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Physicochemical and Sensory Characteristics of Winter Yoghurt Produced from Mixtures of Cow's and Goat's Milk

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ABSTRACT

Winter yoghurt is one of the most popular dairy products in Van and Hatay region of Turkey. It is made of different kinds of milk, and known as "cooked yoghurt" or "salted yoghurt" due to its high solids content and long shelf life. In this study, two different concentration methods were used to produce traditional winter yoghurt. Some physical (firmness and cohesiveness, *L*-, *a*- and *b*- values), chemical (total solid, fat, protein, pH, lactic acid, salt) and sensory analyses (color, odor, consistent and flavor) were made to determine the effect of production methods and storage on winter yoghurt samples at the 1st, 30th, 60th and 90th days. Significant differences were found between sensory, rheological properties and color values of winter yoghurts however no significant differences were found between physicochemical properties of the samples. Especially, winter yoghurts produced from 100% goat milk were the more appreciated samples.

Keywords: Winter yoghurt; Concentrated yoghurt; Goat's milk; Salt; Traditional dairy products

İnek ve Keçi Sütü Karışımlarından Üretilen Kış Yoğurtlarının Fizikokimyasal ve Duyusal Karakteristikleri

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ÖZET

Kış yoğurdu Türkiye'nin Van ve Hatay illerinde en meşhur süt ürünlerinden biridir. Çeşitli sütlerden üretilen kış yoğurdu yüksek kurumadde içeriği ve uzun raf ömründen dolayı "pişmiş yoğurt" veya "tuzlu yoğurt" olarak bilinmektedir. Çalışmada kış yoğurdunun geleneksel olarak üretilmesi amacıyla iki farklı koyulaştırma yöntemi uygulanmıştır. Farklı üretim yöntemlerinin ve depolama süresinin kış yoğurdu örnekleri üzerine etkilerini belirlemek amacıyla 1., 30., 60. ve 90. günlerde bazı fiziksel (sertlik ve yapışkanlık, *L*-, *a*- ve *b*- değerleri), kimyasal (kurumadde, yağ, protein, pH, laktik asit, tuz) ve duyusal (renk, koku, kıvam ve lezzet) analizler yapılmıştır. Kış yoğurdu örneklerinin duyusal ve reolojik özellikleri ile renk değerleri arasında önemli farklıklar bulunmuş, bununla birlikte örneklerin fizikokimyasal özellikleri arasındaki farklar önemsiz olarak tespit edilmiştir. Özellikle % 100 keçi sütünden üretilen kış yoğurtları daha çok beğenilmiştir.

Anahtar Kelimeler: Kış yoğurdu; Konsantre yoğurt; Keçi sütü; Tuz; Geleneksel süt ürünleri

1. Introduction

Elimination of yoghurt whey is one of the most important factors for keeping quality and extending the shelf-life of yoghurt. Traditional and new methods have been used in removing yoghurt whey for the manufacture of strained yoghurt. The strained yoghurt produced by using traditional method is preferred by consumers due to its sensory properties in Turkey. However modern methods of ultrafiltration and centrifugation have been employed to produce strained yoghurts (Tamime et al 1991; Şenel et al 2011). Many strained/concentrated milk products are manufactured by different methods in other countries. They are known as labneh or lebneh in the Middle East, leben zeer in Egypt, skyr in Iceland, chakka and shirkland in India, than or tan in Armenia and Ymer in Denmark (Nergiz & Seçkin 1998; Şenel et al 2011). Several types of strained/concentrated yoghurt have been produced traditionally in Turkey. These products are known as kurut, torba yoghurt, tulum yoghurt, kese yoghurt, peskuten and winter yoghurt. It is recommended that these yoghurts made from different types of milk may be considered an important source of phosphorus, calcium, magnesium, selenium and zinc over the regular yoghurts and whey products and, have a relatively high content of total solids (Güler & Sanal 2009; Kesenkaş 2010; Şenel et al 2011).

Among them, winter yoghurt is one of the most popular varieties of traditional dairy product manufactured in Hatay, Van and Sivas regions in Turkey. It has high total solid content and long shelf life. There are two procedures in the production of winter yoghurt. In the first procedure the set-type yoghurt is boiled (cooked) and then salt is added. The second procedure was the method which yoghurt whey is removed by using cloth bag, boiled, and then salt is added in order to shorten cooking time (Güler & Park 2009).

Because of its peculiar flavor and nutritional properties and its recognition as a healthy food, goat's milk attracts attention by dairy industry. Some properties of goat's milk are known to be advantageous compared with other milk varieties such as higher tolerance by allergic children and the high proportion of smaller fat globules, which provide better digestibility (Queiroga et al 2013).

Thus the aim of this study was to investigate the availability of goat milk for winter yoghurt production and to assess some quality parameters and sensory acceptability of this traditional product made from different mixtures of goat's and cow's milk, by two different concentration methods. For this purpose the difference between samples and the effect of storage period on physical, chemical and sensorial properties of winter yoghurts were investigated throughout 90 days storage.

2. Material and Methods

2.1. Materials

Cow's and goat's milk was obtained from Ege University, Faculty of Agriculture and transferred directly to the pilot dairy plant of the Department of Dairy Technology (İzmir, Turkey). *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* (MYE 96-98 Maysa Istanbul, Turkey) were used as yoghurt starter cultures in accordance with the manufacturer's recommendation. Food grade NaCl (Estuz, Eskisehir, Turkey) was used for salting.

2.2. Winter yoghurt production

Winter yoghurt, samples were made by a traditional method in the pilot dairy plant (Figure 1). Six different yoghurt samples were made from 100% cow milk, 50-50% cow and goat milk and 100% goat

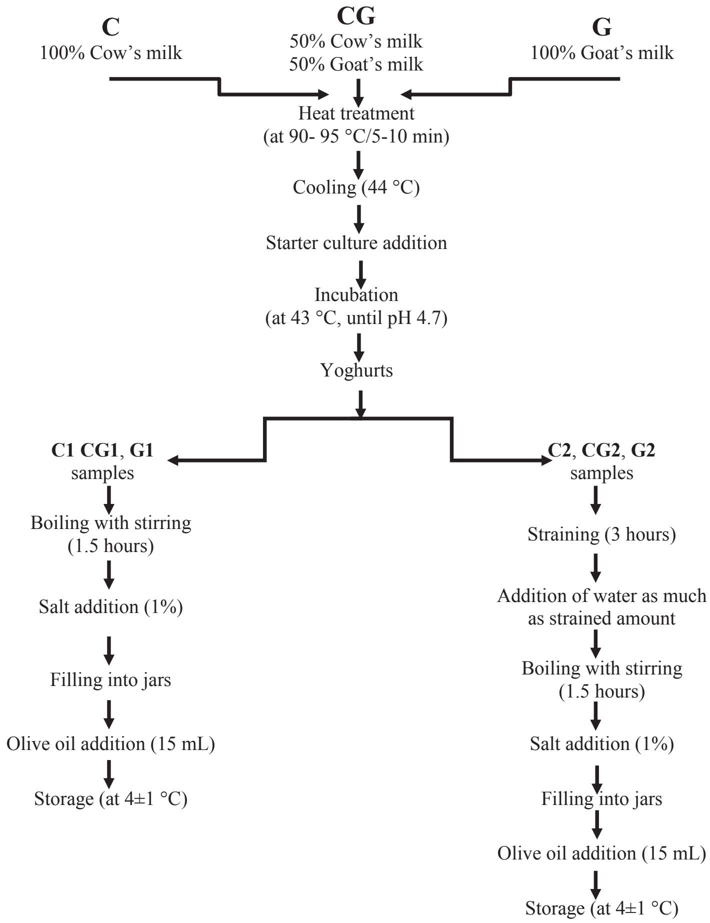

Figure 1- Production of winter yoghurt samples

Şekil 1- Kış yoğurdu örneklerinin üretimi

milk with using two different methods. Samples were grouped as C1: Winter yoghurt made with 100% cow milk only by boiling, C2: Winter yoghurt made with 100% cow milk by straining and boiling, G1: Winter yoghurt made with 100% goat milk only by boiling, G2: Winter yoghurt made with 100% goat milk by straining and boiling, CG1: Winter yoghurt made with 50% cow-50% goat milk only by boiling, CG2: Winter yoghurt made with 50% cow-50% goat milk by straining and boiling. All winter yoghurts were filled to glass jars (100 mL) after cooling and their upper surfaces were coated with olive oil. Winter yoghurts were stored at 4±1 °C for 90-days.

2.3. Physicochemical analyses

The total solids, fat, total protein, pH and lactic acid contents of cow's and goat's milk were determined according to the Association of Official Analytical Chemist methods (AOAC 2003). The total solid contents of samples were determined by gravimetric method using oven drying at 105 °C for 3 h (AOAC 2003). Protein was measured by Kjeldahl method. Fat and salt content were determined by the Gerber method and the titration method as described in Turkish standards, respectively (TSE 1999; 2001). The pH was determined with a pH meter (Hanna

Instruments, Portugal). The textural characterization (firmness and cohesiveness) of samples was carried out by using a Texture Analyzer (Brookfield Texture Analyzer TA-CT3, Middleboro, USA) with a 38 mm diameter probe (TA4/1000). The penetration of 10 mm was determined at following speeds: pre-test 2 mm s^{-1}, test 1 mm s^{-1} and post-test 10 mm s^{-1}. A colorimeter (CR-300, Minolta Co., Japan) was used to determine whiteness/blackness (L-), red/greenness (a-), and yellow/blueness (b-) values of the strained yoghurts.

2.4. Sensory evaluation

Sensory properties of yoghurt samples were evaluated according to Altuğ & Elmacı (2011). Sensory panel was carried out by six panelists who are members of the Dairy Technology Department. Samples were evaluated in terms of color, odor, consistent and flavor with using 5-point scale. Samples were left at the room temperature for 15 minutes and then they were served with a glass of water and an unsalted cracker to the panelists.

2.5. Statistical analysis

One way analysis of variance (ANOVA) and Duncan's Multiple Range Test were applied in order to determine the differences between winter yoghurts and to estimate the effect of storage on samples. Also multivariate general linear model (GLM) ANOVA was carried out to investigate the two-way interactions (production method x storage). All statistical analyses were performed using the statistical software SPSS© 15.0 for Windows. In all cases, the 0.05 probability level was considered. All experiments and analyses were completed in duplicate.

3. Results and Discussion

The mean values for the chemical composition of cow's and goat's milk used to produce winter yoghurt was given in Table 1. The non-fat solid, fat, protein and lactic acid contents of goat's milk were found to be higher than cow's milk. Total solid, fat contents and pH values of the goat's milk were found to be higher than reported by Güler (2007) and Güler & Park (2009).

Table 1- Chemical composition of raw cow and goat milk used in production

Çizelge 1- Üretimde kullanılan çiğ keçi ve inek sütünün kimyasal kompozisyonu

	NFS[1] (g 100 g^{-1})	*Fat (g 100 g^{-1})*	*Protein (g 100 g^{-1})*	*pH*	*Titration acidity (Lactic acid, %)*
Cow milk	8.90±0.10	3.30±0.05	3.38±0.04	6.70±0.03	0.145±0.01
Goat milk	9.10±0.05	4.80±0.05	3.45±0.00	6.68±0.02	0.158±0.02

[1], non-fat total solids

The total solid, fat and salt content of winter yoghurts were determined only at first day of storage (Table 2). Total solid of the yoghurt produced in our study varied between 25.36% and 36.53%. Differences between total solid contents of samples were significant (P<0.05) while CG1 and CG2 samples had closer results. Levels of total solids increased during winter yoghurt-making process. This is due to the removing of whey and evaporation of water as a result of cooking, and also to addition of salt. Especially total solid content were higher than those reported by Gönç & Oktar (1973), Güler (2007), Güler & Park (2009) and Köse & Ocak (2011).

The fat content of winter yoghurts changed between 5.65% and 11.40%. Differences in the fat content between all samples were significant (P<0.05). It was found that fat contents of winter yoghurt samples produced only by boiling were significantly higher than others which were produced by straining and boiling but with the same milk mixture. On the other hand, it was seen that G1 and G2 sample which produced with goat's milk had higher fat content than C1 and C2 sample which

Table 2- Chemical composition of winter yoghurt samples

Çizelge 2- Kış yoğurdu örneklerinin kimyasal kompozisyonu

	Total solids (%)	*Fat (%)*	*Salt (%)*
C1	31.74±1.25^{b}	6.65±0.07^{c}	3.85±0.07^{b}
C2	25.36±0.73^{a}	5.65±0.07^{a}	4.05±0.07^{c}
G1	36.53±1.27^{d}	11.40±0.00^{f}	4.65±0.07^{d}
G2	34.51±2.10^{cd}	9.70±0.14^{e}	4.05±0.07^{c}
CG1	33.89±0.74^{bc}	9.05±0.07^{d}	2.95±0.07^{a}
CG2	32.75±1.09^{bc}	6.35±0.21^{b}	4.10±0.00^{c}

C1, winter yoghurt made with 100% cow milk only by boiling; C2, winter yoghurt made with 100% cow milk by straining and boiling; G1, winter yoghurt made with 100% goat milk only by boiling; G2, winter yoghurt made with 100% goat milk by straining and boiling; CG1, winter yoghurt made with 50% cow-50% goat milk only by boiling; CG2, winter yoghurt made with 50% cow-50% goat milk by straining and boiling; a-d, means in the same column with different superscripts among samples significantly differ (P<0.05)

produced with cow's milk. It was thought that these results depend substantially on the composition of milk.

As shown in Table 2 differences in the salt content between all samples of winter yoghurts were significant (P<0.05). The salt content of winter yoghurts changed between 2.95% and 4.65%. The variation between salt contents can be attributed to evaporation differences during boiling. Güler (2007) indicated that salt content was not changed from the beginning to the end of storage in salted yoghurt samples which were added 2% salt. In our study, salt content of winter yoghurts were similar with Gönç & Oktar (1973), Biçer et al (1995) and Şahan & Say (2003).

3.1. pH and acidity

pH values and the changes occurred during the storage is given in Table 3. Production method and storage affected pH values and also a significant interaction was detected (P<0.05). It can be seen that at the beginning and the end of the storage the lowest pH value was determined for C1, while the highest pH value was determined for G1 at the beginning and for G2 on 90th day of the storage. During the storage, increases and decreases in pH values was determined, this irregular pH changes were also determined by Köse & Ocak (2011) in winter yoghurt which was stored for 180 days. Furthermore similar pH values were also found by Nergiz & Seçkin (1998), Kırdar & Gün (2002) and Ersöz et al (2011). The highest lactic acid value was

Table 3- Acidity of winter yoghurt samples during 90-days storage

Çizelge 3- Kış yoğurdu örneklerinin 90 günlük depolama sırasındaki asitlik değerleri

		Days			
	Samples	*1*	*30*	*60*	*90*
pH	C1*	3.93±0.06^{aZ}	3.95±0.01^{bZ}	3.46±0.02^{aX}	3.77±0.06^{Y}
	C2	4.15±0.00^{bZ}	4.12±0.03^{cZ}	3.65±0.07^{bX}	3.85±0.07^{Y}
	G1	4.23±0.04^{bZ}	4.08±0.02^{cY}	4.15±0.07^{dYZ}	3.93±0.04^{X}
	G2	4.19±0.02^{bY}	4.19±0.00^{dY}	4.22±0.03^{dY}	3.94±0.05^{X}
	CG1	4.00±0.07^{aY}	3.69±0.01^{aX}	3.99±0.05^{cY}	3.80±0.00^{X}
	CG2	4.11±0.02^{bZ}	4.12±0.03^{cZ}	3.58±0.02^{abX}	3.93±0.04^{Y}
Titration acidity (%)	C1	1.98±0.01^{c}	1.97±0.01^{c}	1.98±0.00^{c}	1.88±0.04^{c}
	C2	1.27±0.00^{aX}	1.36±0.00^{aZ}	1.32±0.00^{aY}	1.34±0.01^{aYZ}
	G1	2.24±0.00^{dY}	1.60±0.09^{bX}	2.39±0.00^{fZ}	2.25±0.03^{dYZ}
	G2	1.95±0.02^{cXY}	1.98±0.01^{cYZ}	2.01±0.02^{dZ}	1.92±0.00^{cX}
	CG1	2.35±0.04^{eZ}	2.17±0.01^{dX}	2.27±0.00^{eY}	2.23±0.00^{dXY}
	CG2	1.59±0.02^{b}	1.51±0.08^{b}	1.55±0.00^{b}	1.62±0.02^{b}

*, for C1, C2, G1, G2, CG1 and CG2 please refer to Table 2; means in the same row with different superscripts upper-case letter (X, Y and Z) significantly differ (P<0.05); means in the same column with different superscripts lower case letter (a-f) among yoghurt samples significantly differ (P<0.05)

found for G1 on the 60th day of the storage, while initially the lowest lactic acid value was found for C2. As with the pH values irregular increases or decreases were determined in lactic acid content. Lactic acid amounts of the products vary depending on the activity of culture flora, non-fat solid and fat content of yoghurt samples. A similar nonlinear content of lactic acid amounts were reported by Köse & Ocak (2011). Moreover average lactic acid content is consisted with the studies of Atamer et al (1988), Kırdar & Gün (2002), Ersöz et al (2011) and Mısırlılar et al (2012).

3.2. Textural characteristics

Table 4 shows the textural properties of winter yoghurt samples during 90 days of storage. Storage time significantly affected the firmness of winter yoghurt samples except for sample G1 and CG2, and the differences between samples were also significant at all storage periods ($P<0.05$). There was also a significant ($P<0.05$) production method x storage interaction. The firmness values in all samples showed a decrease on 60th day however increased again on 90th day of storage. Köse & Ocak (2011) reported similar fluctuations in firmness values in winter yoghurt samples. Seçkin & Özkılınç (2011) also observed a decrease in firmness of concentrated yoghurt samples on 14th day and then an increase on the 21st day, and they attributed this to increased water holding capacity of proteins with storage.

Moreover the firmness of yoghurt depends on the total solid content of the product and also on protein-protein interactions (Ekinci & Gürel 2008). Our results are in accordance with this phrase because winter yoghurt samples of higher total solids (Table 2) generally had more firmness and cohesiveness values. On the other hand the difference between cohesiveness values of samples were significant at all periods but the storage period was only effective on sample G2, CG1 and CG2 ($P<0.05$). The interaction effect on cohesiveness values were also significant ($P<0.05$). According to the findings obtained from winter yoghurt samples produced only by boiling (C1, G1, CG1), cohesiveness values were generally higher than those of produced by straining and then boiling (C2, G2, CG2).

3.3. Color

There is very little information about the *L*, *a*, *b* parameters of goat's milk and fermented milk products

Table 4- Textural properties of winter yoghurt samples during 90-days storage

Çizelge 4- Kış yoğurdu örneklerinin 90 günlük depolama sırasındaki tekstürel özellikleri

		Days			
	Samples	*1*	*30*	*60*	*90*
Firmness (g)	C1*	516.25 ± 43^{bY}	536.75 ± 11^{bY}	390.75 ± 15^{dX}	629.00 ± 7^{bcZ}
	C2	256.50 ± 35^{aX}	531.50 ± 93^{bY}	462.25 ± 25^{eY}	422.50 ± 38^{abY}
	G1	427.25 ± 88^{b}	727.75 ± 107^{c}	313.75 ± 39^{c}	702.75 ± 193^{bc}
	G2	251.50 ± 38^{aX}	502.75 ± 68^{abY}	268.75 ± 30^{bcX}	600.25 ± 47^{bcY}
	CG1	568.75 ± 91^{bY}	$631.25 \pm 8b^{cY}$	229.00 ± 21^{abX}	725.75 ± 176^{cY}
	CG2	189.25 ± 37^{a}	347.75 ± 44^{a}	179.75 ± 21^{a}	240.25 ± 59^{a}
Cohesiveness (g)	C1	27.25 ± 7^{ab}	45.25 ± 13^{b}	22.00 ± 3^{a}	36.75 ± 0^{a}
	C2	10.75 ± 15^{a}	24.00 ± 7^{a}	13.25 ± 1^{a}	13.25 ± 1^{a}
	G1	59.49 ± 48^{ab}	207.00 ± 62^{c}	86.00 ± 16^{c}	222.75 ± 95^{c}
	G2	79.75 ± 3^{bX}	162.50 ± 27^{bcY}	74.50 ± 0^{cX}	158.95 ± 14^{bcY}
	CG1	170.75 ± 12^{cY}	179.75 ± 30^{cY}	70.50 ± 13^{cX}	204.00 ± 38^{cY}
	CG2	68.25 ± 11^{bX}	95.50 ± 7^{abY}	49.00 ± 0^{bX}	64.25 ± 14^{abXY}

*, for C1, C2, G1, G2, CG1 and CG2 please refer to Table 2; means in the same row with different superscripts upper-case letter (X, Y and Z) significantly differ ($P<0.05$); means in the same column with different superscripts lower case letter (a-c) among yoghurt samples significantly differ ($P<0.05$)

produced by using goat's milk. The color values of winter yoghurt samples, which play an important role in consumer acceptance, are shown in Table 5.

Whiteness in fluid milk results from the presence of colloidal particles, such as milk fat globules and casein micelles, capable of scattering light in the visible spectrum (Garcia-Perez et al 2005). Production method and storage time (except for sample C1) showed no effect to *L* values (whiteness/lightness values) of winter yoghurts. The interaction effect of these two factors on all color values was also insignificant. In the first day of the storage while the highest *L* value was determined for CG1 sample, the lowest was determined for G1. In the 90th day of the storage while the highest value was determined for CG2 sample, the lowest value was determined for G1 sample also at the beginning of the storage. Besides, the whiteness values of all samples increased throughout the storage. The differences of whiteness/lightness values of yoghurts arise from fragmentation of fat globule diameters due to the result of continuous mixing during processing; furthermore it shows these values can be different for the dairy products produced by using goat's milk. Yazıcı & Akgün (2004) determined higher *L* values of low-fat torba yoghurts than high-fat torba yoghurts; moreover they found that usage of fat substitute does not affect the *L* values of samples. The negative *a* value (greenness) was determined for all samples and the differences between samples were significant at 1st, 30th and 90th days of storage (P<0.05). The storage was significantly affected *a* values of the samples (P<0.05) except for sample C1 and G2. In the first day of the storage while the highest *a* value was found for G1 sample, the lowest was found for CG1. At the end of the storage, the highest value was determined for G1 again, whereas the lowest was determined for G2. These differences occurring in *a* value of samples may be

Table 5- Color values of winter yoghurt samples during 90-days storage

Çizelge 5- Kış yoğurdu örneklerinin 90 günlük depolama sırasındaki renk değerleri

		Days			
	Samples	*1*	*30*	*60*	*90*
L	C1*	70.70±2.40^{X}	64.96±3.39^{X}	69.60±4.21^{X}	82.03±1.52^{Y}
	C2	72.53±3.51	73.10±3.86	69.87±9.22	85.15±0.70
	G1	69.33±4.85	76.52±10.23	66.59±4.56	72.77±1.70
	G2	72.23±7.86	75.44±6.05	83.41±1.79	83.87±1.52
	CG1	80.24±9.58	71.05±4.13	73.46±4.55	85.15±0.43
	CG2	74.79±7.53	76.34±4.67	76.52±4.93	85.35±1.42
-a	C1	-1.26±0.41^{bc}	-2.34±0.09^{c}	-1.89±0.62	-1.42±0.09^{c}
	C2	-1.71±0.09^{abcW}	-2.80±0.03^{bY}	-3.02±0.02^{X}	-1.96±0.10^{bcZ}
	G1	-0.98±0.26^{cY}	-2.41±0.04^{bcX}	-2.92±0.24^{X}	-1.38±0.31^{cY}
	G2	-1.69±0.74^{abc}	-3.26±0.07^{a}	-3.01±0.42	-2.70±0.43^{a}
	CG1	-2.62±0.25^{aXY}	-3.29±0.26^{aX}	-3.25±0.13^{X}	-2.28±0.25^{abY}
	CG2	-2.18±0.21^{abZ}	-3.39±0.09^{aX}	-3.26±0.52^{XY}	-2.42±0.31^{abYZ}
+b	C1	12.72±0.48^{cX}	13.15±0.69^{cX}	12.25±0.82^{X}	15.59±1.04^{Y}
	C2	8.95±0.46^{a}	8.78±0.08^{a}	9.55±0.91	10.68±0.46
	G1	11.16±0.61^{b}	13.06±1.04^{c}	11.68±0.98	13.70±0.55
	G2	9.32±0.48^{a}	11.23±0.68^{b}	11.46±0.31	14.87±3.86
	CG1	10.95±0.91^{b}	10.77±0.39^{b}	10.74±0.47	11.95±0.68
	CG2	8.21±0.46^{a}	9.09±0.07^{a}	9.53±1.18	10.82±1.55

*, for C1, C2, G1, G2, CG1 and CG2 please refer to Table 2; means in the same row with different superscripts upper-case letter (W-Z) significantly differ (P<0.05); means in the same column with different superscripts lower case letter (a-c) among yoghurt samples significantly differ (P<0.05)

due to the lack of a fully homogenous distribution of the olive oil which was added according to the production method. Yazıcı & Akgün (2004) have reported using fat substitute does not affect *a* value, but storage time effects. When *b* values (yellowness/blueness) were analyzed, it was seen that significant differences were occurred on the 1st and 30th day of the storage (P<0.05). While the highest *b* value was determined for C1 initially, the lowest was determined for C2 at the end of storage. Additionally for all samples, *b* values have increased during the storage but this was found statistically insignificant except for sample C1. Because of the production method, heat treatment at the high temperature causes caramelisation of lactose which is the main carbohydrate of milk, and leads maillard reaction by interacting reactions with proteins. This effects yellowness values of samples, too. Yazıcı & Akgün (2004) reported increasing the fat proportion of Torba yoghurt samples give rise to the *b* values, as well as the storage time effects the *b* values.

3.4. Sensory properties

The sensory properties of winter yoghurt samples were given in Table 6. In winter yoghurt samples, statistically no significant changes were determined in production method and storage regarding color-appearance and odor. Furthermore the interaction effect of these two factors on sensory properties

Table 6- Sensory properties of winter yoghurt samples during 90-days storage

Çizelge 6- Kış yoğurdu örneklerinin 90 günlük depolama sırasındaki duyusal özellikleri

		Days			
	Samples	*1*	*30*	*60*	*90*
Color - appearance	C1*	4.00±0.47	3.17±0.23	3.75±0.35	3.66±0.71
	C2	3.50±0.71	3.83±0.24	4.35±0.03	4.08±0.35
	G1	4.83±0.24	3.75±0.59	4.39±0.38	4.08±0.82
	G2	4.66±0.00	4.67±0.47	4.69±0.45	4.25±0.12
	CG1	4.00±0.00	4.00±0.47	4.25±0.35	4.00±1.18
	CG2	3.83±0.71	4.50±0.23	4.42±0.12	4.75±0.35
Odor	C1	4.00±0.47	3.33±0.00	4.13±0.18	4.00±0.00
	C2	4.16±0.71	4.50±0.23	4.17±0.94	4.16±0.71
	G1	4.83±0.24	3.75±0.83	4.29±0.06	4.16±0.00
	G2	4.33±0.47	4.17±0.23	4.33±0.47	4.50±0.23
	CG1	4.13±0.18	4.17±0.23	4.19±0.26	4.25±0.35
	CG2	4.00±0.94	4.50±0.23	4.17±0.94	3.75±0.83
Consistency	C1	3.00±0.00^{a}	3.58±0.11	3.75±0.12	3.50±0.71
	C2	2.83±0.2^{4a}	4.08±0.11	3.67±0.23	3.75±0.59
	G1	4.83±0.24^{c}	4.33±0.47	4.75±0.35	4.08±0.35
	G2	4.67±0.47^{c}	4.67±0.47	4.58±0.59	4.00±0.00
	CG1	3.75±0.35^{b}	4.00±0.23	4.17±0.23	4.00±0.47
	CG2	3.83±0.24^{b}	4.25±0.12	4.25±0.35	4.50±0.24
Flavor	C1	3.42±0.12^{a}	2.92±0.12	3.69±0.26	3.41±0.35
	C2	3.29±0.06^{a}	3.75±0.59	3.75±0.59	3.58±0.59
	G1	4.13±0.18^{bc}	3.92±0.59	4.17±0.23	3.67±0.94
	G2	4.71±0.06^{d}	4.33±0.47	4.25±0.35	4.00±0.00
	CG1	3.71±0.06^{ab}	3.92±0.12	3.79±0.65	3.67±0.94
	CG2	4.31±0.44^{cd}	4.41±0.35	3.33±0.47	3.83±0.47

*, for C1, C2, G1, G2, CG1 and CG2 please refer to Table 2; means in the same column with different superscripts lower case letter (a-d) among yoghurt samples significantly differ (P<0.05)

of winter yoghurt samples was also insignificant. The reason for G1 and G2 samples produced from goat's milk getting high color-appearance points on the 1st day of storage was the whiter color of goat's milk. The excessive darkening of the color in the further days of the storage was assessed negatively by the panelists. Winter yoghurt has a unique, characteristic odor. Panelists have detected the olive oil odor most as the foreign odor which was used for protecting the samples. Throughout the storage process, our samples received an acceptable appreciation, and this is an important criterion in terms of being free of foreign odors. In a previous similar study (Ocak et al 1998), panelists have detected a burnt odor. Our experiences during the conduct of this research showed that intensity of the burner flame, Benmari technique and continuous stirring during cooking process have prevented this defect. Regarding consistency, the production method was found to be statistically effective only on the 1st day of the storage ($P<0.05$). The changes in consistency points of our samples in our research is thought to result from the milk type and total solid content of the milk, acidity of the samples and the changes occurred during cooking. Similar results were also reported in studies by Coşkun & Şimşek (1994), Akın & Konar (1997), Ocak et al (1998), Say & Şahan (2002) and Tokatlı (2011).

One of the most important criterions that determine the quality of yoghurt is flavor and aroma. Raw material quality, faults occurring during production and storage cause undesired flavor and aroma. Regarding flavor, production method statistically have a significant effect on the 1st day of the storage ($P<0.05$), this difference was not determined on the other days of the storage. During the sensory analysis throughout the storage, the highest flavor point was received by G2 sample. Winter yoghurt samples produced from cow's milk (C1 and C2) received lower points throughout the whole storage. Uysal & Gönç (1998) have determined that the total points received by torba yoghurt produced from goat's milk were higher than those received by torba yoghurts produced from cow's milk.

4. Conclusions

The boiling/cooking process increased the total solids content of winter yoghurt samples about 2-2.5-fold in comparison with the regular yoghurt. Especially, in the further days of the storage, the samples that were produced from 100% goat's milk were found to have higher quality regarding both sensory and rheological properties. Therefore, it could be assumed that goat milk can be used easily to produce traditional winter yoghurt. In addition modern production methods, high quality raw milk, pure culture usage and appropriate storage conditions can increase the safety, quality and the marketing potential of the winter yoghurt.

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