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Determination of some characteristic properties in traditional Kargı Tulum cheese

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Abstract

Kargı Tulum cheese is produced and consumed in Çorum province of Turkey. The present study investigates some chemical, microbiological, and textural properties of Kargı Tulum cheese produced using the traditional method by a family-owned company in the Kargı district of Çorum. The mean values of Kargı Tulum cheese samples were as follows; dry matter content %61.71 ± 8.77, fat %30.28 ± 4.84, fat in dry matter %49.09 ± 5.15, protein content %20.17 ± 3.19, ash %4.67 ± 2.09, salt %4.76 ± 1.67, salt in dry matter %7.67 ± 2.43, titration acidity (as lactic acid) %1.41 ± 1.18 and pH is 4.64 ± 0.21, and in the textural analysis of cheese samples, the hardness value was 2750.88 ± 1719 g.

Keywords: Kargı Tulum cheese; microbial quality; texture; traditional cheese.

Practical Application: Traditional Kargı Tulum cheese is produced by traditional cheese makers in Kargı in the northwest Black Sea region from raw cow, goat, and ewe or a mixture of cow, goat, and ewe's milk and is ripened in bags. It has a characteristic taste, aroma, and unique flavors preferred over other Tulum cheeses.

1 Introduction

Cheese is very important in terms of human diet due to the variety of fatty acids it contains in the structure of milk fat. From a nutritional point of view, the digestibility of fat in cheeses is quite high (Barać et al., 2018). The demand of conscious consumers is shifting towards low-fat dairy products day by day. However, consumers do not want to sacrifice taste while reducing fat. Therefore, the necessity of using a fat substitute component in the production of reduced-fat cheese arises. A decrease in the proportion of milk fat in the matrix of low-fat cheese is replaced by free moisture and protein, which is achieved by using technological methods that differ from the generally accepted technology of standard-fat cheese (Chudy et al., 2021; Sviridenko et al., 2022). In addition, cheese is considered a part of a healthy diet because it is an important source of short chain fatty acids (Lock et al., 2014). The milk fat in the cheese contains saturated fatty acids (UFA) such as myristic and palmitic acids, which increase the blood plasma cholesterol level and increase the incidence of coronary heart diseases. However, cheese contains monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA), which have a positive effect on health, in its structure in varying proportions according to cheese types and the processes applied to milk, and it also supports the effect of reducing the risk of cardiovascular diseases (Barać et al., 2018; Lima et al., 2020). Today, studies in the field of nutrition show that foods are more than nutrients in their composition. This approach seems particularly true for cheese. The data obtained reveal that the components in the cheese composition are more advantageous in terms of cardiovascular risk compared to other dairy products (Feeney et al., 2021). In addition, in a study Cais-Sokolińska et al. (2021) firstly, it is reported that the cheese preferences of young consumers have changed. Secondly, is now considerable interest in traditional and regional foods (Cais-Sokolińska et al., 2021).

Kargı Tulum cheese is a form of Tulum cheese that is produced using traditional methods from raw sheep, goat, and cow milk or their mixtures at an altitude of 1,500 to 1,800 feet on the plateaus of the region during the summer months. Its production starts at the end of spring, coinciding with the sheep breeding season, and is consumed after maturing in the plateau. Kargı Tulum cheese is produced in small home-type enterprises using traditional methods. After the traditional production process, cheeses are filled with a region-specific packaging technique and put on the market in 500-, 1-, and 1.5-kilogram packages manufactured from processing sheepskin. Since Kargı Tulum cheese belongs to the group of cheeses made from raw milk, it is put on the market after maturing under suitable conditions for at least four months after production. There are many traditional types of locally produced and consumed cheeses, such as Kargı Tulum cheese, a special product in Turkey, which is made widely in the Kargı district and villages of the Çorum province (Dinkçi et al., 2012; Hayaloglu et al., 2007; Özdemir et al., 2013; Kirdar et al., 2015; Kamber, 2015; Gürsoy et al., 2018; Kiraz 2018).

The production is carried out according to the traditional production method in the highlands of the Kargı district of Çorum; first, the raw milk is filtered through a clean cheesecloth to purify the foreign elements and then heated to 24-25 °C. After the curd formation, the curd crushing and whey removal process is carried out using special cheese bags made of cloth for curd crushing. For this procedure, cloth bags are suspended for 24 hours at 5-7 °C using hooks designed specifically for this purpose. After waiting, the cheese is kept for 24 hours by applying pressure in wooden grooves under the same conditions so that more cheese liquid can be extracted. Dairy-produced fresh cheeses are first packaged in 15-20 kg cloth bags and stored at 15-18 °C. These bags, on the other

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hand, are matured for 3 to 4 months, while the bags are renewed every 15 to 20 days during the summer months. This study aimed to identify some characteristics of the Kargı Tulum cheese, which has the potential for national consumption and export.

2 Materials and methods

In this research, thirty different kinds of Kargı Tulum cheese ripened for four months in Kargı wells were purchased in their original packaging from the retail market in Kargı. The samples were stored in a refrigerator at +4 °C until being analyzed.

2.1 Chemical analysis

Total solids (TS) content of the cheese samples were measured by gravimetric method, fat was determined by the Gerber method, salt was measured by Mohr titration, acidity was determined, and ash content was determined using the method of Kurt et al. (1991) and Kurt & Çağlar (1993), pH was measured using a pH meter (model Adwa AD1000) with a combined glass electrode.

2.2 Microbiological analysis

Each sample was homogenized and diluted. The number of coliform group bacteria was determined on Violet Red Bile Agar (VRBA) (Oxoid), Potato Dextrose Agar of pH 3.5 adjusted with 10% tartaric acid (PDA) (Oxoid) for yeast and mold counts. Alter incubation at 35, and 25 °C for 48 h and 5-day colonies with characteristic properties were counted for coliform and yeast mold, respectively (Çakır, 2012).

2.3 The texture profile analysis

The texture profile analysis (TPA) was performed at room temperature using a texture analyzer (TA-XT Plus) with a 5 kg load cell. The Tulum cheeses were cut into 25 mm cubes. The TPA conditions were under a stainless compression probe (5 cm diameter) as follows: pre-test speed 1.0 mm/s, test speed of 5.0 mm/s. Texture profile analysis (TPA) was performed by compressing the sample to 40% of its original height and 5 s between two compressions. The values for hardness (N), adhesiveness (g.s), cohesiveness, springiness, chewiness (N), and gumminess (N) were determined according to the texture analyzer manual.

2.4 Statistical analysis

One-way analysis of variance (ANOVA) was performed to establish statistical differences between the chemical, microbiological, and textural properties of the samples. Tukey's multiple range test was applied to determine differences among groups using SPSS for Windows (version 25).

3 Results and discussion

3.1 Chemical characteristics of Kargı Tulum cheeses

The results of the chemical analyses applied to the samples (pH, titratable acidity, total dry matter, fat, NaCI, total nitrogen, ash) are shown in Table 1. In this study, the titratable acidity and pH values ranged from 0.2 to 4.79 and 4.08 to 5.01 average values of 1.41 and 4.64, respectively. The pH and titratable acidity values

Table 1. Some chemical compositions of Kargı Tulum cheese*.

Sample no	Dry matter (DM) (%)	Fat (%)	Fat in DM %	Salt (%)	Salt in DM %	Ash (%)	pH	Lactic acid (%)	Protein (%)
1	67.96^{a}	34^{a}	50.03^{a}	3.51^{a}	5.16^{a}	5.66^{a}	4.66^{a}	2.21^{a}	18.28^{a}
2	67.92^{a}	31^{ab}	45.64^{a}	3.69^{ac}	5.42^{ab}	2.63^{bc}	4.61^{a}	3.7^{b}	23.04^{b}
3	50.92^{b}	27^{a}	53.02^{a}	1.99^{b}	3.91^{a}	1.86^{b}	4.41^{a}	1.76^{c}	16.82^{a}
4	41.32^{bc}	14^{c}	34.15^{b}	4.80^{c}	11.62^{c}	2.94^{b}	4.64^{a}	2.18^{ac}	20.42^{ab}
5	49.78^{bc}	26^{ad}	52.23^{a}	3.48^{a}	7.03^{b}	2.57^{c}	4.40^{a}	1.60^{c}	14.42^{a}
6	60.45^{ab}	30^{ab}	49.63^{a}	5.38^{dc}	8.90^{bc}	5.46^{ab}	4.70^{a}	2.23^{a}	20^{a}
7	55.70^{ab}	26.50^{b}	47.58^{a}	4.74^{c}	8.51^{b}	4.90^{ad}	5.01^{a}	1.31^{dc}	17.71^{ab}
8	53.70^{bc}	27^{b}	50.28^{a}	4.56^{ac}	8.49^{b}	4.50^{d}	4.84^{a}	1.22^{dc}	17^{a}
9	75.50^{a}	37^{a}	49.01^{a}	5.38^{c}	7.13^{b}	4.60^{e}	4.56^{a}	4.79^{e}	26.50^{b}
10	64.40^{ab}	32^{ab}	49.69^{a}	6.32^{d}	9.81^{bc}	6^{af}	4.74^{a}	3.13^{g}	20.25^{ab}
11	65.20^{a}	31^{ab}	47.55^{a}	6.61^{d}	10.14^{bc}	6.90^{af}	4.76^{a}	2.84^{hg}	19.97^{ab}
12	60.90^{ab}	30^{ab}	49.26^{a}	6.96^{d}	11.42^{c}	6.80^{f}	4.79^{a}	2.18^{ac}	17.94^{a}
13	57.10^{ab}	28^{ab}	49.04^{a}	4.62^{ac}	8.09^{b}	4.90^{ad}	4.77^{a}	1.49^{cd}	16.65^{a}
14	61.80^{ab}	29.25^{ab}	47.33^{a}	5.38^{c}	8.71^{b}	6.10^{a}	4.83^{a}	1.80^{c}	19.15^{ab}
15	63.10^{ab}	30^{ab}	47.54^{a}	6.14^{d}	9.73^{bc}	7^{f}	4.32^{a}	2.18^{ac}	18.71^{ab}
16	62.90^{ab}	30.5^{ab}	48.49^{a}	7.31^{d}	11.62^{c}	7.90^{f}	4.68^{a}	2.34^{a}	19.88^{ab}
17	71.70^{a}	32.75^{ab}	45.68^{a}	6.55^{d}	9.14^{b}	7.60^{f}	4.79^{a}	0.27^{j}	21.01^{ab}
18	74.70^{a}	31.50^{ab}	42.17^{ab}	7.66^{d}	10.25^{bc}	8.30^{f}	4.79^{a}	0.43^{hj}	23.87^{ab}
19	77.50^{a}	36.50^{a}	47.10^{a}	5.62^{c}	7.25^{b}	5.40^{a}	4.64^{a}	0.74^{h}	27.61^{b}
20	67.90^{a}	32.25^{a}	47.50^{a}	5.32^{c}	7.84^{b}	7^{a}	4.74^{a}	0.43^{jh}	21.68^{b}
21	70.50^{a}	31.25^{a}	44.33^{ab}	6.49^{d}	9.21^{bc}	6.70^{f}	4.74^{a}	0.43^{hj}	23.60^{b}
22	53.10^{bc}	28^{a}	52.73^{a}	2.57^{ab}	4.84^{ad}	2.60^{c}	4.15^{a}	0.45^{hj}	16.62^{a}
23	48.10^{bc}	20^{c}	41.58^{ab}	2.81^{ab}	5.84^{ac}	2.60^{bc}	4.40^{a}	0.29^{j}	20.42^{ab}
24	55.20^{abc}	31^{ab}	56.16^{c}	2.75^{ab}	4.98^{a}	2.60^{c}	4.08^{a}	0.38^{hj}	17.71^{a}
25	53.90^{bc}	33.25^{ab}	61.69^{ac}	2.05^{b}	3.80^{a}	2.30^{c}	4.60^{a}	0.29j	15.44^{a}
26	55.40^{ab}	31^{ab}	55.60^{ac}	2.46^{ab}	4.44^{a}	2.20^{bc}	4.59^{a}	0.34^{jh}	19.15^{ab}
27	67.20^{a}	35.75^{a}	53.20^{ac}	4.80^{c}	7.14^{b}	2.10^{b}	4.53^{a}	0.43^{jh}	24.26^{bc}
28	67.60^{a}	37^{a}	54.73^{ac}	2.81^{ab}	4.16^{a}	2.50^{b}	4.80^{a}	0.34^{jh}	22.86^{b}
29	67.90^{a}	36.5^{a}	53.76^{ac}	3.57a	5.26^{a}	1.90^{b}	4.72^{a}	0.34^{jh}	23.80^{b}
30	61.90^{ab}	28.25^{ab}	45.64^{a}	6.38^{da}	10.31^{bc}	5.50^{d}	4.75^{a}	0.20^{j}	20.29^{ab}
Min	41.32	14	34.15	1.99	3.91	1.86	4.08	0.20	14.42
Max	77.50	37	61.69	7.66	11.62	8.30	5.01	4.79	27.61
Mean ± SD	61.71 ± 8.77	30.28 ± 4.84	49.09 ± 5.15	4.76 ± 1.67	7.67 ± 2.43	4.67 ± 2.09	4.64 ± 0.21	1.41 ± 1.18	20.17 ± 3.19

*Means in the same column followed by different letters represent significant differences ($p < 0.05$).

were similar to other studies (Bostan et al., 1992; Dinkçi et al., 2012; Erdem, 2016; Çakır, 2011). The average dry-matter content was 61.71% changing between 41.32 and 77.50. The fat content of cheese has important functions on the textural properties (Akpınar et al., 2017). The average fat in dry matter samples was 49.10%. The maximum fat content was 61.69%, and the minimum fat content was 34.15%; it is classified as full-fat cheese. The mean MNFS (%) value of cheese samples was found to be 49.09%, and it is classified as semi-hard cheese according to the Cheese Bulletin of Turkish Food Codex (Turkey, 2015). Salt is important in terms of texture properties, flavor, and microbial quality of cheese. 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 are in accordance with TS 3001 Tulum Cheese Standard (Türk Standartları Enstitüsü, 2016). Kargı Tulum cheese samples were analyzed for salt content, and it was found that the average salt content of the samples was 4.76%. The maximum salt content of the cheese sample was 7.66%, and the minimum salt content was 1.99%. According to the Turkish Food Codex, the salt content of cheese must not be higher than 5.0%. In some samples, therefore, the salt content exceeds the Codex value. The protein and ash content of cheese samples was determined through analysis. The average protein content of Kargı Tulum cheese was 20.17%, with a maximum of 27.16% and a minimum of 14.42%. The discrepancies in sample compositions are related to the fact that this type of cheese is made by local producers and does not have a standardized production procedure or milk composition. We observed statistically significant differences between cheese samples for all measured chemical parameters except for pH ($p < 0.05$). There is a limited number of Kargı Tulum cheese.

3.2 Microbiological quality of Kargı Tulum cheese

The results obtained from the microbiological analyses of Kargı Tulum cheese samples are presented in Table 2. There was no statistically significant difference between samples ($p > 0.05$). The average coliform count determined was 3.48 log cfu/g cheese changing between < 10 log cfu/g and 5.05 log cfu/g. According to the Turkish Food Codex, the permissible rate for coliform bacteria in cheese borders is 10^2/g. It was observed that the Turkish Food Codex of coliform limit was exceeded in all the cheese samples (Turkey, 2015).

The range of yeast and mold counts was between 3.79 and 7.76 cfu/g. The average was 6.44. The yeast and mold counts were similar to those reported by Bayar (2008a, b) and Dinkçi et al. (2012); however, they were higher than Haki (2012). High yeast and mold counts are generally associated with inadequate hygiene conditions during production and storage. The increased number of molds and yeasts, especially during the manual shredding and kneading process before the cloth bags are filled for ripening and storage, could be explained by the possibility of yeast and molds metabolizing lactic acid at lower pH (Turkoglu et al., 2003; Amran & Abbas, 2011).

3.3 Textural properties

The cheese's texture is an important parameter that influences consumer taste and purchasing profit (McKenna, 2003; Ercan, 2009; Aday et al., 2010). Texture Profile Analysis results of samples are shown in Table 3. In tissue profile analysis, the hardness value is the most descriptive of the textural properties of the samples and is, therefore, the most important parameter. Hardness is the maximum force exerted on the cheese at the initial press (Yaşar, 2007). Hardness amounts of samples ranged from 764.35 to 6836.56 g. According to Table 3, the hardness values of cheeses vary over a wide range. The amount of fat, moisture, and mineral contents have important effects on the hardness and firmness of cheese (Solís-Méndez et al., 2013).

The high water and fat content of cheese increase the separation of protein molecules and causes softening. Similarly, in our study, sample values with a high dry matter and high hardness values were found to be higher than others. A lower fat content in the cheese resulted in less firmness, spreadability and stickiness. However, it has greater resistance to extension (Cais-Sokolińska et al., 2021). The adhesiveness of cheese can be characterized by moisture (Karatekin, 2014). The adhesiveness

Table 2. Microbiological analysis results of Kargı Tulum cheese (log cfu/g)*.

Örnek No	Maya-Küf log kob/g	Koliform log kob/g
1	6.66^{ac}	4.40
2	3.79^{b}	3.85
3	7.55^{ac}	4.28
4	6.92^{ac}	4.29
5	7.3^{ac}	3.11
6	6.32^{ac}	4.15
7	7.76^{c}	3.93
8	7.66^{ac}	3.92
9	4.6 ^{b}	2.16
10	6.24^{a}	3.64
11	6.24^{a}	3.57
12	7.7^{a}	2.81
13	6.4^{a}	3.65
14	7.23^{a}	3.10
15	6.28^{a}	3.6
16	7.07^{a}	3.56
17	6.13^{a}	2.78
18	5.53^{ac}	3.33
19	3.85^{b}	< 10
20	6.23^{a}	3.48
21	5.84^{ab}	3.18
22	7.00^{ac}	2.39
23	7.06^{ac}	3.79
24	6.13^{a}	2.24
25	6.22^{a}	3.54
26	7.05^{ac}	3.91
27	6.45^{ac}	5.05
28	6.50^{ac}	4.8
29	6.32^{ac}	4.56
30	7.09^{ac}	3.40
Min	3.79	< 10
Max	7.76	5.05
Mean ± SD	6.44 ± 0.99	3.48 ± 0.96

*Means in the same column followed by different letters represent significant differences ($p < 0.05$).

Table 3. Texture profile analysis results of Kargı Tulum cheese*.

	Hardness	Adhesiveness	Springiness	Cohesiveness	Gumminess	Chewiness	Resilience
1	2796.39^{a}	-389.09^{a}	0.3986^{a}	0.2286^{a}	636.87^{a}	254.26^{ac}	0.033^{a}
2	2740.40^{a}	-128.13^{b}	0.3856^{a}	0.1742^{ac}	482.81^{ab}	190.43^{a}	0.0346^{a}
3	1171.73^{b}	-39.49^{c}	0.7114^{ba}	0.1732^{ac}	198.26^{c}	137.70^{a}	0.0468^{ac}
4	764.35^{bc}	-17.53^{c}	0.5366^{ab}	0.1752^{ac}	138.15^{c}	74.21^{a}	0.0568^{ac}
5	1124.72^{bc}	-33.36^{c}	0.5978^{ca}	0.2778^{ba}	309.27^{ab}	169.39^{a}	0.0764^{bc}
6	3223.02^{ab}	-97.35^{c}	0.5323^{ab}	0.286^{ba}	920.56^{dc}	489.86^{c}	0.0663^{c}
7	2220.69^{ab}	-47.66^{c}	0.465^{a}	0.2806^{ba}	626.36^{a}	289.95^{ca}	0.076^{c}
8	1748.54^{bc}	-36.76^{c}	0.4972^{a}	0.2254^{a}	401.35^{ab}	199.07^{a}	0.0682^{c}
9	4520.76^{a}	-68.74^{bc}	0.449^{a}	0.1713^{a}	806.66^{ca}	352.31^{ba}	0.0483^{ab}
10	4012.03^{ab}	-92.64^{bc}	0.5816^{ab}	0.2184^{a}	892.50^{ca}	502.22^{b}	0.0522^{ab}
11	2926.00^{a}	-87.35^{bc}	0.595^{ab}	0.226^{a}	656.80^{ca}	372.97^{ba}	0.054^{ab}
12	2425.66^{ab}	-50.73^{c}	0.4098^{a}	0.2258^{a}	564.01^{ab}	224.88^{a}	0.0542^{ab}
13	1586.98^{ab}	-40.86^{c}	0.4574^{a}	0.2618^{a}	416.03^{ab}	185.94^{a}	0.064^{c}
14	2469.91^{ab}	-57.07^{c}	0.5456^{ab}	0.2236^{a}	552.37^{ab}	303.83^{ba}	0.0554^{a}
15	2497.61^{ab}	-55.13^{c}	0.5164^{ab}	0.2474^{a}	631.69^{ca}	313.84^{ba}	0.0622^{c}
16	3742.25^{ab}	-76.64^{bc}	0.4846^{a}	0.2106^{a}	791.07^{ca}	379.92^{ba}	0.052^{a}
17	6526.89^{a}	-19.74^{c}	0.3506^{a}	0.1238^{c}	837.20^{ca}	304.13^{ba}	0.038^{a}
18	6414.19^{a}	-18.54^{c}	0.4404^{a}	0.1128^{c}	735.87^{ca}	321.15^{ba}	0.0416^{a}
19	2510.82^{a}	-8.45^{dc}	0.4956^{a}	0.103^{c}	253.96^{ab}	127.73^{a}	0.0344^{a}
20	5937.95^{a}	-20.27^{c}	0.3696^{a}	0.153^{ca}	920.29^{ca}	342.86^{a}	0.0502^{a}
21	6836.56^{a}	-48.43^{c}	0.4006^{a}	0.0898^{c}	630.38^{ca}	260.20^{a}	0.031^{a}
22	887.51^{bc}	-62.38^{c}	0.35^{a}	0.259^{a}	230.53^{a}	80.89^{a}	0.0486^{a}
23	1845.14^{bc}	-56.65^{c}	0.493^{a}	0.2188^{a}	405.00^{a}	198.82^{a}	0.062^{c}
24	1172.03^{ab}	-62.80^{bc}	0.3408^{a}	0.2612^{a}	309.50^{a}	103.85^{a}	0.0512^{a}
25	1810.45^{bc}	-62.50^{bc}	0.4512^{a}	0.2462^{a}	451.36^{a}	202.07^{a}	0.067^{c}
26	1369.75^{a}	-62.72^{bc}	0.3516^{a}	0.2892^{ba}	387.35^{a}	136.61^{a}	0.0698^{c}
27	1665.79^{a}	-153.72^{b}	0.4188^{a}	0.2952^{ba}	491.13^{a}	207.88^{a}	0.0536^{a}
28	1654.91^{a}	-155.65^{b}	0.4274^{a}	0.3212^{ba}	531.15^{a}	227.05^{a}	0.0552^{a}
29	1779.92^{a}	-154.93^{b}	0.4332^{a}	0.322^{b}	575.78^{ab}	249.84^{a}	0.0616^{c}
30	2143.54^{ab}	-49.58^{c}	0.5944^{ab}	0.1968^{a}	441.18^{a}	256.27^{a}	0.053^{a}
Min	764.35	-389.096	0.34	0.0898	138.15	74.21	0.031
Max	6836.56	-8.45	0.7114	0.322	920.56	502.22	0.0764
Mean ± SD	2750.88 ± 1719	-75.16 ± 71.56	0.4693 ± 0.0898	0.2199 ± 0.0627	540.85 ± 218.56	248.67 ± 107.44	0.0539 ± 0.0122

*Means in the same column followed by different letters represent significant differences ($p < 0.05$).

values of samples ranged between -8.45 and -389.09 g.s. Our results were lower than those of Kose et al. (2022) for the traditional cheese sample; however, they were similar to the results of Tarakçı & Deveci (2019) for White cheese. Resilience is the ability to regain the original shape after the second compression is applied to the cheese. Resilience values of samples ranged between 0.03 and 0.07%. Cohesiveness is called the rate of resistance of the food to the second compression (Aydın, 2019). Cohesiveness values of cheese samples ranged between 0.10 and 0.32. These results differed from the study conducted by Kose et al. (2022) for Malatya cheese and Aydın (2019) for kashar cheese. The rate of regaining the former shape after the maximum deformation generated by the initial application of pressure applied to the food is known as springiness (Karatekin, 2014). Springiness values of samples changed from 0.35 to 0.71. Gumminess is defined as the product of cohesiveness and hardness (Kose et al., 2022). As indicated in Table 3, the highest value was obtained for sample no. 6 (920.56) and the lowest for sample no. 4 (74.21). Similar results existed prior to the publication in the literature. Chewiness value is a major quality parameter that determines the appeal of a product to consumers (Eroglu et al., 2015; Kose et al., 2022). The chewiness values differ between cheese samples. We observed statistically significant differences between cheese samples for all texture parameters measured ($p < 0.05$). There is a limited number of Kargı Tulum cheese.

4 Conclusion

The chemical, textural, and microbiological quality of 30 different Kargı Tulum cheese samples were determined. In Turkey, there is no standard production method and quality standards for the optimization of the final product, as shown by the research's findings. This is owing to the fact that all chemical, microbiological, and textural characteristics of cheese samples exhibited significant variation. Considering the results of Kargı Tulum cheese samples, it is determined that standard production techniques should be used in the production of this cheese to increase consumer perception and acceptability.

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