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Research Article

The Volatile Compounds, Free Fatty Acid Composition and Microbiological Properties of Sepet Cheese Packaged with Different Modified Atmosphere Conditions [1][2]

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Abstract

The objective of this present study was to investigate traditional sepet cheese samples which were packaged with different modified atmosphere conditions (MAP). The volatile compounds, free fatty acid composition and microbiological properties of Sepet cheeses were analyzed on 1., 45., 90. and 180. day of the storage period at +4°C. In packaking of cheese, three different modified atmosphere packaging conditions were tried. These cheeses were packaged into polystyrene packages that include 100% N_2 (N), 80% N_2 + 20% CO_2 (NC), 100% CO_2 (C). In accordance with volatile compounds of sepet cheese samples, it was shown that control cheese sample was different from MAP samples in terms of aroma fractions. MAP samples showed variability in preservation of aroma fractions. When fatty acid composition during the storage period was researched, it was found that there was a significant difference in all samples. When microbiological properties were investigated statistically, it was determined that there was not a significant difference in samples during storage. In general, it could be said that sepet cheeses that were packaged in different modified conditions protected their specialities better.

Keywords: *Sepet cheese, Modified atmosphere packaging, Cheese quality*

Farklı Modifiye Atmosfer Koşulları İle Paketlenen Sepet Peynirinin Aroma Bileşenleri, Serbest Yağ Asitleri Kompozisyonu ve Mikrobiyolojik Özellikleri

Özet

Çalışmamızın amacı farklı modifiye atmosfer koşullarında paketlenen geleneksel sepet peyniri örneklerini incelemektir. +4°C' de depolanan sepet peynirlerinin aroma bileşenleri, serbest yağ asitleri kompozisyonu ve mikrobiyolojik özellikleri depolamanın 1., 45., 90. ve 180. günlerinde incelenmiştir. Peynirlerin paketlenmesinde 3 farklı modifiye atmosfer koşulu denenmiştir. Üretilen peynirler 100% N_2 (N), 80% N_2 + 20% CO_2 (NC), 100% CO_2 (C) içeren atmosfer koşullarda polistiren ambalajlarda paketlenmiştir. Sepet peynirlerinin aroma maddeleri komposizyonu incelendiğinde kontrol grubunun MAP grubundan farklılık gösterdiği tespit edilmiştir. MAP örnekleri aroma fraksiyonları bakımında çeşitlilik göstermiştir. Yağ asitleri komposizyonu tüm sepet peyniri örneklerinde farklılık göstermiştir. Mikrobiyolojik özellikler istatistiksel olarak değerlendirildiğinde depolama boyunca meydana gelen farklılığın önemli olmadığı tespit edilmiştir. Genel olarak bakıldığında farklı modifiye koşullarda paketlenmiş olan sepet peynirlerinin özelliklerini daha iyi muhafaza ettiği görülmüştür.

Anahtar sözcükler: *Sepet peyniri, Modifiye atmosfer paketleme, Peynir kalitesi*

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INTRODUCTION

There are various cheese types in the Aegean region of Anatolia various cheese types with different shape, color, and taste. Cheese is one of the important traditional foods in the Turkish cuisine. Many cheese types produced only in certain regions are consumed locally in large quantities in Turkey [1-3]. The Sepet cheese is a traditional semi-hard cheese produced in the Mediterranean region of Turkey. Some cheese types have begun to sink into oblivion and such products are sold only at local markets and produced within families [4]. The Sepet Cheese is produced in small towns close to the shore in the Aegean region, especially in Ayvalik and also in Dikili, Burhaniye, Foça, Çesme, Urla, Karaburun, Ödemis and Söke [5].

Technological advances in processing and packaging of dairy foods have an impact on the consumers' trends. Dairy products with enhanced nutrition and specific product functionalities are particularly demanded by the consumers [6,7]. Reduction of the chemical and microbial overload in foods have been especially recommended by the food safety regulatory authorities. The food industry has begun to search for ways to develop new packaging concepts due to these strict regulations and the consumer preferences for natural and healthy products free of preservatives with extended shelf lives. It was determined that, one of these packaging concepts, modified atmosphere packaging (MAP), in combination with refrigeration, is successful in extending the shelf life of milk and milk products [8-11]. Modified atmosphere packaging, elimination of oxygen from inside package and filled with different concentrations of CO_2 and N_2 [12].

The objective of this study is to investigate technological, microbiological and biochemical aspects of Sepet cheese during manufacture and ripening, and to consider future work on certain specific topics. For this purpose, sepet cheese was compared with other brined cheeses.

MATERIAL and METHODS

Goat milk was used in the production of these sepet cheeses. Production of cheese has been made in a local manufacturer. Cheese was produced as follow: Without any heat treatment, raw goat's milk was heated up to 58-60°C and immediately cooled to renneting temperature. Coagulation occured in 2 h using animal origin rennet (1/16.000 MCU/ml). The curd's temperture was increased to 36-38°C by pourin hot water on for easier and faster draining. Meanwhile, curd subsided and seperated from whey. The curd at the bottom of container, was collected with hand, given a ball shape and stuffed in optinally 1, 3 or 5 kg capacity baskets made of reed stems and top surface was flattened. The cheese in the basket was left to draining spontanously without putting any weight on the basket. In the meantine curd took the basket's shape during draining. Cheese have been turned upside down in order to make the top surface take the basket's shape. Cheese had been taken out of the basket 15 min after the whey started to drain. Top and bottom surfaces were salted with thin salt and relocated in the basket for further percolation. Approximately 18 h later, when it became a single firm hoop, it was taken out of the basket and put on a wooden surface in a shady place. Cheeses were rubbed with salt every other day in a total of 15 days. Then the cheeses were packaged with polystyrene material in different modified atmospheric conditions. The sepet cheese (about 200 g) were packaged in expanded polystyrene (EPS) (0.2 mm thickness, oxygen transmission rate 2.600-7.700 cm^3/m^2/day bar, CO_2 transmission rate 10.000-.26.000 cm^3/m^2/day bar at 25°C) trays placed in gas-barrier bags under three different atmosphere conditions (100% nitrogen, 80% nitrogen + 20% carbondioxide, 100% carbondioxide). The cheeses were ripened for 6 months at +4°C and were analysed at 1., 45., 90. and 180. day of the storage period. K, N, NC and C codes were given to the cheese samples Control, 100% N_2, 80% N_2 + 20% CO_2, 100% CO_2, respectively.

The volatile compounds of Sepet cheeses were determined with a solid-phase-microextraction (SPME) method using a fiber (57348-U, Supelco Inc., Bellefonte, PA, USA) coated with the sorbent material, divinylbenzene/carboxen/polydimethylsiloxane. Volatile compounds of Sepet cheeses were determined with using gas chromatography (GC) (Clarus 600, Pelkin Elmer Inc., Massachusetts, USA) equipped with flame ionization detector. The temperature of GC oven was programmed as follows: held at 40°C for 6 min, then the temperature was raised to 100°C with 5°C/min and held for 2 min. and finally the temperature was reached to 250°C (10°C/min, held for 4 min). Carrier gasses were He with 1 ml/min and H_2 with 1 ml/min flow rates. The analysis was performed in duplicate. The identification of chromatographic peaks were carried out with comparison of the retention times of appropriate standards (Sigma Chemical Company, St. Louis, MO, USA) [13].

Lipids were extracted using purified kieselgurh (Fluka Chemie GmbH, Buchs, Switzerland) and diethyl ether (Riedel-de Haën, Germany) as described by Renner [14]. Approximately 50 g of sample was measured with 6-8 g of kieselgurh, and then mixed with 200 ml diethyl ether. Fatty acid methyl esters were prepared according to AOCS Official Method Ce 2-66 [15]. Fatty acid composition was determined by a Hewlett-Packard Gas Chromatography (model 6890, Avondale, PA, USA equipped with Supelco SP-2380 fused silica capillary column (100 m × 0.25 mm i.d., 0.2 µm film thickness; Supelco Inc., Bellefonte, PA, USA) [16].

For each cheese sample, 10 g was weighed, diluted aseptically in 90 mL of citrate buffer (2%, wt/vol), and homogenized in a sterile polyethylene bag using a Stomacher 400 (Seward Laboratory, London, UK) for 1.5 min. Serial dilutions were made in sterile ringer solution and all

determinations were made in duplicate. The enumeration of *Lactobacillus* ssp. (MRS Agar; Merck Darmstadt, Germany) at 37°C for 72 h [17], *Lactococcus ssp.* (M17 Agar; Merck) at 37°C for 48 h [17], and *Enterococcus* ssp. (Kanamycin esculin Agar; Merck) at 37°C for 48 h [18] were performed during the ripening of Sepet Cheese.

The experiment was carried out in duplicate. Data were analyzed using the general linear model procedure of the SPSS software (version 20; SPSS Institute Inc., Chicago, IL). Analysis of variance for each set of data was conducted and Duncan's multiple range tests were used to compare the means when the effect was sinificant ($P<0.05$). In addition statistical significances ar the 95% confidence interval ($P<0.05$) as being considered statistically significant.

RESULTS

Total of 24 volatile compounds were determined in Sepet cheeses packaged under different modified atmosphere conditions during 6 months of storage *(Table 1)*. In all sepet cheese samples, free fatty acids were the most abundant volatile compounds of total identified fraction such as hexanoic acid, octanoic acid, and butyric acid which had the highest percentage values, respectively. There were statistical differences in fatty acids results ($P<0.05$). Free fatty acids reduced during storage in sample K. However, only butyric acid increased during storage in this sample. Butyric acid was found with the highest percentage in all samples during storage. Hexanoic acid had also high percentages in all samples. The esters in the volatile fraction of Sepet cheeses were ethyl hexanoate, ethyl decanoate, ethyl octanoate, and ethyl butyrate. Some differences were observed in ethyl butyrate percentage in all samples during storage ($P<0.05$).

Some aldehydes such as octanal, decanal, 2,6-nonadienal were also found in low percentage in all samples. When cheese samples were compared with aldehydes amount, it was seen that percentage of aldehydes in C, NC and C cheese samples were higher than sample K. In addition some ketones as a diacetyl, acetoin and 2-nonanone were detected during storage. Other important aromatic compounds for cheese, ethanol and acetaldehyde, were also found in some samples during storage. In sample N and NC, acetaldehyde percentage was higher than in sample C and K.

The unsatureted and satureted fatty acid composition of Sepet cheeses ripened different modified atmosphere conditions are given *Table 2*. Butyric acid (C4:0) is a fatty acid which has an important role in formation of flavour in brine-cured cheeses and in formation of rancid taste. As seen in *Table 2*, butyric acid content of the cheeses changes between 1.71% and 2.50%. Compared to control sample, N, NC and C cheeses were found to have lower butyric acid content on the 45th day of storage. But on the further days of storage results are found to be closer. The avarage amount of caproic (C6:0) and caprilic (C8:0) acids, among total fatty acids were between 1.50-1.73% and 0.94-1.15% respectively. In many types of cheese similar to white cheese butyric, caproic and caprilic acids are the indicators of starter oriented lipolytic activity. Also these fatty acids may easily influence flavour. Among the fatty acids, the amount of capric (C:10), lauric (C:12) and myristic (C:14) acids were changed between 2.09-2.58%, 2.54-2.99% and 9.96-11.89% respectively. In the N, NC and C cheese samples, fatty acid content were higher than the control sample, as seen in *Table 2*.

In *Table 2*, among the long chain fatty acids (C16-C20), palmitic acid (C16:0) was found to have a bigger ratio with an avarage of between 28.05% -33.15%. In the control sample, palmitic acid content was higher on the last day of storage, where the other samples had lower palmitic acid content. The NC cheese sample was found to contain a higher avarage palmitic acid content than the other samples. Among the total fatty acids the amount of stearic and oleic acids were 14.81-26.30% and 16.15-27.26%, respectively. The avarage ratios of palmitoleic acid among the fatty acid composition, which was said to give information on the level of lipolysis and causing off flavour and aroma, were between 0.06% and 0.69%. Another significant fatty acid in the composition was linoleic acid (C18:2 *cis*-9,12) and these values were ranged between 1.42 - 2.69% in all samples.

The microbiological characteristics of Sepet cheeses were studied during 180 d of ripening *(Table 3)*. In all cheeses, the highest levels of *Lactobacillus* ssp. were found at the first stage of ripening, and counts decreased until 90 d. However, the counts increased sharply at the end of ripening (180 d), and the final values ranged from 6.56 to 7.08 log cfu/g in all samples. The counts of *Lactobacillus ssp*. were significantly affected by storage period in control sample ($P<0.05$). It was seen that *Lactococcus* ssp. counts changed between 7.67 to 9.78 log cfu/g. Statistical differences were seen in K, N and C samples ($P<0.05$). The all samples had high level of *Lactococcus* ssp. on the first day of storage, but their count decreased until 180 d. *Enterococcus* ssp. count changed between 3.23 and 4.96 log cfu/g. It was seen that *Enterococcus ssp*. count increased on the further days.

DISCUSSION

Aroma is the one of the most important parameters in food quality while influencing selection and consumption of food. Several volatile compounds such as fatty acids, esters, hydrocarbons, alcohols, aldehydes, ketones, lactones, sulphur- and nitrogen-containing compounds contribute to cheese flavor [19]. Esters, which are responsible for the fruity flavor in cheese, are formed through 2 enzymatic reactions, esterification and alcoholysis [2,20,21]. Esterification is the

Table 1. *Volatile compounds during production and ripening of Sepet Cheese in different atmosphere packaking Condition*[1]
Tablo 1. *Farklı Atmosfer Koşullarında Paketlenen Sepet Peynirlerinin Üretim ve Olgunlaşma Aşamasında Aroma Maddeleri*[1]

Chemical	RT (min)	Cheese											
		K			N			NC			C		
		Storage Days			Storage Days			Storage Days			Storage Days		
		1	45	180	1	45	180	1	45	180	1	45	180
Free Fatty acid													
Butyric Acid	24.48	29.82±0.07^{a}	27.47±1.27^{a}	34.97±0.31^{bY}	30.68±2.32^{a}	24.57±5.92^{a}	49.00±1.66^{bZ}	32.86±1.63^{a}	33.02±4.89^{a}	5.33±0.98^{bX}	32.99±1.78^{a}	23.42±1.54^{b}	49.89±4.69^{aZ}
Hexanoic Acid	27.20	37.14±3.82^{bX}	35.96±0.77^{bY}	25.12±3.18^{aY}	23.62±4.21^{abY}	29.86±4.21^{bY}	13.10±0.55^{aX}	21.66±0.83^{Y}	21.15±0.78^{X}	29.87±5.62^{Y}	21,29±2.71^{Y}	10.23±0.38^{Z}	19.81±3.86^{XY}
Heptanoic Acid	28.72	0.13±0.03	0.15±0.01	0.18±0.09	0.24±0.02	0.30±0.13	0.07±0.06	0.15±0.08	0.54±0.37	0.17±0.16	0.14±0.01	0.36±0,12	0.16±0.13
Octanoic Acid	28.99	16.14±1.39^{cX}	9.83±1.04^{bX}	6.14±0.66^{aY}	0.81±0.48^{aY}	2.89±1.36^{aY}	5.76±0.54^{bY}	4.72±0.78^{Y}	4.15±1.08^{Y}	2.19±0.68^{X}	14.03±3,06^{bX}	3.05±1.24^{aY}	1.36±0.83^{aX}
4-Methy octanoic Acid	30.79	0.49±0.08^{X}	0.79±0.29	0.29±0.20	0.31±0.03	0.41±0.15^{X}	0.35±0.13	0.48±0.13^{X}	0.50±0.22	0.57±0.02	1.10±0.16^{c}	0.62±0.00^{bY}	0.16±0.16^{a}
Decanoic Acid	31.40	0.14±0.04	0.22±0.17	0.15±0.01	0.15±0.04	0.18±0.09	0.21±0.04	0.16±0.05	0.09±0.01	0.17±0.00	0.11±0.00	0.22±0.17	0.20±0.01
Dodecanoic Acid	32.75	0.53±0.04^{cY}	0.32±0.04^{b}	0.13±0.00^{a}	0.68±0.38^{X}	0.18±0.04	0.40±0.24	0.22±0.19^{X}	0.74±0.19	0.30±0.25	0.09±0.00^{X}	0.62±0.87	0.17±0,00
Ketone													
Diacetyl	4.42	0.58±0.06^{X}	3.85±0.63^{XY}	2.17±0.90	12.13±1.97^{bY}	1.67±1.51^{aX}	4.02±1.56^{a}	0.06±0.09^{aX}	1.56±0.09^{aX}	7.99±1.98^{b}	9.42±1.92^{Y}	7.06±2.00^{Y}	2.56±1.67
Acetoin	15.01	1.33±0.29^{X}	0.66±0.48	0.29±0.31^{X}	5.94±0.94^{Y}	5.73±1.07	2.02±1.51^{X}	10.92±0.99^{Z}	4.77±0.99	12.54±3.18^{Y}	0.00±0.00^{aX}	4.41±1.17^{b}	1.01±0.54^{aX}
2-Nonanone	18.29	2.79±0.56	2.07±0.15	3.92±2.26	7.38±1.81	1.79±0.91	0.00±0.00	0.00±0.00	3.63±0.01	0.00±0.00	0.95±0.44	4.39±1.37	1.91±1.13
Aldehyde													
Acetaldehyde	3.24	1.25±0.01^{X}	6.49±2.89^{Y}	3.52±0.28	7.42±1.50^{aY}	11.07±1.63^{Y}	8.01±0.07	1.48±0.6^{aX}	7.57±1.51^{bY}	7.72±0.00^{b}	4.66±1.75^{XY}	0.00±0.00^{X}	2.02±1.09
Octanal	15.65	0.09±0.12^{X}	0.14±0.20^{X}	0.41±0.19^{X}	1.63±2.31^{aX}	0.76±1.07^{bX}	0.91±0.73^{bX}	12.48±2.32^{bY}	1.78±2.32^{aXY}	9.55±3.01^{bX}	3.23±1.60^{X}	4.14±0.82^{Y}	2.58±0.24^{Y}
Nonanal	18.87	0.34±0.23^{Y}	4.23±2.57	0.68±0.95	0.00±0.00^{Z}	0.00±0.00	0.04±0.05	1.15±0.76^{aX}	0.00±0.00^{b}	0.72±1.02^{a}	0.00±0.00^{XY}	0.00±0.00	0.02±0.03
Decanal	21.65	0.00±0.00^{aX}	0.07±0.04^{a}	0.75±0.29^{b}	0.06±0.08^{X}	0.96±0.89	0.54±0.18	0.10±0.13^{aX}	0.23±0.02^{a}	2.68±0.76^{b}	0.39±0.03^{Y}	1.58±0.39	2.21±0.39
E-2. Z-6 Nonadienal	23.80	0.08±0.11	0.64±0.49^{X}	1.51±0.67	0.36±0.51^{a}	3.17±1.52^{X}	0.36±0.36	0.03±0.04^{a}	0.88±0.21^{bX}	0.08±0.00^{a}	0.04±0.01^{a}	7.94±2.22^{bY}	0.80±0.72^{a}
E-2 Decenal	24.96	0.20±0.16	0.59±0.41	0.12±0.13	0.54±0.77^{a}	3.29±2.74	0.13±0.18	0.52±0.74^{a}	7.72±0.65^{b}	0.41±0.09^{a}	0.34±0.10^{a}	5.23±1.69^{b}	0.76±0.50^{a}
Ester													
Ethyl butyrate	7.57	0.16±0.22^{X}	0.17±0.24	0.54±0.05	0.00±0.00^{aX}	0.00±0.00^{a}	0.58±0.23^{a}	3.72±1.00^{bY}	0.00±0.00^{a}	0.12±0.17^{a}	0.00±0.00^{aX}	0.0±0.00^{a}	0.25±0.02^{b}
Etyhl hexanoate	14.00	0.50±0.08	0.42±0.07^{X}	3.00±1.21	2.86±0.15	3.33±0.88^{Y}	1.29±0.17	0.01±0.02^{a}	0.28±0.02^{aX}	7.99±2.60^{b}	4.91±1.22	0.54±0.14^{X}	2.96±1.30
Ethyl octanoate	22.32	0.26±0.28	0.16±0.07	0.35±0.04	0.22±0.31	0.00±0.00	0.04±0.03	0.08±0.04	0.00±0.00	0.16±0.23	0,27±0.01	0.00±0.00	0.30±0.22
Ethyl decanoate	25.95	1.38±0.52	0.95±0.19^{XY}	0.23±0.00	0.38±0.53	0.00±0.00^{X}	0.99±0.39	0.36±0.03	0.13±0.03^{X}	1.10±0.39	0.92±0.01	1.88±0.67^{Y}	1.09±0.74
Other													
Ethanol	3.40	2.43±0.98^{bY}	0.00±0.00^{bX}	8.92±0.03^{cX}	3.16±1.12^{Y}	1.95±1.1.^{X}	0.00±0.00^{Y}	0.00±0.00^{aX}	6.55±0.96^{bY}	3.62±1.34^{bZ}	0.14±0.19^{X}	6.62±2.27^{Y}	2.77±1.73^{YZ}
D-Limonene	13.60	0.00±0.00^{X}	0.00±0.00	0.00±0.00	0.08±0.11^{X}	0.00±0.00	0.10±0.14	2.51±1.31^{bY}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{X}	0.00±0.00	0.59±0.83
1-Hexanol	17.85	1.45±0.44^{Y}	1.91±0.86	0.97±0.65	0.08±0.11^{a}	0.00±0.00^{aX}	4.61±1.22^{b}	1.71±1.87	0.00±0.00^{X}	2.03±1.68	2.92±0.18^{b}	0.00±0.00^{aX}	0.24±0.33^{a}
γ-Dodecalactone	32.10	0.04±0.05	0.04±0.05	0.14±0.19	0.00±0.00	0.00±0.00	0.18±0.14	0.07±0.10	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
Unknown 1	16.32	1.72±0.40	0.90±0.85	2.13±2.55	0.00±0.00	3.83±3.42	2.36±0.92	0.00±0.00	0.43±0.61	0.00±0.00	0.00±0.00	6.68±2.31	1.81±0.97
Unknown 2	19.70	0.12±0.01	0.24±0.00	0.86±0.13	0.90±0.09	2.34±1.19	4.17±0.45	0.29±0.14	1.42±0.46	3.60±0.83	0.31±0.11	0.49±0.03	2.54±1.10
Unknown 3	21.25	0.89±0.05	1.70±0.70	2.37±2.71	0.30±0.43	1.65±1.17	0.43±0.02	4.16±0.33	2.84±1.63	1.00±0.80	1.73±0.38	10.47±0.27	1.82±0.28
Unknown 4	33.15	0.00±0.00	0.00±0.00	0.13±0.18	0.00±0.00	0.00±0.00	0.25±0.22	0.02±0.03	0.00±0.00	0.00±0.00	0.00±0.00	0.07±0.10	0.00±0.00

$^{a-d}$ Means ± SD within a row with no common superscript differ (P<0.05). (for compare storage days) $^{X-Z}$ Means ± SD within a row with no common superscript differ (P<0.05). (for compare between product difference) [1] Values are the means of 2 replicates. K refer to the cheeses ripened in normal condition ; N, NC and C refer to the cheeses ripened in 100% nitrogen, 80% nitrogen + 20% carbondioxide, 100% carbondioxide respectively

Table 2. *Unsaturated and saturated fatty acid composition of Sepet cheese in different atmosphere packaking condition*[1]

Tablo 2. *Farklı Atmosfer Koşullarında Paketlenen Sepet Peynirlerinin Doymamış ve Doymuş Yağ asitleri Kompozisyonu*[1]

Cheese	Unsaturated Fatty Acid Composition											
	Days	C14:1	C15:1	C16:1	C17:1	C18:1 cis	C18:1 tr	C18:2 cis	C18:2 tr	C18:3	C20:1	C22:4
K	1	0.54±0.29	0.01±0.00	0.06±0.03	0.32±0.06	17.74±4.68	0.60±0.20^{ab}	2.59±0.36	0.17±0.02	0.39±0.18	0.23±0.02	0.07±0.03
	45	0.66±0.01	0.01±0.00	0.08±0.05	0.33±0.01	23.28±9.79	0.74±0.03^{b}	2.77±0.46	0.16±0.04	0.31±0.08	0.31±0.09	0.04±0.01
	90	0.73±0.22	0.02±0.00	0.11±0.03	0.42±0.17	17.78±1.95	0.62±0.20^{ab}	1.80±0.94	0.21±0.02	0.18±0.07	0.18±0.07	0.07±0.01
	180	0.92±0.40	0.01±0.00	0.06±0.01	0.44±0.01	17.58±0.38	0.27±0.11^{a}	1.42±1.81	0.18±0.06	0.17±0.05	0.30±0.11	0.06±0.00
N	45	0.57±0.28	0.02±0.00^{b}	0.15±0.06	0.31±0.05	25.46±2.20^{b}	0.60±0.22	2.38±0.86	0.16±0.06	0.23±0.00	0.25±0.01	0.03±0.02
	90	0.56±0.24	0.02±0.00^{a}	0.69±0.47	0.33±0.07	16.15±1.43^{a}	0.60±0.43	2.45±0.77	0.16±0.06	0.23±0.12	0.24±0.04	0.06±0.00
	180	0.70±0.67	0.01±0.00^{a}	0.03±0.01	0.25±0.05	18.68±3.44^{ab}	0.58±0.12	2.58±0.10	0.18±0.02	0.26±0.12	0.18±0.11	0.08±0.05
NC	45	0.54±0.27	0.01±0.00	0.16±0.20	0.53±0.29	18.51±2.84	0.33±0.11	1.63±0.68	0.14±0.02	0.18±0.03	0.24±0.01	0.04±0.00^{ab}
	90	0.59±0.32	0.01±0.00	0.16±0.15	0.32±0.07	18.26±2.42	0.68±0.36	2.69±0.56	0.17±0.06	0.22±0.16	0.26±0.05	0.02±0.00^{a}
	180	0.52±0.27	0.07±0.00	0.55±0.36	0.28±0.05	22.17±4.06	0.64±0.15	2.23±0.72	0.14±0.03	0.29±0.08	0.24±0.00	0.07±0.01^{b}
C	45	0.94±0.20	0.03±0.01	0.17±0.13	0.69±0.52	27.26±3.44^{b}	0.64±0.38	1.51±0.72	0.10±0.00	0.24±0.00	0.24±0.05	0.05±0.05
	90	0.53±0.36	0.01±0.00	0.18±0.22	0.29±0.05	19.22±0.09^{ab}	0.57±0.20	2.43±0.48	0.15±0.07	0.24±0.08	0.23±0.03	0.08±0.07
	180	0.56±0.24	0.01±0.00	0.04±0.00	0.37±0.08	17.84±3.06^{a}	0.72±0.37	2.08±0.52	0.18±0.08	0.22±0.01	0.31±0.09	0.04±0.00

Cheese	Saturated Fatty Acid Composition												
	Days	C4	C6	C8	C10	C11	C12	C13	C14	C15	C16	C17	C 18
K	1	2.50±0.18	1.70±0.38	1.05±0.01	2.30±0.03	0.021±0.00	2.78±0.09	0.011±0.00	11.62±0.93	1.29±0.19	32.07±5.45	0.66±0.01	21.13±1.33
	45	2.15±0.38	1.57±0.22	1.04±0.21	2.33±0.54	0.017±0.00	2.54±0.29	0.021±0.01	9.96±0.46	1.40±0.02	28.72±2.75	0.58±0.11	20.94±5.75
	90	2.37±0.12	1.72±0.32	1.07±0.24	2.31±0.61	0.019±0.00	2.61±0.61	0.011±0.00	10.29±1.69	1.44±0.07	29.04±0.76	0.65±0.05	26.30±1.82
	180	2.17±0.32	1.50±0.16	0.94±0.04	2.09±0.07	0.016±0.00	2.57±0.30	0.037±0.03	11.09±1.90	1.30±0.20	33.15±5.29	0.62±0.02	23.09±5.60
N	45	1.71±0.06^{a}	1.41±0.02	0.94±0.03	2.27±0.01	0.019±0.00	2.79±0.01	0.017±0.00	11.89±0.73	1.42±0.00	31.85±4.39	0.62±0.09	14.81±1.41^{a}
	90	2.13±0.19^{ab}	1.64±0.19	1.08±0.18	2.42±0.40	0.023±0.00	2.95±0.35	0.014±0.00	11.84±0.28	1.36±0.45	31.69±3.28	0.66±0.15	22.60±2.60^{b}
	180	2.36±0.14^{b}	1.72±0.01	1.15±0.03	2.58±0.11	0.023±0.00	2.80±0.18	0.011±0.00	10.57±0.93	1.45±0.16	28.05±1.96	0.58±0.12	25.11±0.42^{b}
NC	45	1.95±0.56	1.54±0.28	1.02±0.16	2.29±0.28	0.02±0.00	2.81±0.12	0.012±0.00	11.49±0.73	1.32±0.33	31.94±4.84	0.66±0.07	22.49±6.78
	90	2.25±0.23	1.68±0.17	1.09±0.14	2.45±0.33	0.02±0.00	2.99±0.32	0.010±0.00	12.00±0.21	1.42±0.46	32.07±3.50	0.69±0.11	19.90±2.56
	180	2.45±0.76	1.73±0.34	1.08±0.15	2.38±0.24	0.13±0.14	2.79±0.12	0.033±0.02	11.42±0.79	1.39±0.09	30.61±5.13	0.65±0.06	17.95±1.96
C	45	2.1±0.49	1.62±0.45	1.052±0.27	2.34±0.57	0.02±0.00	2.76±0.40	0.021±0.01	11.22±0.37	1.254±0.34	30.73±1.63	0.632±0.07	19.06±8.41
	90	2.23±0.34	1.62±0.30	1.033±0.22	2.29±0.47	0.02±0.00	2.75±0.40	0.013±0.00	11.34±0.88	1.227±0.35	30.30±1.83	0.601±0.12	22.63±2.43
	180	2.05±0.30	1.62±0.17	1.070±0.08	2.41±0.12	0.02±0.00	2.85±0.06	0.015±0.00	11.60±0.97	1.464±0.10	31.76±3.70	0.622±0.07	22.61±6.28

$^{a-d}$ Means ± SD within a column with no common superscript differ (P<0.05).$^{x-z}$ Means ± SD within a row with no common superscript differ (P<0.05).[1] Presented values are the means of 2 replicate trials. K refer to the cheeses ripened in normal condition ; N, NC and C refer to the cheeses ripened in 100% nitrogen, 80% nitrogen + 20% carbondioxide, 100% carbondioxide respectively

Table 3. *Microbiological characteristics (in log cfu/g) of Sepet cheeses ripened in different atmosphere packaking Condition[1]*
Tablo 3. *Farklı Atmosfer Koşullarında Paketlenen Olgunlaşmış Sepet Peynirlerinin Mikrobiyolojik Özellikleri[1] (log cfu/g)*

Variable	Days	Cheese			
		K	N	NC	C
***Lactobacillus* ssp.**	**1**	8.11±0.05	8.11±0.05	8.11±0.05 ^{a}	8.11±0.05
	45	7.47±0.67	7.25±0.36	7.70±0.53 ^{a}	7.83±1.06
	90	7.24±0.33	7.30±0.36	7.27±0.19 ^{ab}	7.36±0.60
	180	6.98±0.03	7.08±0.01	6.59±0.16 ^{b}	6.56±0.73
***Lactococcus* ssp.**	**1**	9.78±0.01 ^{a}	9.78±0.01 ^{a}	9.78±0.01	9.78±0.01 ^{a}
	45	9.31±0.48 ^{ab}	9.26±0.49 ^{ab}	9.17±0.63	9.03±0.27 ^{ab}
	90	8.46±0.19 ^{bc}	8.60±0.09 ^{bc}	8.60±0.10	8.50±0.20 ^{b}
	180	7.67±0.52 ^{c}	8.41±0.25 ^{c}	8.06±0.54	8.06±0.02 ^{b}
***Enterococcus* ssp.**	**1**	3.28±0.28	3.28±0.28	3.28±0.28	3.28±0.28
	45	3.53±0.75	3.99±0.40	4.60±0.36	3.93±0.20
	90	4.71±1.01	4.96±0.16	4.91±0.30	4.67±0.50
	180	4.80±1.08	4.93±0.59	4.90±0.82	4.85±0.77

$^{a-d}$ Means ± SD within a column with no common superscript differ (P< 0.05). $^{x-z}$ Means ± SD within a row with no common superscript differ (P<0.05). [1] Presented values are the means of 2 replicate trials. K refer to the cheeses ripened in normal condition; N, NC and C refer to the cheeses ripened in 100% nitrogen, 80% nitrogen + 20% carbondioxide, 100% carbondioxide respectively

formation of esters from alcohols and carboxylic acids whereas alcoholysis is the production of esters from alcohols and acylglycerols or from alcohols or acyl-coenzyme A. Aldehydes are produced by the catabolism of fatty acids or aminoacid via decarboxylation or deamination [2,22]. Some aldehydes such as octanal, decanal, 2,6-nonadienal were also found in low percentage in all samples. According to free faty acids, esters, aldehydes results, our research show similarities with Sepet cheese produced from goat milk and Tulum cheese produced from ewe milk [2,23]. When all volatile results were analyzed, the butyric acid, hexanoic acid, octanoic acid, diacetly and acetaldehyde were found to be at the highest percentage in all of the samples during storage. The low percentages of ester contents were observed in all samples. When percentages of esters were compared in samples, it could be said that sample K and sample NC had the lowest percentages. In terms of volatile compunds, similar results were determined by Trobetas *et al.*[24].

Compared to the control sample, linoleic acid content of N, NC and C cheese samples were lower on the 45th day of storage period, where on the further days the levels of linoleic acid dropped even below the other samples. Temiz [25] stated that predominant short-chain fatty acid was lauric acid, the most abundant medium-chain fatty acid was palmitic acid and long-chain fatty acid was oleic acid in sliced Kashar cheeses which packaged different modified atmosphere conditions.

According to *Lactobacillus* ssp. count, a similar trend was reported by Demir *et al.*[11], Ercan [13] and Ercan *et al.*[26] in sepet cheese samples. However, counts of *Lactobacillus* ssp. at the end of the storage were lower than our study results. All samples had high level of *Lactococcus* ssp. on the first day of storage, but their count decreased during 180 d. Lactococci counts of all samples on the 45th day of the storage period were found close to each other. On the further days, Lactococci counts decreased in all sample. However the highest reduction was seen in control sample during the storage days. This difference may be due to the packaging conditions and packaging may effect the consistency in lactococci count. Ercan *et al.*[26] reported that the lactococci count of Sepet cheeses changed between 5.49 and 8.89 log cfu/g. In our study, counts were found to be higher. This difference could be due to the starter microflora. *Enterococcus* ssp. count on the first days of storage was low where on further days an increase in counts were observed in all Sepet cheese samples. The highest rising count were observed in NC sample. Ercan *et al.*[26] stated that the *Enterococcus* ssp. counts were between 5.44 and 8.87 log cfu/g. These values are considerably higher than the values found in our study.

In this study, volatile, fatty acid composition and microbiological properties of Sepet cheese were investigated during manufacture and ripening. For this purpose, the cheeses were compared with control sample. When Sepet cheese samples were compared to the control sample, it was found that packaging in different conditions had made a significant difference between samples regarding volatile compounds, fatty acid compositions and microbiological characteristics. The values were found to be statistically close and similiar. For the local community, Sepet cheese, with its high nutritional values is an important source of food for the families' protein needs. There is no standard method for production. Standard and industrial production technologies of traditional cheeses must be necessarily

conserved. Local cheeses should be manufactured in high capacities using modern technologies. Also, there is vital importance in choosing the appropriate packaging material for the preservation of its characteristics and immediate packaging following their production. This study showed that cheeses ripened in 100% nitrogen (N) and 80% nitrogen + 20% carbondioxide (NC) maintained their properties during the storage period. In the further studies, Sepet cheese and other similar regional cheeses should be scientifically researched and found the methods for production to gain standard products complying food safety for public.

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