



# Investigation of Some Quality Properties of Kars Gravyer, Gruyere, and Emmental Cheese

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## Abstract

In the present study, the characteristic features of the cheese known as Kars Gravyer cheese were determined. In addition, some parameters of Gruyere and Emmental cheeses, which are Swiss-type cheeses, were compared to the Kars Gravyer. Swiss Gruyere and Emmental cheeses were supplied from six various places. Also, six Gravyer cheese was obtained from different sales points in Kars. Some physicochemical properties of cheeses were investigated. Average moisture values were found to be the highest in Emmental cheeses, while the lowest was in Gruyere. The fat value was measured highest in Gruyere cheeses and the lowest in Emmental. Average b\* values were found to be the highest in Emmental cheeses; therefore, Emmental cheeses had a more yellow appearance than the others. Average hardness values were the highest in Kars Gravyer and the lowest in Gruyere.

**Keywords:** Gravyer, Swiss Cheeses, Physicochemical properties.

## Kars Gravyeri, Gruyere ve Emmental Peynirlerinin Bazı Kalite Özelliklerinin İncelenmesi

### Öz

Bu çalışmada Kars Gravyer peyniri olarak tanınan peynirin karakteristik özellikleri belirlenmiştir. Ayrıca İsviçre tipi peynir çeşitlerinden olan Gruyere ve Emmental peynirlerinin bazı parametreleri ile karşılaştırılmıştır. Kars'ta farklı satış noktalarından temin edilen 6 adet Gravyer peyniri, yine çeşitli satış noktalarından İsviçre Gruyere ve Emmental peynirlerinden 6'şar adet numune örneği alınarak fizikokimyasal ve tekstürel açıdan analiz edilmiştir. Ortalama nem değerleri en yüksek Emmental peynirlerinde, en düşük ise Gruyere peynirlerinde ölçülmüştür. Yağ değeri en yüksek Gruyere peynirlerinde, en düşük Emmental peynirlerinde ölçülmüştür. Ortalama b\* değeri en yüksek peynirler Emmental peynirler olduğu için bu peynirler diğerlerine göre daha sarı görünüme sahiptir. Ortalama sertlik değerleri en yüksek Kars gravyer peynirlerinde, en düşük Gruyere peynirlerinde ölçülmüştür.

**Anahtar Kelimeler:** Gravyer, İsviçre Peynirleri, Fizikokimyasal özellikler.

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## 1. Introduction

Gravyer cheese is from raw or pasteurized milk using calf siren and thermophilic starter cultures (propionic acid bacteria). It has medium-sized pores evenly spaced. It ripens for about 12 months and has a strong aroma. Its color is light yellow, and its crust color is golden yellow to brownish (Fernandes R. 2008; Lavanchy and Bütikofer, 1999).

Milk with high-fat contents is used in cheese making. This milk is obtained from Zavot cows, fed with plants with more than a thousand seeds (Koçulu, 2014). Gravyer cheese is a kind of local cheese produced in Turkey. Apart from this, it is a European type of cheese with economic value and is liked by consumers. Due to the increase in demand in the domestic market, its imports and production are increasing day by day. Gravyer cheese is produced in the Eastern Anatolia Region, especially in Kars province and its surroundings, as in other country regions. It is stated that this cheese was brought to Kars by the Russians, and its production was thought (Kurt, 1968). 90% (approximately 214 tons) of Gravyer is produced annually in Kars, Turkey (Anonymous, 2012; Anonymous, 2007b).

Le Gruyere cheese is a hardened cheese traditionally produced from raw milk from cows fed on meadows and pastures in the Alpine region of Switzerland. (Gerz et al., 2007). The origin of Swiss-type cheeses is the Emment valley in Switzerland. Swiss-type cheeses have round, smooth and medium to large (1-3 cm) pores (Steffen et al., 1993; Fröhlich-Wyder and Bachmann 2007). The authenticity of this cheese, which is known in many countries, varies according to milk. Milk is affected by the country's climate, geology, and flora. The Swiss-type Gruyere cheese is known by the name of the town of Gruyère in Switzerland. It has been produced since the 13th century in the town of Gruyère, northeast of Lake Lemman.

Boğatepe Gravyer or Kars Gravyer resembles porous Emmental cheese in appearance. Emmental cheese is another type of cheese originating from Switzerland. These two types of cheese differ from each other in terms of taste and production process. Swiss Gruyère cheese is non-porous and salty, while Emmental is porous and less salty (Arınç, 2018). Gravyer cheese has a stronger flavor than Emmental cheese and smaller pores. (İnal and Ergün, 1990; Fox et al., 2004a).

Gravyer cheese is one of the 20 kinds of hard and pored cheese globally. One of the most important features is that its pores are 1.3-1.5 cm in diameter, and these pores are generally 2.5-5 cm apart from each other (Nath and Kostak, 1986). On the other hand, in some studies, it has been stated that the diameters of the pores in Gravyer cheese vary between 0.5-1.3 cm (Kosikowski, 1981).

This study aimed to determine the characteristics of the Kars Gravyer cheese and to compare some parameters with Gruyere and Emmental cheeses, which are Swiss-type cheeses,

## 2. Material and Method

### 2.1. Materials

Within the scope of the study, a total of 18 types of cheese were used, including six types of Kars Gravyer cheese, six types of Gruyere cheese, and six types of Emmental cheese. Kars Gravyer cheese was obtained from factories and dairy farms in

and around Kars province. Gruyere and Emmental cheeses, Swiss ones, were also obtained from the sales place (Metro A.Ş) with suitable storage conditions (+4 °C). The samples were brought to the Iğdır University laboratory under cold chain conditions.

### 2.2. Physicochemical properties

Dry matter analysis of cheeses was made according to Metin and Öztürk (2002). Fat determination in cheese samples was determined using the Gerber method. (Anonymous 1978a). Gravimetric analysis was used to determine the Ash content of the cheeses. Salt analysis was carried out according to the Mohr method (Anonymous, 1978b; Metin and Öztürk 2002). Acidity in the samples was determined as %lactic acid (Kurt et al. 2015).

To determine the pH values of the cheeses, 10 g of grated cheese and 10 ml of distilled water were mixed and homogenized with the help of a homogenizer. The pH of the prepared mixture was measured with a digital pH meter (Kurt et al., 2015). Protein analysis was performed according to the Kjeldahl method (Kurt et al. 2015, Anonymous 2007a). The ratio of water-soluble protein and nitrogen in % was determined by the Micro-Kjeldahl method. The result was multiplied by 6.38 to determine the proportion of water-soluble protein (Kurt et al., 2015).

### 2.3. Color parameters

The color characteristics of the cheeses were determined with a color determination device (Lovinbond Reflectance Tintometer 962, Canada). Samples were measured light-darkness with L\* value (from black (0) to white (100)), green-red color with a\* value, and yellow-blue color with b\* value (Mitsumoto et al. 2005).

### 2.4. Textural properties

The textural properties of the cheese samples were determined using the TA.XT Plus Texture Analyzer texture measuring device (Mcmahon et al., 2009). Samples were cut into 2.0 cm cubes. A 2 cm diameter spherical head was used in the oppression. Compression speed was set to 1 mm.sec<sup>-1</sup>, with a total processing time of 10 sec. The compression process was carried out so that 25% of the original size of the samples was compressed.

### 2.5. Statistical Analysis

Results of some physicochemical properties of Kars Gravyer, Swiss-Gruyere and Emmental cheese were expressed with the standard normal distribution (Kissell and Poserina, 2017). All analyses were conducted with JMP Pro 15.

## 3. Results and Discussion

The physicochemical and textural values of Kars Gravyer cheese and Swiss Gruyere and Emmental cheeses were given in Table 1, Table 2, and Table 3.

### 3.1. Physicochemical measurements

The normal distribution graphs of the moisture, protein, fat, and ash contents of cheese samples were given in Figure 1. Moisture values of Kars Gravyer cheeses were also found to vary between 29.82-33.52% (Table 1). According to TS 2174 (38%), the moisture value of Kars Gravyer cheese was within the standard values. The moisture value of Kars Gravyer cheese was determined by Ulutas et al. (1993), 31.8%, Kamber et al. (2008)

found 19.8%, Topuk, and Sezer (2015) determined the moisture value of gravyer cheese bought from 40 different sales points between 20.37-36.8%, Çetinkaya, and Öz (2018) determined the moisture value of gravyer cheese in their study. The moisture value of Emmental cheeses was found to be between 35.12-40.52% (Table 1). The moisture value of Gruyere cheeses was

found to be between 28.08-32.60% (Table 1). Zerfiridis et al. (1984) measured the moisture value of Swiss gruyere cheeses matured for six months between 33.96% and 38.61%. Sabanoğlu (2010) found the moisture value of Emmental cheeses to be 37.40% - 39.26%, and Erol (2014) found the moisture value of Emmental cheeses to be 37.75%.

Table 1. Physicochemical values of Kars Gravyer, Swiss Gruyere, and Emmental cheeses

SAMPLE NO	Ash (550)	pH	Moisture	Acidity	Protein	Salt	Fat	WSN
<b>KG-1</b>	5.13	5.66	29.82	1.16	26.38	2.50	32.25	0.11
<b>KG-2</b>	4.39	5.96	33.52	1.02	28.35	1.65	31.50	0.16
<b>KG-3</b>	4.76	5.61	32.91	1.55	27.69	2.05	31.50	0.16
<b>KG-4</b>	4.53	5.66	32.92	1.57	29.96	1.79	28.75	0.19
<b>KG-5</b>	4.59	5.72	32.45	1.67	28.71	1.78	28.50	0.19
<b>KG-6</b>	4.45	5.64	30.45	1.19	29.06	1.62	30.75	0.20
<b>MEAN</b>	<b>4.64±0.27</b>	<b>5.71±0.13</b>	<b>32.01±1.51</b>	<b>1.36±0.27</b>	<b>28.36±1.23</b>	<b>1.90±0.33</b>	<b>30.54±1.56</b>	<b>0.17±0.03</b>
<b>SE-1</b>	3.83	5.99	36.74	1.23	29.92	1.44	27.25	0.19
<b>SE-2</b>	3.36	5.59	37.28	1.29	29.74	0.68	27.00	0.22
<b>SE-3</b>	3.83	5.86	36.78	1.44	27.93	1.37	28.50	0.18
<b>SE-4</b>	3.79	5.79	35.62	1.03	27.41	1.32	28.50	0.14
<b>SE-5</b>	3.79	5.79	35.12	1.24	26.95	1.00	27.75	0.17
<b>SE-6</b>	4.32	5.93	40.80	1.28	28.26	2.11	26.00	0.18
<b>MEAN</b>	<b>3.82±0.30</b>	<b>5.83±0.14</b>	<b>37.06±2.00</b>	<b>1.25±0.13</b>	<b>28.37±1.22</b>	<b>1.32±0.48</b>	<b>27.50±0.96</b>	<b>0.18±0.03</b>
<b>SG-1</b>	3.94	5.56	32.60	1.68	29.21	1.51	32.50	0.23
<b>SG-2</b>	4.18	5.95	30.41	1.63	29.06	1.81	33.50	0.35
<b>SG-3</b>	4.26	5.96	29.88	1.50	29.71	1.79	33.25	0.25
<b>SG-4</b>	3.58	6.76	29.95	1.56	28.51	1.12	36.00	0.33
<b>SG-5</b>	4.31	6.06	28.08	1.28	30.14	1.88	34.50	0.17
<b>SG-6</b>	4.54	6.05	30.59	1.51	28.96	1.99	34.25	0.18
<b>MEAN</b>	<b>4.14±0.33</b>	<b>6.06±0.39</b>	<b>30.25±1.46</b>	<b>1.53±0.14</b>	<b>29.27±0.58</b>	<b>1.68±0.32</b>	<b>34.00±1.21</b>	<b>0.25±0.07</b>

**KG:** Kars Gravyer **SE:** Emmental **SG:** Swiss-Gruyere

The pH value of Kars Gravyer cheese was found to be between 5.61 and 5.96 (Table 1). Kamber (2015) found the pH value of Kars Gravyer cheeses to be 5.73-6.82. Topuk and Sezer (2015) found the average pH value of Kars Gravyer cheeses purchased from 40 different sales points to be 6.02. The pH value of Emmental cheeses was found between 5.59-5.99 (Table 1). The pH value of Gruyere cheeses was found between 5.56-6.76 (Table 1). Zerfiridis et al. (1984) found the pH value of Swiss gruyere cheeses matured for 6 months between 5.35 and 5. Erol (2014) found the pH value of Emmental cheeses to be 5.33. Sabanoğlu (2010) found the pH value of Emmental cheeses to be between 5.42 and 5.76. It was emphasized that the reason for the different results was the raw material content and cheese culture used.

The average ash value of Kars Gravyer cheese is 4.64. In various studies on Kars Gravyer cheese, the ash value of cheeses was determined as 5.4 by Kamber et al. (2008), 3.95-6.61 by Topuk and Sezer (2015), and 4.94 by Ulutaş et al. (1993). The

average ash value of Emmental cheeses was measured as 3.82. The average ash value of Gruyere cheeses was measured as 4.14. Ash values were determined as 3.50 in Emmental cheeses (Langsrud and Reinbold, 1973) and 4.10 in Gruyere cheeses (Kosikowski, 1981).

The acidity value of Kars Gravyer cheese was measured between 1.02-1.67. The acidity value of Kars Gravyer cheese was found to be 1.54 by Kamber et al. (2008) and 1.87 by Ulutas et al. (1993). Çetinkaya and Öz (2018) found the average titration acidity of Gravyer cheese to be 1.12 in their study. They reported that the effect of ripening on titration acidity is significant. Gölge (2009) found 0.35-0.53% acidity value in fresh and ripened kelle cheese. The acidity value of Emmental cheeses was determined between 1.03 and 1.44 (Table 1). The acidity value of Gruyere cheeses was found between 1.28-1.68 (Table 1).

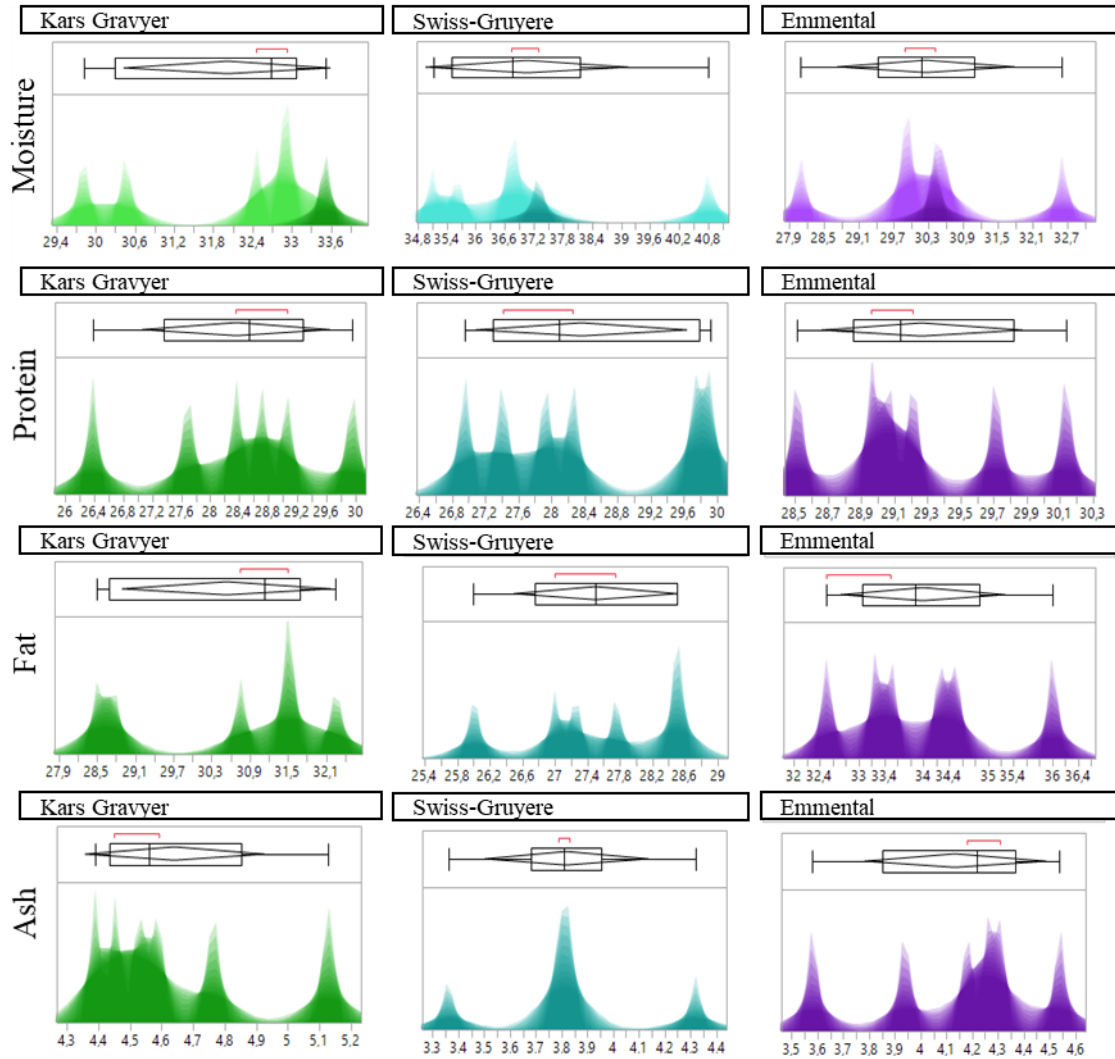


Figure 1. Normal distribution plot of Kars Gravyer, Swiss Gruyere, and Emmental cheeses

In this study, the protein value of Kars Gravyer cheese was found to be between 26.38-29.96 (Table 1). The protein values of Kars Gravyer cheese were found to be 31.3 by Kamber et al (2008), 23.7-33.3 by Topuk and Sezer (2015), 28.95 by Ulutas et al (1993), and 29.65 by Çetinkaya and Öz (2018). The protein value of Emmental cheeses was determined between 26.96-29.92 (Table 1). The protein value of Gruyere cheeses was found to be between 28.51-30.14 (Table 1). Langsrud and Reinbold (1973) determined the protein value of Emmental cheese as 27.50, Kosikowski (1981) determined the protein value of Gruyere cheese as 30.0, and Erol (2014) determined the protein value of Emmental cheese as 27.40. The results of our study show similarities with the studies carried out.

The salt value of Kars Gravyer cheese was found to be between 1.62-2.50% (Table 1). In various studies on Kars Gravyer cheeses, the salt value of cheeses was determined 11.0 % by Kamber et al. (2008), 1.03-5.57 % by Topuk and Sezer (2015), 3.70 % by Ulutas et al. (1993), and 1.53% by Çetinkaya and Öz (2018). Grappin et al. (1993) reported that salt concentration is quite effective in forming propionic acid fermentation in Gravyer cheese. At the same time, Huc et al. (2014) found that the number and size of pores decreased as the salt concentration increased. The salt value of Emmental cheeses was measured between 0.68-2.11 (Table 1). The salt value of Gruyere cheeses was found

between 1.12-1.99 (Table 1). The salt value in Emmental cheeses was determined as 1.20 by Langsrud and Reinbold (1973) and 2.60 by Erol (2014). Kosikowski (1981) determined the salt value in Gruyere cheese as 1.10 in his study. Our results were slightly lower than the TS2174 (3-10%) Kars Gravyer cheese standard. Salt values in various studies on Kars Gravyer cheese were slightly higher than our results. This is thought to be due to production differences.

The fat value of Kars Gravyer cheese was found to be between 28.50-32.25% (Table 1). The fat values of Kars Gravyer cheese were found as 32.4 by Kamber et al (2008), 23-42 by Topuk and Sezer (2015), 33.45 by Ulutas et al (1993), and 26.67 by Çetinkaya and Öz (2018). The fat value of Emmental cheeses was found to be between 26-28.5 (Table 1). The fat value of Gruyere cheeses was found to be between 32.5-36.0 (Table 1). Fat values in Emmental cheeses were found as 30.5 by Langsrud and Reinbold (1973) and 29.81 by Erol (2014). Fat values in Gruyere cheese were found as 30.0 by Kosikowski (1981). Zerfiridis et al. (1984) determined that the fat value of Gravyer cheese matured for 6 months is relatively high. Our results were within the limit values according to TS2174 (30-48) Kars Gravyer cheese standard.

The WSN value of Kars Gravyer cheese was found to be between 0.11-0.20 (Table 1). The WSN value of Emmental cheeses was determined between 0.14-0.22 (Table 1). The WSN value of Gruyere cheeses varied between 0.17-0.35 (Table 1). Çelebi and Şimşek (2020) found the water-soluble nitrogen rates to be 0.48% on the first day and 0.61% at the end of storage. Water-soluble nitrogen contains peptides, free amino acids, and the non-casein fraction of proteins. The formation of water-soluble nitrogen compounds with maturation gives us clues about proteolysis.

### 3.2. Color measurements

The L\* value of Kars Gravyer cheese was found to be between 71.13 and 79.39 (Table 2.). The L\* value of Emmental cheeses was found to be between 71.02-77.29 (Table 2.). The L\* value of Gruyere cheeses was found to be between 70.39 and 82.25 (Table 2.). It has been determined that Gruyere cheese is brighter than other cheeses, as the L\* value shows the degree of black and whiteness. Kavak and Karabıyık (2019) found the L value of kashar cheese to be between 85.87-87.42 on the first day of storage and between 81.45-83.34 on the end of storage. Metzger et al. (2000) reported that fat globules and casein affect the L value of cheese. A decrease in L\* values at the end of ripening was also reported by Dinkci et al. (2011). This decrease in L\* value is due to the Maillard reaction between lactose and casein during ripening. (Corzo et al., 2000).

Table 2. Color values of Kars Gravyer, Swiss Gruyere, and Emmental cheeses

SAMPLE NO	L*	a*	b*
KG-1	79.39	-3.63	24.24
KG-2	74.97	-3.01	23.05
KG-3	76.10	-2.83	24.83
KG-4	71.13	-1.46	19.61
KG-5	76.69	-2.97	26.33
KG-6	74.98	-2.87	22.98
MEAN	<b>75,54±2,70</b>	<b>-2,80±0,72</b>	<b>23,51±2,28</b>
SE-1	72.64	-2.34	24.86
SE-2	75.90	-3.32	27.92
SE-3	77.29	-1.71	21.80
SE-4	76.05	-3.09	28.59
SE-5	71.61	-2.93	24.92
SE-6	71.02	-1.47	19.32
MEAN	<b>74,09±2,65</b>	<b>-2,48±0,76</b>	<b>24,57±3,54</b>
SG-1	77.39	-1.63	21.90
SG-2	82.25	-2.46	27.71
SG-3	76.45	-2.98	25.97
SG-4	70.39	-1.45	19.45
SG-5	79.62	-3.11	26.52
SG-6	76.79	-2.89	24.84
MEAN	<b>77,15±3,96</b>	<b>-2,42±0,72</b>	<b>24,40±3,13</b>

KG: Kars Gravyer SE: Emmental SG: Swiss-Gruyere

The a\* value of Kars Gavyer cheese was found to be between -1.46--3.63 (Table 2). The a\* value of Emmental cheeses was found to be between -1.47--3.32 (Table 2). The a\* value of Gruyere cheeses was found to be between 1.45 and -3.11 (Table

2). Kavak and Karabıyık (2019) found the a\* value of kashar cheese between -4.32- -3.11 on the first day of storage and between -4.24- -2.78 at the end of storage. Sahan et al. (2008) reported that the reduced-fat cheese samples had a more greenish hue.

The b\* value of Kars Gravyer cheese was found to be between 19.61-26.33 (Table 2.). The b\* value of Emmental cheeses was found between 19.32-28.59 (Table 2.). The b\* value of Gruyere cheeses was found between 19.45-27.71 (Table 2.). Emmental cheeses are the cheeses with the highest average b\* value. Therefore, these cheeses have a more yellow appearance than others. Kavak and Karabıyık (2019) found the b\* value of kashar cheese to be between 9.61-10.21 on the first day of storage and between 11.23-12.60 at the end of storage. At the same time, Buffa et al. (2004) reported that the b\* value of cheese increased at the end of storage, so the yellowness of cheese increased with ripening.

### 3.3. Textural properties

The hardness value of Kars gravyer cheese was found to be between 3702.33 - 9013.03 g (Table 3).

The hardness value of Emmental cheeses was found between 3163.67-6153.53 g (Table 3). The hardness value of Gruyere cheeses was found to be 2788.33-6974.81 g (Table 3). The hardest one among the cheeses was the sample numbered KG-6. Ozcan et al. (2017) attributed the different textural properties of cheeses to the composition of the milk, heat treatment process, pH, salt content, and different starter cultures in their study. Many researchers have reported that moisture loss, enzymatic activity, and salt content during the ripening stage are effective in the formation of textural features (Fox and Wallace, 1997; Puvaca et al., 2020). Eroglu et al. (2015) reported that the hardness values of 30 different fresh kashar cheeses ranged from 34.76 to 112.6 N. Alam et al. (2016) measured the average hardness value of mozzarella cheese as 138.89. They stated that atmosphere packaging types play an important role in the proteolysis and textural properties of mozzarella cheese. Khanal et al. (2018), in their study on kashar cheese, stated that the texture values of cheeses with added sodium alginate were softer than low-fat kashar cheese.

The long ripening period in Gravyer cheese causes the formation of a hard crust. It has been reported by researchers that the moisture content of this type of cheese affects different characteristics of the cheese, such as texture, aroma, and taste (Fox et al., 2004a; Fox et al., 2004b).

It is also known that because of the enzymatic hydrolysis of casein, the hardness value of cheeses decreases with ripening (Eroglu et al., 2015). The adhesiveness value of Kars Gravyer cheese was found to be between -4.91- -27.28 (Table 3). The adhesiveness value of Emmental cheeses was found between -3.78- -15.85 (Table 3). The adhesiveness value of Gruyere cheeses was found between -9.21- -74.95 (Table 3). Eroglu et al. (2015) examined 30 different fresh kashar cheeses and found the adhesiveness values of their cheeses between -0.310 and -1.176 N.s. Eroglu et al. (2015) reported that the adhesiveness values of kashar cheeses changed between -75.00 – -61.00 on the first day of storage and -14.50 – -5.90 at the end of storage.

The springiness value of Kars Gravyer cheese was found to be between 0.77-0.89 (Table 3). The springiness value of Emmental cheeses was found between 0.78-0.87 (Table 3). The

springiness value of Gruyere cheeses was found between 0.51-0.81 (Table 3). It is known that the decrease in springiness with maturation is due to proteolytic degradation (Sahan et al., 2008; Jaster et al., 2019). Kavak and Karabıyık (2020) found that the springiness value of kashar cheeses varied between 0.76-0.86.

The cohesiveness value of Kars Gravyer cheese was found to be between 0.30-0.53 (Table 3). The cohesiveness value of Emmental cheeses was found between 0.38-0.63 (Table 3). The cohesiveness value of Gruyere cheeses was found between 0.15-0.52 (Table 3). Alam et al. (2016) determined mozzarella cheese's average cohesiveness value as 0.38. It is known that the cohesiveness value decreases due to the increase in lipolysis and proteolysis levels during maturation (Delgado et al., 2011). It has been reported by some researchers that there is a positive relationship between the moisture content and stickiness of cheeses (Koca and Metin, 2004). Yaşar, (2007), Eroğlu et al., (2015), and Çelebi and Şimşek (2020) stated that the cohesiveness values of kashar cheese decreased with ripening.

The gumminess value of Kars Gravyer cheese was found to be between 1461.80 and 4361.92 (Table 3). The gumminess value of Emmental cheeses was found to be between 1614.26 and

3344.37 (Table 3). The gumminess value of Gruyere cheeses was found to be between 981.33 and 1462.33 (Table 3). The gumminess value changes in direct proportion to the cohesiveness and hardness values (Göksel et al., 2013). Eroğlu et al. (2015) reported that the gumminess value of kashar cheeses varied between 20.50 and 66.28. Alam et al. (2016) reported that the average gumminess value in mozzarella cheese was 50.34 N. At the same time, Çelebi and Şimşek (2020) reported that the gumminess value of kashar cheese decreased with ripening.

The chewiness values of Kars gravyer cheese were found to be between 1163.97 and 3895.13 (Table 3). The chewiness values of Emmental cheeses were found to be between 1259.68 and 2648.41 (Table 3). The chewiness values of Gruyere cheeses were found to be between 507.33 and 1159.33 (Table 3). Alam et al. (2016) measured the average chewiness of Mozzarella cheese as 25.17 N.mm. The resilience values of Kars gravyer cheese were found to be between 0.05 and 0.16 (Table 3). The resilience values of Emmental cheeses were found to be between 0.11 and 0.23 (Table 3). The resilience values of the Gruyere cheeses were found to be between 0.03 and 0.17 (Table 3).

Table 3. Textural values of Kars Gravyer, Swiss Gruyere, and Emmental cheeses

SAMPLE NO	Hardness	Adhesiveness	Springiness	Cohesiveness	Gumminess	Chewiness	Resilience
<b>KG-1</b>	8532.44	-17.88	0.82	0.34	1619.48	1214.57	0.09
<b>KG-2</b>	3702.33	-4.91	0.79	0.53	1968.00	1552.33	0.16
<b>KG-3</b>	4033.20	-9.34	0.79	0.36	1461.80	1163.97	0.11
<b>KG-4</b>	7500.04	-19.81	0.77	0.30	2201.00	1708.97	0.05
<b>KG-5</b>	8736.99	-27.28	0.89	0.50	4361.92	3895.13	0.16
<b>KG-6</b>	9013.03	-13.47	0.78	0.35	2230.15	2677.83	0.07
<b>MEAN</b>	<b>6919,67±2420,98</b>	<b>-15,45±7,97</b>	<b>0,81±0,04</b>	<b>0,40±0,09</b>	<b>2307,06±1052,79</b>	<b>2035,47±1062,49</b>	<b>0,11±0,05</b>
<b>SE-1</b>	4940.71	-7.07	0.87	0.42	2045.68	1776.09	0.12
<b>SE-2</b>	3726.00	-3.78	0.84	0.62	2346.67	1961.00	0.23
<b>SE-3</b>	5668.59	-4.20	0.79	0.59	3344.37	2648.41	0.18
<b>SE-4</b>	3163.67	-7.30	0.79	0.63	1989.67	1556.33	0.20
<b>SE-5</b>	6153.53	-5.73	0.83	0.54	3321.19	2780.51	0.12
<b>SE-6</b>	3761.00	-15.85	0.78	0.38	1614.26	1259.68	0.11
<b>MEAN</b>	<b>4568,92±1199,71</b>	<b>-7,32±4,42</b>	<b>0,82±0,04</b>	<b>0,53±0,11</b>	<b>2443,64±727,07</b>	<b>1997,00±604,34</b>	<b>0,16±0,05</b>
<b>SG-1</b>	3514.67	-11.92	0.72	0.41	1462.33	1065.00	0.12
<b>SG-2</b>	6974.81	-74.95	0.62	0.15	1020.02	631.88	0.03
<b>SG-3</b>	3046.33	-9.21	0.70	0.47	1512.67	1051.33	0.15
<b>SG-4</b>	3655.33	-40.39	0.51	0.27	981.33	507.33	0.07
<b>SG-5</b>	2806.00	-19.83	0.79	0.40	1164.50	873.00	0.13
<b>SG-6</b>	2788.33	-28.04	0.81	0.52	1440.00	1159.33	0.17
<b>MEAN</b>	<b>3797,58±1597,58</b>	<b>-30,72±24,46</b>	<b>0,69±0,11</b>	<b>0,37±0,14</b>	<b>1263,48±237,27</b>	<b>881,31±261,57</b>	<b>0,11±0,05</b>

KG: Kars Gravyer SE: Emmental SG: Swiss-Gruyere

## 4. Conclusions and Recommendations

When the results of the physicochemical analysis were evaluated, the moisture value of the cheeses was found within the standard values. The average protein value of the cheeses was measured the highest in Gruyere cheeses, then in Emmental cheeses, and the lowest in Kars gravyer cheeses. The average salt values of the cheeses were found to be slightly lower than the TS2174 (3-10%) Kars Gravyer cheese standard. The average fat values of the cheeses were within the limit values according to the TS2174 (30-48) Kars Gravyer cheese standard. The mean L\* values of the cheeses were measured the highest in Gruyere cheeses, then in Kars Gravyer cheeses, and the lowest in Emmental cheeses. The a\* values were highest in Gruyere cheeses, followed by Emmental cheeses, and the lowest in Kars Gravyer cheeses. The b\* values were highest in Emmental cheeses, followed by Gruyere cheeses, and the lowest in Kars Gravyer. Since the cheeses with the highest average b\* values are Emmental cheeses, these cheeses have a more yellow appearance than others. The average hardness value of the cheeses was the hardest sample KG-6.

As a result, it is thought that the data obtained may increase the chance of competing with the world-famous counterparts of Kars Gravyer cheese, such as similar cheese varieties with high economic potential. At the same time, it is thought that it can contribute to the economy of the region and the country.

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