standard our Kargı Tulum cheese samples were classified as full fat cheese and our chemical composition results were in accordance with the standard. We found statistically significant differences between cheese samples for all texture parameters measured (firmness, adhesiveness, springiness, gumminess, resilience) except for chewiness. Average total mesophilic aerobic bacteria count was $6.40 \log \text{cfu.g}^{-1}$ mean mold and yeast counts were found to be $1.07 \log \text{cfu.g}^{-1}$. Coliform group bacteria were not found in the analyzed samples. When microbiological results were compared statistically, it was determined that there was no significant difference between cheese samples.

Keywords: Kargı Tulum cheese, traditional cheese, texture, microbiology

1. INTRODUCTION

Kargı Tulum cheese is a type of cheese produced in the highlands in the summer season from sheep's milk, goat's milk, cow's milk and buffalo milk and their mixtures in certain proportions in the Kargı district of Çorum and put on the market in autumn. It is particularly consumed in Çorum, Kastamonu, Samsun and Ankara provinces. For the marketing of cheeses, tulum made of sheep and lamb skins are cleaned and cut into small pieces and sewn. Cheese curds, after the whey draining, are sewn and pressed into the prepared tulum by being compressed so that there is no air gap in them. Traditional production and sales methods are still used in Kargı Tulum cheese, therefore standardized products cannot be obtained in every production. For this reason, the stages involved in traditional cheese production and the packaging material used in ripening affect the chemical, textural, microbial load and therefore, quality of the product. Milk and milk products have an important role in human health in terms of containing essential proteins, calcium, phosphorus, vitamins and other minerals that are necessary for a balanced and adequate nutrition. Being rich in protein and calcium, cheese is the best way to utilize dairy products. Due to the unhygienic conditions, and use of raw milk in traditional cheese varieties, it may pose a microbiological risk. Many studies have been carried out on the microbiological quality of cheese, which is widely produced and consumed in our country. It has been stated that especially in cheese types that are traditionally produced and offered for consumption without packaging, their microbiological properties may be a risk factor for human health (Bostan et al., 1992; Ceylan et al., 2007; Çelik and Uysal, 2009).

The aim of this study is to determine some chemical, textural and microbiological properties of traditionally produced Kargı Tulum cheese. There are few number of studies on Kargı Tulum cheese and no extensive study examined the texture and rheological characteristics of it. Texture is a distinctive quality parameter for the cheese. After the flavor it is the most important property that distinguishes a cheese from other cheese types. Therefore it is important to determine the texture characteristics of traditional cheese types. We wanted to evaluate the texture characteristics of the

Kargı Tulum cheese by a test that mimic the sensation of actual chewing of the cheese in the mouth, therefore we applied the TPA test and determined the hardness, adhesiveness, resilience, cohesiveness, springiness, gumminess and chewiness values. Cheese texture is influenced by many factors, such as composition, microbiological load, ripening conditions and proteolysis; therefore texture properties should be evaluated together with the chemical and hygienic parameters. In this study we also measured some chemical properties; moisture, fat, pH and acidity. Lastly, the number of coliform group bacteria, the total number of bacteria and the number of yeast and mold were determined in tulum cheeses obtained from Kargı district of Çorum province.

2. MATERIALS AND METHODS

2.1. Kargı Tulum Cheese Production

Kargı Tulum cheese samples were produced with three replicates at local producer in Kargı district of Çorum province. Raw milk obtained from animals is filtered through a cloth and animal rennet is added at about 28-29°C. Coagulation and curd forming took 24 h at cooler temperatures (15-18 °C). Cheese curds are then put into a clean white cloth bag for whey draining and these bags hang for 24 h. After 24 h these cloth bags are pressed for about another 24 h and then, the curd is broken up, salted and kneaded by dough mixing machine. Salted (0.4 kg per 100 kg milk) and kneaded cheeses are first transferred into cloth bags of 135 kg capacity and pressed by around 50 kg weight. After 10 to 12 days cloth bags are emptied mixed well and put into clean bags for press using half of the weight used in the beginning. After desired dryness is reached curds are mixed with previous production curds and pressed into cloth bags for further drying. This cycle is repeated until the sufficient whey is drained and curds reach to desired dryness level, which took 150 days. 'Tulum' made of sheep skin is cleaned and cut into small pieces and sewn. At the end of ripening in large cloth bags cheeses are pressed into the prepared tulum (0,5 kg each) by being compressed and sewn so that there is no air gap in them. In this study 8 months old three cheese samples (T1, T2, T3) were produced by the aforementioned method. Some images of the Kargı Tulum cheese samples used in the study are given in Fig. 1.



Fig. 1. Kargı Tulum cheese samples used in the study.

2.2. Chemical Analysis Methods

Moisture and titratable acidity were determined according to Marshall (1992). Fat content was determined by the Gerber method. The pH was determined using a pH-meter (Ohaus ST3100-F, USA).

2.3. Texture Profile Analysis

Texture analysis was performed using a Texture Analyzer TA-XT2 with a 5 kg load cell (Stable Micro Systems, Godalming, Surrey, UK). Cheese was cut into cylindrical samples (15.5 mm in diameter, 16.5 mm high) and stored overnight at 4°C before compression. Analysis was performed on 3 cheese samples and from each cheese 8 to 12 test samples were prepared. Texture profile analysis (TPA) was performed by compressing the sample to 60% of its original height at 0,8 mm/s test speed. Hardness, adhesiveness, resilience, cohesiveness, springiness, gumminess and chewiness was calculated as previously described by Bourne (1978).

2.4. Microbiological analysis

In this study, 3 different tulum cheeses of 1 kg, filled in tulum obtained from sheep skin were used. In order to determine the hygienic quality of Kargı Tulum cheese, total mesophilic aerobic bacteria (TMAB), yeast and mold and coliform group bacteria counts. 10 grams of samples brought to the laboratory were weighed under aseptic conditions and put into sterile bags. 90 ml sterile 0.1% peptone water was added, homogenized, dilutions were prepared with peptone water successive dilutions and the spread plate method was used. TMAB counts were determined on Plate Count Agar (PCA, Merck) plates incubated at 30°C for 24-48 hours; yeast and moulds counts was determined on Potato Dextrose Agar (PDA, Merck) plates incubated at 25°C for 5 days. The number of coliform group bacteria was determined on Violet Red Bile Agar (VRBA, Merck) and after 24 hours of incubation at 37°C (Halkman, 2005). The results were expressed as log of colony forming units (cfu) per gram of cheese. Microbial enumeration experiments were conducted in triplicates.

2.5. Statistical analysis

Statistical analysis was performed by SPSS version 16 (SPSS Inc., Chicago, IL). Analysis of variance (ANOVA) was done to establish statistical differences between the chemical, textural and microbial properties of the samples. Differences between means were evaluated by Tukey multiple comparisons test.

3. RESULTS AND DISCUSSION

3.1. Chemical Analysis

Chemical Composition and pH of Kargı Tulum cheese samples are given in Table 1. We didn't see any significant difference between chemical analysis results of cheese samples ($P>0.05$). Mean pH value of the cheese samples was found 4.50 and similar to the results found by Kiraz (2018). Total acidity was 2.55% and higher than the results found by Dinkçi et al. (2012) while it was in the range of the results of Kiraz (2018), in which their acidity levels varied from 0.2 to 4.79 %. Moisture content of the Kargı Tulum cheese samples was 43.45% and much higher than the results of Dinkçi et al. (2012), they found a mean value of 38.09%. According to the TS 3001 Tulum Cheese Standard, tulum cheese should not contain more than 45% moisture. Our chemical composition results of Kargı Tulum cheese is in accordance with TS 3001 Tulum Cheese Standard (Anonymous, 2016) and it is classified as full fat cheese. Mean MNFS (%) value of cheese samples was found 57.93% and it is classified as semi-hard cheese according to Cheese Bulletin of Turkish Food Codex (Anonymous, 2015).

Table 1. Chemical analysis results of Kargı Tulum cheese (Mean ± SD)

Parameter	Cheese Sample			Mean	SD
	T1	T2	T3		
pH	4.53±0.00	4.49±0.01	4.47±0.02	4.50	0.03
Acidity (lactic acid %)	2.52±0.02	2.62±0.00	2.53±0.00	2.55	0.05
Moisture (%)	44.45±0.02	43.45±0.00	42.45±0.01	43.45	1.00
Fat (%)	24.00±0.00	25.00±0.00	26.00±0.01	25.00	1.00
FDM (%)	43.20±0.01	44.21±0.00	45.18±0.02	44.19	0.99
MNFS (%)	58.48±0.01	57.93±0.00	57.36±0.02	57.93	0.56

FDM: Fat in dry matter

MNFS: Moisture in nonfat substance

3.2. Texture Analysis

Texture Profile Analysis results of cheese samples are given in Table 2. Hardness is the maximum force attained at the first compression of the cheese and hardness values of our samples ranged between 789-981 with a mean hardness value of 919 g. Cheese T1 was significantly softer than others. We observed statistically significant differences between cheese samples for all texture parameters measured except for chewiness ($P < 0.05$).

Table 2. Texture Profile Analysis Results of Kargı Tulum cheese (Mean ± SD)

Parameter	Cheese Samples			Mean	SD
	T1	T2	T3		
Hardness (g)	789.87±94.46 _a	981.05±234.04 _b	988.60±79.57 _b	919.81	112.66
Adhesiveness (g.s)	- 438.51±99.79 _a	-329.26±95.01 _b	- 554.39±95.02 _a	-440.72	112.58
Resilience (%)	3.11±0.18 ^b	2.61±0.26 ^a	3.05±0.11 ^b	2.92	0.27
Cohesiveness	0.17±0.02 ^a	0.09±0.02 ^b	0.15±0.01 ^a	0.14	0.04
Springiness (%)	30.33±4.59 ^a	46.68±18.41 ^b	37.50±11.19 _{ab}	38.17	8.19
Gumminess	116.69±17.23 _b	93.13±30.31 ^a	151.43±20.77 _c	120.42	29.33
Chewiness	39.66±8.65 ^a	41.75±18.73 ^a	56.73±17.86 ^a	46.02	9.33

^{a,b,c} Mean values with different superscript letter in the same row are significantly different ($P < 0.05$)

There are limited number of previous study on Kargı Tulum cheese and to the authors knowledge no TPA test was performed before. Kiraz (2018) assessed hardness and adhesiveness values of Kargı Tulum cheese samples collected from local producers and stores by applying a penetration test on 4 cm³ cheese samples to a 10 mm depth using spherical probe. Their hardness values ranged between 77 to 697 N having a mean value of 293 N, and adhesiveness values ranged between 14 – 93 N. They did not mention the cheese age. In our study 8 months old cheese samples were used. Mean adhesiveness value of our samples was -440 g.s. Looking at the TPA results we could say that our Kargı Tulum cheese samples were soft and highly adhesive and sticky. Resilience is the measure of how well a product fights to regain its original position; and cohesiveness is defined as the strength of internal bonds making up the body of the product (Gunasekaran and Ak, 2003). Low

resilience and cohesiveness values also show that it was almost like a spreadable cheese. Springiness, gumminess and chewiness values were also found to be lower than hard cheese types. Texture properties of cheese strongly depend on its age and composition. Therefore not only different cheese varieties, but also same type of cheeses can exhibit a wide range of texture characteristics depending on their age and proteolysis levels, moisture, protein and fat contents. It is expected to have differences between Kargı Tulum cheese samples even in the same party since every batch is a mixture of cheeses produced for days.

3.3. Microbiological analysis

The results obtained from the microbiological analyzes of Kargı Tulum cheese samples are presented in Table 3. No significant difference was seen between cheese samples ($P > 0.05$). Three main sources are effective in the formation of the microflora of cheese: microorganisms present in the milk, starter cultures used in production and contaminations during processes (Kongo and Malcata, 2016). The number of TMAB in the samples was determined 6.43, 6.38 and 6.40 log cfu/g, respectively. In the studies conducted with tulum cheeses, it was determined that the average TMAB number was 6.98 log cfu/g in Kargı tulum cheese (Dinkçi et al., 2012), 6.85 log cfu/g in Şavak tulum cheese (Demir et al., 2018), 6.60 log cfu/g in Afyon tulum cheese (Kara and Akkaya, 2015), 6.78 log cfu/g in Divle tulum cheese (Morul and İşleyici, 2012). The values obtained in this study are similar to the results of the studies with Tulum cheese. Generally, the high number of TMAB in Tulum cheeses is due to the use of raw milk in production. This group of hygiene indicator microorganisms does not make much sense in fermented products such as cheese, but can provide information about the possible shelf life of the food and the contamination levels in the production stages (Temiz, 2003).

Table 3. Microbiological analysis results (log cfu/g) of Kargı Tulum cheese (Mean \pm SD)

Analysis	Cheese Samples			Mean	SD
	T1	T2	T3		
TMAB	6.43 \pm 0.08	6.38 \pm 0.05	6.40 \pm 0.13	6.40	0.02
Yeast and Molds	2.15 \pm 0.15	2.04 \pm 0.04	2.02 \pm 0.02	1.07	0.07
CGB	<1	<1	<1		

TMAB: Total mesophilic aerobic bacteria, CGB: Coliform group bacteria

Yeast and mold counts in samples were found to be 2.15, 2.04 and 2.02 log cfu/g, respectively. In a study, it was reported that the amount of mold and yeast in Kargı Tulum cheese samples was between 5.54-7.24 log cfu/g (Dinkçi et al., 2012). These values are much higher than the results we found in our study. Due to the fact that the raw milk used in cheese making is obtained from different sources, there may be significant differences between the microbiological properties of Kargı Tulum cheese samples. It was determined that the average number of yeast molds in Şavak tulum cheese samples was 5.06 log cfu/g. Less than 2 log cfu/g was reported in 46% of the analyzed samples (Demir et al., 2018). The value of 2.78 log cfu/g found in a study on Afyon Tulum cheeses is similar to our study (Kara and Akkaya, 2015). The high number of yeast and molds is an indication that the products are not made under hygienic conditions. In another study, the average yeast-mold amount of 20 types of tulum cheese sold in Ankara was found to be 4.83 log cfu/g (Öner et al., 2003). It was stated that the ripening time of Tulum cheeses will also have an effect on microbiological properties, and it was stated that the amount of mold and yeast of cheese samples made from sheep's milk and matured in tulum varied between 5.79-6.50 log cfu/g during 90 days of storage (Ceylan et al., 2007). In this study, the number of yeast and mold was determined to be lower.

The coliform group bacteria were not found in the analyzed samples which are started with the 1st dilution. Similarly, coliform group bacteria were not found in the study conducted with Kargı tulum cheese. (Dinkçi et al., 2012). Since Kargı Tulum cheese is produced traditionally, some hygienic problems may arise. However, similar results have formed positive ideas about hygiene quality. In a study on Afyon Tulum cheeses, it was determined to be 1.23 log cfu/g (Kara and Akkaya, 2015), and in another study, it was determined to be 1 log or less in 6% of Şavak tulum cheese samples (Demir et al., 2018). The high number of coliform bacteria causes flavor and structure disorders in cheeses.

It has been revealed that the packaging material used affects some of the characteristics of Tulum cheese during the ripening period, as well as the microbiological properties of cheese production stages (Bayar and Özrenk, 2011). In a study, it was stated that cheeses matured in tulum contain more mold and yeast than those matured in plastic. It was observed that the TMAB in all cheeses was high in the initial stage of ripening and decreased as the ripening period increased, and it was reported to be between 6.15-6.74 log cfu/g (Hayaloğlu et al., 2007). The same trend was observed in similar studies on this subject (Çağlar, 2001) however, it has been reported that higher TMAB counts were obtained (Sengul et al., 2001; Patır et al., 2001).

4. CONCLUSIONS

In this study, the chemical, textural and microbiological quality of Kargı Tulum cheese was investigated. As a result of the microbiological analysis evaluated in terms of TMAB number and molds and yeasts, it was determined that it was below the critical values, while coliform group bacteria were not found even though raw milk was used in cheese making. Ripening could have eliminated the coliforms and could have helped keeping the microbial load in limits. It is thought that if there are insufficient hygiene conditions in traditionally produced cheeses, the microbial load will be higher, especially the packaging materials should be carefully selected against the risk of contamination and the tulum cheese should be packed airtight. There are few number of studies on Kargı Tulum cheese and no extensive study examined the texture and rheological characteristics of it. Texture is an important quality parameter for cheese. We wanted to evaluate the texture characteristics of the Kargı Tulum cheese by a test that mimic the sensation of actual chewing of the cheese in the mouth, therefore we applied the TPA test. Although no significant difference was observed between moisture, fat levels, pH and acidity of the samples, there were significant differences between texture properties. Therefore, not only chemical and microbial properties but also texture properties should be evaluated for the quality determination of any traditional cheese. Many factors play role on cheese texture, such as ripening time and conditions, packaging used during ripening and packaging used for marketing and accompanying proteolysis at all stages.

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