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Research Article

Effect of Different Preservation and Salting Methods on Some Volatile Compounds and Sensory Properties of Kashar Cheese

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Abstract

The purpose of this study was to determine the effect of different preservation and salting methods of Kashar cheese on some volatile compounds. On the 1st, 7th, 15th, 30th, 60th, 90th and 120th days of the maturation of the samples of kashar cheese produced experimentally with three replications volatile compounds were examined, and their sensory properties were examined on the 30th, 60th, 90th and 120th days. The volatile compounds in cheese samples were determined by the Gas Chromatographic-Headspace method. Volatile compounds determined by chromatographic method generally include acetaldehyde, acetone, ethanol, 1-butanol, 2-butanol, ethyl acetate, and methyl alcohol. It was determined that the preservation period for salting method in brine is 60-120 days in terms of the sensory properties of the cheese samples, the cheese salted in a boiler can be preserved for 90 days with waxing, and vacuum-packed cheese can be preserved for 60 days. It was determined that vacuum packaging and wax coating with salting methods had an effect on the volatile compounds during ripening.

Keywords: *Traditional production, Kashar cheese, Ripening, Packing method, Volatile compounds*

Kaşar Peynirinde Farklı Muhafaza ve Tuzlama Yöntemlerinin Bazı Uçucu Bileşenleri ve Duyusal Özellikleri Üzerine Etkisi

Öz

Bu çalışmanın amacı; Kaşar peynirinin bazı uçucu bileşenleri üzerine farklı muhafaza ve tuzlama yöntemlerinin etkisinin belirlenmesidir. Deneysel olarak 3 tekerrürlü olarak üretilen Kaşar peyniri örneklerinde olgunlaşmanın 1, 7, 15, 30, 60, 90 ve 120. günlerinde uçucu bileşenleri; 30, 60, 90 ve 120. günlerinde ise duyusal özellikleri incelenmiştir. Peynir örneklerindeki uçucu bileşenlerinin belirlenmesi için uçucu bileşikler, Gaz Kromatografik-Headspace yöntemiyle tespit edilmiştir. Kromotografik yöntemle belirlenen uçucu bileşenler çoğunlukla asetaldehit, aseton, etanol, 1-bütanol, 2- butanol, etil asetat ve metil alkoldür. Peynir örneklerinin duyusal özellikleri yönünden salamurada tuzlama yönteminde 60 ve 120 günlük muhafaza süresinin; kazanda tuzlanarak mumla kaplanan peynirlerde 90 gün muhafaza süresinin ve vakum ambalajlanan peynirlerde ise, 60 günlük sürenin kullanılabileceği belirlendi. Vakumlu paketleme ve peynir mumuyla kaplama ile tuzlama yöntemlerinin olgunlaşma sırasında uçucu bileşenler üzerinde etkili olduğu tespit edildi.

Anahtar sözcükler: *Geleneksel üretim, Kaşar peyniri, Olgunlaşma, Paketleme metodu, Uçucu bileşenler*

INTRODUCTION

Cheese is a type of food that consumed largely in the world. Morover, cheese is a product of milk and so it is easily degradable by decreasing the rate of humidity, moisture, converting it to a product that can be undisturbed for a long time (cheese can be stored for a long time depending on its type and storage conditions) [1].

Kashar cheese is a kind of holeless cheese that its curd is processed by boiling and kneading and is ripened with bacteria. It has a rich composition and it is very popular in Turkey, it is also produced under different names in some Balkan and European countries. In the classification made by considering some features (coagulation with rennet, boiling the curd, hand shaping and not being pressed) of the processing, the kashar cheese is a Pasta-Filata (plastic-curd) and according to the humidity amount, it belongs to the semi-hard cheese group [2,3]. Pasta Filata cheeses are a wide cheese group that are produced in regions including Italy, Greece, the Balkans, Turkey and Eastern Europe [4].

Ripening is the change that each cheese undergoes under certain conditions (temperature, humidity, etc.) in order to

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gain its own characteristics such as structure, taste and aroma. Hundreds of volatile aroma substances are formed in this complex process where many biochemical reactions occur and cheeses gain their own taste and odor [5]. The aroma is caused by various chemical and physicochemical compounds such as volatile or non-volatile compounds in complex food matrixes such as cheese. Alcohols, aldehydes, esters, dicarbonyl, short and medium chain free fatty acids, methyl ketones, lactones, phenolic compounds, and sulfur compounds are the main aroma compounds that have an important effect on cheese flavor [6]. Aromatic compounds result from the further degradation with the cheese aroma that has occurred due to correct balance and concentrations of amino acids and fatty acids, many essential and aromatic compounds. The remaining lactose, lactic and citric acids metabolism produces compounds, such as acetate, acetaldehyde, ethanol, 2,3-butanediol and diacetyl [7]. Vacuum packaging used as packaging material avoids the oxidative changes that affect the taste and aroma of cheese products and the drying of the cheese surface. Vacuum packaging and storage at a cooler temperature not only prolongs the shelf life of the cheeses but also allows for a more reasonable and efficient distribution of the cheeses that are divided into pieces in all shapes and sizes [8].

Cheese wax: Paraffin is a mixture made up of microcrystalline and some color pigment. The cheese wax gets warm slowly, resists to high temperatures, and peels and bends easily, and flexible. Cheddar, Parmesan, Romano, Colby, and Edam cheeses are the cheeses that are covered with wax. The wax that used to cover hard cheeses has low humidity, helps to keep humidity in the cheese and prevents the formation of mold inside of and at the surface of the cheese. The waxing also helps to keep the flavor unaffected by making the cheese light-proof [9].

In this study, it was intended to determine the volatile compounds in kashar cheese samples which were produced by the traditional method, salted in boiler and brine, covered with cheese wax and kept for 120 days.

MATERIAL and METHODS

Materials

Milk

Raw cow milk was used for cheese production. After the necessary analysis performed for raw milk, then Kashar cheese production was carried out in three replicates. Weighing 500 g, 80 pieces of Kashar cheese (40 salted in boiling and molding,40 salted in brine) were produced *(Fig. 1)*.

Packaging Material

Packaging materials of polyamide + polyethylene mixture with 90-micron thickness were used in the packaging of cheeses and packed with Novicac Mic-co+400 vacuum packaging machine. The cheese wax was used as second packaging material, melted in a water bath and kashar cheese surfaces are coated.

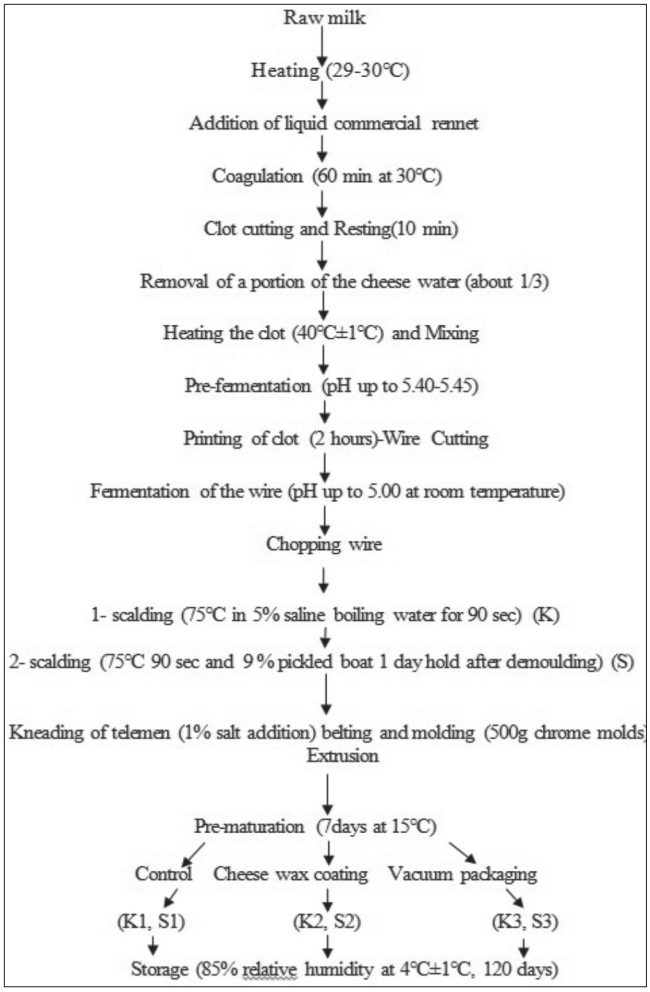

Fig 1. Production flowchart of Kashar cheese

Methods

Chemical Analysis

The amount of dry matter, fat and acidity (% l.a) of cheese samples were made according to the methods determined by Kurt et al.[10]. The amount of fat and protein in dry matter were found by calculation. It was determined using the micro-Kjeldahl method accordance with International Dairy Federation [11] and the total amount of nitrogen by Kjeldahl method was calculated by multiplying the factor of 6.38 and expressed as in percentages.

Volatile Compounds Analysis

Volatile compounds were determined by Gas Chromatography (Varian, GC - Headspace). Ethanol and n-propanol were used as internal standard in chromatographic separation. In the sample preparation stage, 2 g of sample was grated into small particles for easy collection of flavours; 1 mL of deionized water was added to the vial and placed in the Autosampler unit of GC after capping.

The samples were subjected to agitation and heating at 65°C for 15 min before the injection, so that the volatile substances left the sample and were collected in the vial and 500 uL injection was performed.

The Device Features and Analysis Parameters

After waited for 5 min while Column Varian (30 mX0.32 i.d), injector temperature at 180°C, detector temperature at 200°C, oven temperature at 40°C, the temperature was increased by 5°C per min and waited for 1 min at 140°C. The carrier gas was Helium gas. FID detector was used.

Headspace conditions: 0.08 min injection time, 3 min pressure duration, 0.5 min stay time, 27 psi working pressure have been applied.

Sensory Analysis

Sensory evaluation of cheese was done on the 30th, 60th, 90th and 120th days of ripening. The cheese samples were removed from the refrigerator, cut into pieces and coded. The sensory panel was kept at room temperature for about 1 h before the procedure. Cheese samples were placed on plates (about 30 g) with numbers. Sensory properties of the samples were evaluated according to the method specified in the Turkish Standardization Institute cheese standard [12]. Each panel member evaluated the samples in terms of five sensory characteristics; colour, cross-section and appearance, structure, taste and odour. Samples were evaluated using the following criteria: colour (scale 0-10), cross section and appearance (scale 10-30), taste and odour (scale 8-40), and structure (scale 4-20). The sensory properties of Kashar cheese were evaluated by 10 trained panels (Kafkas University, Department of Food Engineering, permanent staff) familiar with the taste and texture of kashar cheese.

Statistical Analysis

During the ripening period of cheese samples, volatile compounds were analyzed on 1st, 7th, 15th, 30th, 60th, 90th and 120th days. The statistical evaluation of the volatile compounds values of cheeses was done by using Annova and Duncan multiple comparison test and SPSS 18 computer program [13].

RESULTS

The characteristics of milk used in cheese production are given in *Table 1*. During the ripening of cheeses produced using different packaging materials and different salting methods, dry matter, acidity (%l.a), protein in dry matter and fat content in dry matter are given in *Table 2, 3, 4* and *5*. It was determined that salting methods were effective on dry matter and dry matter fat ratios in Kashar cheese during ripening period and this effect was significant in statistical evaluation (P<0.01)

The average values of the volatile compounds of Kashar cheese are shown in *Table 6*. Cheese samples that are salted in the boiler, coated with web ant vakum paket, he difterince betsen he daya as statistically insignificant (P>0.05), but the difference between the days of salting methods was

Table 1. *Chemical composition of milk used in Kashar cheese production*

Parameters	Raw Milk
pH	6.70±0.03
Acidity (%l.a)	0.18±0.17
Dry Matter (%)	12.55±0.06
Fat (%)	3.56±0.05
Protein (%)	3.40±0.02

Table 2. *Changes in the amount of dry matter (%) during the ripening of Kashar cheese samples*

Samples	1. Day	7. Day	15. Day	30. Day	60. Day	90. Day	120. Day	F value
K	53.09±1.92fB	53.42±2.03efB	54.42±2.31eB	56.14±2.20dB	59.16±2.20bcB	61.22±2.61bB	64.20±2.39aB	32.16**
S	58.05±1.34fA	58.85±1.57efA	60.76±1.56eA	62.14±1.79dA	63.62±2.36bcA	65.14±2.24bA	67.28±2.83aA	57.60**
t value	6.32**	6.32**	6.79**	6.33**	4.13**	3.41**	2.57*	
1	56.36±3.25d	57.11±3.25d	58.75±4.37cd	60.67±4.21c	63.47±3.53b	65.30±2.97b	67.64±3.10a	8.30**
2	55.63±2.70d	56.07±3.04d	57.47±3.12cd	59.01±2.54c	60.94±2.47b	62.71±2.69b	65.22±2.66a	10.00**
3	54.72±3.64d	55.25±3.74d	56.54±4.08cd	57.74±4.07c	59.76±2.87b	61.52±3.02b	64.36±1.82a	4.44**
F value	0.41	0.44	0.48	0.96	2.49	2.81	2.35	
K1	53.52±1.13e	53.83±1.20e	54.82±1.05de	56.95±1.57d	60.59±1.69c	63.20±1.84b	65.83±1.80a	31.46**
K2	54.00±3.03e	54.21±3.40e	55.59±3.67de	57.30±2.63d	59.53±2.87c	61.34±3.33b	64.34±3.32a	4.41*
K3	51.77±0.46e	52.24±0.53e	52.83±0.90de	54.18±1.09d	57.37±0.43c	59.12±0.46b	62.43±0.17a	55.86**
F value	1.15	0.73	1.18	2.47	2.13	2.54	1.82	
S1	59.21±0.97f	60.39±1.14f	62.68±0.67eA	64.39±0.65dA	66.35±1.87cA	67.41±2.32b	69.45±3.33a	12.73**
S2	57.27±1.03f	57.93±1.08f	59.34±0.63eB	60.73±0.71dB	62.36±0.97cB	64.08±1.16b	66.10±2.09a	22.56**
S3	57.67±1.44f	58.25±1.45f	60.25±0.10eB	61.30±0.56dB	62.14±1.06cB	63.93±1.36b	66.30±1.48a	20.23**
F value	2.29	3.49	30.94**	27.61**	8.99*	4.04	1.80	

** P<0.05, ** P<0.01; **a-f:** Different letters on the same line indicate significant differences between the means; **A,B:** Different letters in the same column refers significant differences between the averages. K: Salting in boiler, S: Salting in brine, 1: Open storage samples, 2: Wax covered samples, 3: Vacuumed covered samples; K1: Control (5% salt boiling), K2: Wax coating (5% salt boiling), K3: Vacuum coating (5% salt boiling) , S1: Control (9% brine), S2: Wax coating (9% brine), S3: Vacuum coating (9% brine)*

Table 3. *Changes in amount of fat (%) in dry matter during ripening of Kashar cheese samples*

Samples	1. Day	7. Day	15. Day	30. Day	60. Day	90. Day	120. Day	F value
K	42.36±1.10cB	42.63±1.15bcA	42.81±1.19bcB	43.37±1.18abB	43.68±1.25abB	44.06±1.33aB	44.52±1.36aB	3.99*
S	46.48±2.06cA	47.28±2.16bcA	47.90±2.41bcA	48.12±2.32abA	48.31±2.25abA	49.28±0.45aA	49.41±2.04aA	2.43*
t value	5.28**	5.68**	5.65**	5.45**	5.38**	5.64**	4.23**	
1	45.44±2.95	45.75±3.11	46.24±3.53	46.70±3.24	46.72±2.92	47.18±2.69	47.45±2.50	0.35
2	43.36±2.15	43.92±2.68	42.28±2.93	44.56±2.72	46.96±2.97	45.34±2.95	46.59±2.85	0.48
3	44.47±2.84	45.19±3.18	45.55±3.38	45.98±3.23	46.31±3.23	46.50±3.16	46.87±3.46	0.33
F value	0.05	0.17	0.08	0.04	0.23	0.24	0.26	
K1	42.92±1.52c	43.07±1.53bc	43.23±1.54bc	43.94±1.41abc	44.23±1.59ab	44.90±1.51a	45.35±1.49a	1.44
K2	42.20±1.24c	42.47±1.35bc	42.69±1.44bc	43.08±1.35abc	43.38±1.32ab	43.60±1.42a	44.00±1.35a	0.67
K3	41.96±0.51c	42.33±0.81bc	42.51±0.91bc	43.09±1.04abc	43.44±1.15ab	43.68±1.08a	44.22±1.39a	1.13
F value	054	0.28	0.23	0.44	0.36	0.86	1.25	
S1	47.95±0.74c	48.42±0.63bc	49.25±1.28abc	49.47±1.16abc	49.22±0.42ab	49.46±0.43a	49.55±0.45ab	1.73
S2	44.53±2.43c	45.38±3.13bc	45.86±3.45abc	46.04±3.19abc	46.53±3.59ab	48.94±0.84a	49.18±3.32ab	0.25
S3	46.97±1.07c	48.04±0.55bc	48.59±0.35abc	48.86±0.24abc	49.18±0.19ab	49.23±0.09a	49.52±0.06ab	9.63**
F value	3.65	2.35	0.54	0.75	1.62	1.46	1.48	

** P<0.05, ** P<0.01; **a-c:** Different letters on the same line indicate significant differences between the means, **A,B:** Different letters in the same column refers significant differences between the averages. K: Salting in boiler, S: Salting in brine, 1: Open storage samples, 2: Wax covered samples, 3: Vacuumed covered samples; K1: Control (5% salt boiling), K2: Wax coating (5% salt boiling), K3: Vacuum coating (5% salt boiling) , S1: Control (9% brine), S2: Wax coating (9% brine), S3: Vacuum coating (9% brine)*

Table 4. *Changes in protein content of dry matter during ripening of Kashar cheese samples (%)*

Samples	1. Day	7. Day	15. Day	30. Day	60. Day	90. Day	120. Day	F value
K	48.35±3.48bc	50.88±2.62abA	52.87±3.67abA	54.15±2.99aA	53.43±3.05a	47.51±2.54c	43.43±2.62d	14.78**
S	46.71±2.69bc	47.50±2.84abB	46.53±2.33abB	46.42±2.77aB	46.34±3.69a	43.58±3.40c	41.31±3.86d	4.91**
t value	1.11	2.90**	4.37**	5.67**	0.90	0.73	1.57	
1	47.69±2.20ab	48.445±2.97a	49.17±5.45a	49.09±5.73a	48.36±5.87a	43.79±3.97b	41.04±3.83c	2.92*
2	47.05±4.06ab	48.80±3.02a	49.05±3.34a	50.99±4.56a	50.76±4.99a	47.03±3.34b	43.96±3.37c	3.00**
3	47.87±3.39ab	50.07±3.63a	50.87±4.80a	50.78±4.90a	50.54±4.27a	45.82±3.11b	42.27±2.83c	3.75**
F value	0.10	0.42	029	0.25	0. 40	1.32	0.58	
K1	49.62±0.76cd	50.91±0.29bc	53.44±4.08ab	53.99±2.75a	53.27±2.96ab	46.43±2.48d	43.03±3.12e	7.08**
K2	46.32±4.86cd	49.59±3.19bc	50.71±3.54ab	53.63±4.65a	53.79±4.16ab	48.28±2.97d	44.10±2.70e	3.04*
K3	49.12±3.84cd	52.16±3.51bc	54.46±3.67ab	54.83±2.36a	54.24±3.32ab	47.84±2.96d	43.18±3.06e	4.35**
F value	0.10	0.42	0.29	0.25	0.081	1.32	0.58	
S1	45.76±0.60ab	45.98±1.95a	44.90±1.73ab	44.19±1.62ab	43.46±2.31ab	41.15±3.51bc	39.06±3.89c	3.20*
S2	47.77±4.01ab	48.01±3.29a	47.40±2.68ab	48.35±3.08ab	47.74±4.19ab	45.79±3.80bc	43.82±4.38c	0.82
S3	46.63±3.05ab	47.99±2.77a	47.28±2.36ab	46.73±2.32ab	47.84±3.57ab	43.81±1.83bc	41.36±2.53c	2.50
F value	0.36	0.54	1.12	2.25	1.58	1.61	0.58	

** P<0.05, ** P<0.01; **a-e:** Different letters on the same line indicate significant differences between the means, **A,B:** Different letters in the same column refers significant differences between the averages . K: Salting in boiler, S: Salting in brine, 1: Open storage samples, 2: Wax covered samples, 3: Vacuumed covered samples; K1: Control (5% salt boiling), K2: Wax coating (5% salt boiling), K3: Vacuum coating (5% salt boiling) , S1: Control (9% brine), S2: Wax coating (9% brine), S3: Vacuum coating (9% brine)*

statistically significant (P<0.05). The average values of the sensory analysis of Kashar cheese are shown in *Table 7, 8, 9* and *10*. In the evaluations of the cheese samples in terms of their colour, cross section and appearance, structure, taste and odour, the effect of maturation time on color scores was found statistically significant (P<0.05*)*.

DISCUSSION

The pH value of the milk used in cheese production is similar to that of Çürük [14] and higher than that of Yılmaz [15]. The amount of protein, dry matter and fat is higher than the values found by Çürük [14] and Yılmaz [15].

The increase in dry matter of the wax coated cheese samples was higher than the vacuum-packed cheese samples. The increase in dry matter amount of unpackaged cheese samples was higher than that of all cheese samples. The effect of packaging method on the amount of dry matter was not determined.

The increase in the amount of fat in the salted cheese samples in the brine was higher than the salted cheese samples in the boiler. The increase in dry matter fat content

Table 5. *Changes in acidity (% l.a) values during the ripening of Kashar cheese samples*

Samples	1. Day	7. Day	15. Day	30. Day	60. Day	90. Day	120. Day	F value
K	0.19±0.02gB	0.26±0.01fB	0.35±0.02eB	0.42±0.03dB	0.47±0.04cB	0.55±0.04bB	0.68±0.10a	98.99**
S	0.23±0.04gA	0.33±0.07fA	0.46±0.05eA	0.54±0.05dA	0.61±0.02cA	0.70±0.04bA	0.80±0.07a	121.21**
t value	2.14*	2.52*	5.44**	5.64**	8.39**	6.97**	1.19	
1	0.20±0.05g	0.29±0.06f	0.40±0.08e	0.49±0.09d	0.55±0.09c	0.65±0.11b	0.85±0.08aA	38.25**
2	0.21±0.03g	0.27±0.04f	0.39±0.03e	0.46±0.06d	0.54±0.07c	0.60±0.07b	0.68±0.09aB	41.09**
3	0.21±0.03g	0.32±0.07f	0.42±0.06e	0.49±0.08d	0.54±0.08c	0.63±0.08b	0.69±0.06aB	32.01**
F value	0.07	0.82	0.21	0.25	0.02	0.42	7.74**	
K1	0.18±0.01g	0.26±0.01f	0.33±0.02e	0.42±0.03d	0.47±0.05c	0.56±0.07b	0.80±0.09aA	48.40**
K2	0.21±0.03g	0.27±0.01f	0.37±0.01e	0.42±0.03d	0.47±0.04c	0.53±0.03b	0.60±0.03aB	58.21**
K3	0.19±0.01g	0.27±0.01f	0.37±0.01e	0.42±0.03d	0.47±0.05c	0.56±0.04b	0.63±0.01aB	69.89**
F value	1.71	0.33	3.55	0.07	0.00	0.23	10.63*	
S1	0.23±0.07g	0.33±0.08f	0.47±0.05e	0.57±0.07d	0.63±0.01c	0.74±0.05b	0.89±0.03a	33.52**
S2	0.22±0.05g	0.28±0.06f	0.42±0.03e	0.51±0.05d	0.60±0.03c	0.66±0.02b	0.77±0.06a	64.00**
S3	0.23±0.02g	0.38±0.07f	0.47±0.05e	0.56±0.04d	0.62±0.01c	0.70±0.02a	0.75±0.00a	61.26**
F value	0.06	1.17	0.97	1.01	0.67	2.91	0.95	

** P<0.05, ** P<0.01; **a-g:** Different letters on the same line indicate significant differences between the means, **A,B:** Different letters in the same column refers significant differences between the averages. K: Salting in boiler, S: Salting in brine, 1: Open storage samples, 2: Wax covered samples, 3: Vacuumed covered samples; K1: Control (5% salt boiling), K2: Wax coating (5% salt boiling), K3: Vacuum coating (5% salt boiling) , S1: Control (9% brine), S2: Wax coating (9% brine), S3: Vacuum coating (9% brine)*

of vacuum packed cheese samples was higher than that of wax coated cheese samples. The dry matter fat ratios of the cheese samples were similar to those determined by Çürük [14] and Yılmaz [15] and were close to the lower limit and lower than the upper limit of Ürkek [16].

The protein content of cheese samples in dry matter is higher than the values determined by Çürük [14] and Ürkek [16] in Kashar cheese samples.

The determined acidity values (0.19-0.89% l.a) are within the range of values of Yılmaz [15], whereas it is lower than the upper limit of the values determined by Çürük [14] in Kashar cheese samples.

In the food industry, different preservation and packaging techniques are used to ensure food safety by delaying enzymatic and microbial degradation. By increasing the variety of packaged food products, the spoilage of the food delivered to the end consumer during the long storage periods can be prevented or reduced.

It was noted that several recent studies have been conducted on the use of edible film or coatings and wax as a coating material in Kashar cheese.

Cetinkaya et al.[17] Reported significant differences in the sensory characteristics of Turkish cheese, Kashar protected with bee wax in different ripening periods.

Sarıoğlu and Öner [18], in a study on the effect of edible film coating on the quality of Kashar cheese, found that acetaldehyde, butanol values were lower than uncoated cheese samples, and ethanol amount released as a result of amino acid metabolism or heterofermentative lactic acid bacteria was high as from the 1st day. According to the results of the analysis, it was stated that edible film application had no negative effect on the ripening time of cheese and could be alternative in packaging.

In a study on determining the volatile compounds of Mengen cheese, a total of 130 compounds were identified. Most of these compounds are grouped as, ester, aldehydes, alcohols and ketones [19].

One of the oldest methods used for surface protection of Kashkaval cheese is paraffin coating. For this purpose, different types of paraffin wax, a combination of refined food hydrocarbon wax and polymers, are used [20].

Fox et al.[21] Stated that some types of wax used to preserve the cheese could be colored, but that certain types of cheese were known to the consumers (for example, red for extra Edam, black for Manchego and Cheddar for edam). Different types of wax have different melting points and may influence the gas passage from cheese to the environment with its rheological properties or regulate moisture and affect cheese yield.

In Kashar cheese samples produced by a conventional method, coated with wax, vacuum packed and applied both two salting methods, acetaldehyde, acetone, ethanol, methyl alcohol, 2-propanol, ethyl acetate, 2-butanol and 1-butanol have been identified.

In the Kashar cheese samples, which are salted in the boiler, the amount of 1-butanol, 2-propanol, 2-butanol, and acetone was higher in vacuum packed cheese than the control group and the wax-coated samples, while the amount of methyl alcohol and acetaldehyde was higher in the wax-coated samples. The amount of ethyl alcohol was found higher in the control group.

In cheese that is salted in brine, the amount of ethyl alcohol and methyl alcohol was lower in the control groups while the vacuum packed and the wax-coated samples were found in similar rates. The amounts of ethyl acetate and acetaldehyde in the control groups were high, the amounts of 2-propanol and 1-butanol in vacuum packed cheese

Table 6. *Volatile compounds of Kashar cheese samples during ripening (mg/kg)*

Compound		Samples	1. Day	7. Day	15. Day	30. Day	60. Day	90. Day	120. Day	P
Alcohol	Methyl alcohol	K1	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	2.77±4.79	ns
		S1	0.85±0.73	0.33±0.29	1.20±1.04	0.87±0.75	0.13±0.11	0.00±0.00	0.20±0.17	ns
		P value	*	*	*	*	*	ns	*	
		K2	0.10±0.17	0.30±0.52	0.03±0.05	0.07±0.11	0.35±0.49	29.07±25.17	13.90±23.99	**
		S2	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	7.27±12.58	0.00±0.00	ns
		P value	*	*	*	*	ns	ns	*	
		K3	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	14.53±25.17	0.00±0.00	ns
		S3	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	7.50±12.99	0.00±0.00	ns
		P value	ns	ns	ns	ns	ns	ns	ns	
	2-Propanol	K1	0.07±0.11	0.47±0.64	0.17±0.12	0.20±0.17	0.00±0.00	1.43±2.48	0.83±1.36	ns
		S1	1.27±0.29	0.07±0.06	0.08±0.11	8.97±6.64	0.00±0.00	4.70±0.06	0.00±0.00	**
		P value	ns	*	ns	*	ns	ns	*	
		K2	0.07±0.05	0.13±0.15	0.00±0.00	0.00±0.00	0.00±0.00	8.60±6.23	5.90±9.78	ns
		S2	1.27±2.11	0.67±0.51	0.03±0.05	0.40±0.60	0.87±1.50	13.67±23.67	2.01±2.16	ns
		P value	*	ns	*	*	*	*	*	
		K3	0.27±0.25	0.17±0.29	0.07±0.12	0.00±0.00	0.03±0.06	4.07±7.04	8.80±10.13	ns
		S3	0.63±0.42	0.37±0.64	0.03±0.06	0.05±0.05	4.42±7.65	9.73±0.45	0.57±0.98	ns
		P value	ns	ns	ns	*	*	ns	*	
	Ethanol	K1	46.60±34.45	79.19±34.37	35.20±6.15	38.93±19.94	79.50±77.25	75.40±21.19	41.91±26.88	ns
		S1	36.07±60.22	21.13±36.08	20.70±35.85	18.95±32.34	12.90±22.34	10.10±0.01	14.87±79.56	ns
		P value	ns	ns	*	ns	ns	ns	*	
		K2	44.83±56.14	28.78±49.64	33.47±32.23	46.17±40.29	61.20±86.55	40.50±23.90	42.87±37.12	ns
		S2	26.82±28.10	85.63±44.55	84.80±31.20	49.57±5.66	106.03±66.48	80.70±54.58	58.93±24.58	ns
		P value	ns	*	ns	*	ns	ns	ns	
		K3	80.37±35.20	22.01±21.12	46.77±0.06	41.83±2.82	72.27±8.60	37.97±16.01	67.27±17.52	ns
		S3	91.63±53.67	49.63±66.05	99.03±34.47	72.33±44.23	57.03±30.76	48.87±16.07	112.13±79.56	ns
		P value	ns	ns	*	ns	ns	ns	ns	
	2-Butanol	K1	0.07±0.11	3.93±6.46	0.50±0.70	0.20±0.34	0.00±0.00	0.57±0.98	2.30±3.98	ns
		S1	6.20±10,74	0.03±0.06	0.23±0.40	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	ns
		P value	*	*	ns	*	ns	*	*	
		K2	0.07±0.11	2.03±3.52	0.00±0.00	0.00±0.00	1.45±2.05	0.27±0.23	0.20±0.34	ns
		S2	0.77±1.15	1.10±1.05	0.00±0.00	4.03±6.81	0.00±0.00	0.87±1.50	0.10±0.17	ns
		P value	*	ns	ns	*	*	*	ns	
		K3	4.57±3.73	3.10±3.97	0.07±0.11	0.23±0.40	0.10±0.17	0.13±0.23	0.50±0.62	ns
		S3	1.87±0.87	1.13±1.06	0.20±0.35	0.07±0.11	47.03±77.43	0.00±0.00	1.67±2.63	ns
		P value	ns	ns	ns	*	*	*	*	
	1-Butanol	K1	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	ns
		S1	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	ns
		P value	ns	ns	ns	ns	ns	ns	ns	
		K2	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	ns
		S2	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	ns
		P value	ns	ns	ns	*	ns	ns	ns	
		K3	0.10±0.17	0.10±0.17	0.12±0.14	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	
		S3	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	ns

*Results are expressed as mean ± standard deviation of means; * P<0.05, ** P<0.01; ns: >0.05*

Table 6. *Volatile compounds of Kashar cheese samples during ripening (mg/kg) (continued....)*

Compound		Samples	1. Day	7. Day	15. Day	30. Day	60. Day	90. Day	120. Day	P
Esters	Etil Acetate	K1	0.03±0.05	0.37±0.63	0.10±0.10	0.30±0.43	0.00±0.00	4.23±6.16	0.17±0.28	ns
		S1	12.57±7.93	0.10±0.01	0.53±0.46	4.20±7.27	0.00±0.00	0.20±0.00	0.00±0.00	*
		p value	*	*	*	*	ns	*	*	
		K2	12.53±21.70	17.47±29.56	0.07±0.11	1.37±2.36	7.23±12.52	1.20±1.03	0.67±1.15	ns
		S2	0.30±0.43	0.50±0.78	0.57±0.60	0.33±0.49	2.13±1.94	3.27±4.99	0.47±0.80	ns
		P value	*	*	ns	*	*	*	ns	
		K3	17.30±29.44	17.10±29.62	0.17±0.06	0.07±0.11	2.77±2.31	3.37±4.37	2.37±2.97	ns
		S3	1.47±1.50	0.20±0.35	0.13±0.23	0.00±0.00	1.17±1.39	1.53±2.66	1.33±1.35	ns
		P value	*	*	*	*	ns	ns	ns	
	Acetaldehyde	K1	0.47±0.56	16.50±27.80	2.43±3.21	0.60±0.36	0.50±0.70	0.23±0.32	3.00±2.29	ns
		S1	69.23±58.92	41.60±35.68	42.13±34.93	103.97±88.92	25.43±21.94	61.90±28.14	30.47± 26.21	ns
		P value	*	*	*	*	*	*	*	
		K2	39.63±68.70	96.40±33.16	84.60±18.51	17.27±25.70	81.59±13.51	24.20±41.73	53.33±32.70	ns
		S2	2.07±2.40	1.33±0.73	1.17±1.67	42.30±72.83	2.83±4.82	0.90±0.81	0.43±0.66	ns
		P value	*	*	*	*	*	*	*	
		K3	2.93±2.51	3.13±2.55	0.27±0.29	0.47±0.38	3.40±2.25	0.07±0.11	0.40±0.69	ns
		S3	1.57±1.12	1.10±1.47	0.33±0.15	0.30±0.20	20.48±35.73	0.40±0.61	1.13±0.50	**
		P value	ns	ns	ns	ns	*	ns	ns	
Ketones	Acetone	K1	0.10±0.17	0.80±1.30	0.20±0.35	0.07±0.06	0.00±0.00	4.30±7.45	0.53±0.92	**
		S1	1.43±0.29	0.03±0.06	0.20±0.17	1.03±0.63	0.00±0.00	0.00±0.00	0.00±0.00	ns
		P value	ns	*	ns	*	ns	*	*	
		K2	0.07±0.11	0.47±0.64	0.00±0.00	0.00±0.00	0.00±0.00	3.23±0.92	0.93±1.51	ns
		S2	0.43±0.67	0.33±0.25	0.03±0.05	1.80±3.03	0.53±0.68	16.00±23.12	5.00±6.92	ns
		P value	*	ns	*	*	*	*	ns	
		K3	0.57±0.35	0.23±0.32	0.13±0.23	0.00±0.00	0.10±0.17	0.90±1.56	6.03±5.97	
		S3	0.37±0.32	0.17±0.29	0.50±0.70	0.17±0.15	7.10±12.30	2.97±3.17	1.77±1.62	ns
		P value	ns	ns	ns	*	*	*	ns	

*Results are expressed as mean ± standard deviation of means; * P<0.05, ** P<0.01; ns: >0.05*

Table 7. *Changes in colour scores of Kashar cheese samples during maturation*

Samples	30. Day	60. Day	90. Day	120. Day	F Value
K	8.43±1.10	8.77±1.33A	8.94±0.92A	8.12±1.12	3.01*
S	8.28±1.71	7.91±1.41B	7.89±2.01B	8.19±1.29	0.42
t value	1.89	3.70**	4.39**	0.35	
K1	9.00±0.82a	8.83±1.08a	8.91±0.79a	8.60±0.81bA	0.45
K2	8.67±1.10a	8.51±1.87a	9.06±0.81a	8.18±0.96bA	1.11
K3	8.55±1.25a	8.88±0.97a	8.71±1.18a	7.76±1.40bB	1.81
F value	1.82	0.41	1.03	4.28*	
S1	7.95±1.16B	8.44±1.25A	8.08±1.21	8.03±1.26B	0.20
S2	8.03±1.09B	7.34±1.29B	7.65±2.36	7.89±1.20B	0.26
S3	8.93±2.36A	8.10±1.52AB	7.90±2.41	8.70±1.23A	0.58
F value	3.46*	4.89**	0.33	4.10*	

A,B: *Different letters in the same column refers significant differences between the averages; * P<0.05, ** P<0.01*

Table 8. *Changes in cross-section and apparance during the ripening of Kashar cheese samples*

Samples	30. Day	60. Day	90. Day	120. Day	F Value
K	26.27±3.61A	27.20±3.56A	25.45±4.50	25.89±3.47	1.60
S	24.05±5.49B	25.27±4.44B	24.06±7.39	25.59±3.82	0.85
t value	3.25**	3.22**	1.50	0.58	
K1	26.68±3.52	27.81±1.93	26.16±3.20	26.01±3.29AB	0.91
K2	25.54±3.90	25.98±5.43	26.26±4.79	24.74±3.76B	0.29
K3	26.58±2.65	27.93±1.78	23.83±4.97	27.02±3.01A	3.47
F value	1.10	2.95	2.95	3.33*	
S1	23.71± 4.91	24.16±4.70	23.40±6.48	25.04±3.58	0.26
S2	24.58±5.40	25.30±4.85	24.50±7.93	25.52±4.83	0.05
S3	23.78±6.14	26.36±3.53	24.30±7.87	26.28±2.69	0.61
F value	0.23	1.85	0.19	0.73	

A,B: *Different letters in the same column refers significant differences between the averages, ** P<0.01*

samples were higher. The amount of acetone was higher in the samples coated with wax. Differences between days in salting and packaging methods were found to be insignificant in terms of statistical evaluation (P>0.05) for methyl alcohol in the cheese samples that are brined and salted in boiler and vacuum packed (P>0.05).

Table 9. *Changes in taste and odour during the ripening period of Kashar cheese samples*

Samples	30. Day	60. Day	90. Day	120. Day	F value
K	32.91±4.83A	34.68±5.51A	35.01±4.31A	33.81±4.41	2.22
S	30.31±6.91B	32.82±6.81B	31.95±8.69B	33.01±5.47	1.41
t value	3.27**	2.03*	2.89**	1.01	
K1	32.46±5.47	33.82±7.72	35.20±4.09	33.90±4.13	2.06
K2	32.76±4.73	34.56±4.02	36.16±3.92	33.73±3.94	1.28
K3	33.53±4.43	34.70±5.48	33.76±4.75	33.80±5.20	0.12
F value	0.37	0.92	2.39	0.01	
S1	30.43±6.15	33.93±7.09	31.23±6.79	32.46±4.70	1.08
S2	29.70±7.35	32.20±7.33	32.83±8.94	34.43±5.81	0.60
S3	30.73±7.40	32.40±6.11	31.90±8.24	32.23±5.79	0.14
F value	0.17	0.57	0.25	1.46	

A,B: *Different letters in the same column refers significant differences between the averages, * P<0.05), ** P<0.01)*

Table 10. *Changes in structure during the ripening of Kashar cheese samples*

Samples	30. Day	60. Day	90. Day	120. Day	F Value
K	16.73±2.72B	17.51±3.03	18.22±2.61	17.03±2.81B	2.79
S	17.63±2.15A	18.01±2.41	17.40±4.39	18.18±2.34A	1.87
t value	2.51**	1.22	1.57	2.91**	
K1	16.61±2.26	18.16±1.93	18.10±1.88	17.70±3.10	2.80
K2	16.03±2.91	17.10±3.85	18.94±2.30	17.08±2.54	5.50*
K3	17.49±2.61	17.28±2.99	17.50±3.37	16.35±2.63	0.41
F value	2.31	1.10	2.45	1.92	
S1	17.38±2.14	18.54±2.10	18.32±1.95	17.71±2.89	2.06
S2	17.84±1.87	17.89±2.60	16.87±4.92	18.21±2.01	2.10
S3	17.68±2.40	17.62±2.45	16.61±5.47	18.53±2.03	1.58
F value	0.36	1.25	1.12	0.87	

A,B: *Different letters in the same colımn refers significant differences between the averages, * P<0.05, ** P<0.01*

Ethanol, methanol 2-propanol, 2-butanol, and 1-butanol amounts that are determined in the Kashar cheese samples are 0.10-112.13 mg/kg, 0.00-29.07 mg/kg, 0.00-13.67 mg/kg, 0.07-6.20 mg/kg, and 0.00-0.12 mg/kg, respectively.

Among the alcohols found in cheese samples, ethanol is the main alcohol, Ethanol amount in old Kashar cheese sample was found as higher than that of the fresh ones. There are significant differences between the alcohol concentration of Kashar cheese samples that may be related to the production process.

Determined ethanol and 1-butanol concentrations in Dolaz cheese (2.6056 mg/kg, 0.0046 mg/kg) by Okur and Güzel-Seydim [22] and in Kashar cheese (198.36-304.26 ppb) by Sarıoğlu and Öner [18] was found to be higher.

Hayaloğlu [23] has stated that in the 90-day duration of ripening period the amount of ethanol and 1-butanol were 11.37-32.67 and 2.70-3.96 peak area/10^5, Eroğlu et al.[24] has stated the amount of ethanol in Kashar cheese as 1.82-7.17%. Bontinis et al.[25] have determined the amount of ethanol in Greek Goat cheese as 68.12-161.55%.

Sulejmani et al.[26] found 73 volatile compounds, including alcohols (16), esters (17), acids (14), terpenes (7), ketones (5) and aldehydes (4) during the 180-day period of traditional Beaten (Bieno sirenje) cheeses.

Twenty-three volatile aroma compounds were detected and identified in the headspace of the maturity Cheddar cheeses [27].

The determined amounts of 2-propanol in 11 different types of cheese (0.65-10.76 µg/100g) by Hayaloglu and Karabulut [28] and in Brine White cheese (0.1-0.9 µg/100g) by Şahangil et al.[29] were lower than the values of Kashar cheese samples.

Fat-reduced Cheddar cheese were determined in 38 volatile compounds and the highest ratio was found in 2-butanone (32%) [30].

A total of 60 compounds including aldehyde, ketone, alcohol, acid, ester, terpene, aliphatic hydrocarbon, aromatic hydrocarbon, furan and other compenents have been identified in cheeses containing 4 different herbs [31].

A total of 24 volatile compounds have been identified in Sepet cheeses that are packaged under different modified atmospheric conditions and stored for 6 months. In all Sepet cheese samples, it was stated that some fatty acids, such as hexanoic acid, octanoic acid and butyric acid are the highest [32].

Esters, which are responsible for fruity flavours in cheese, are formed through direct esterification of alcohols and carboxylic acids or via alcoholysis [33]. Therefore, the composition of the milk and reaction conditions such as pH might be an important factor affecting the ester compounds formation [23]. Esters are highly effective in cheese aroma because of their low perception threshold valesi [34]. The ester compositions (ethyl acetate) of the fresh kashar cheese samples at the beginning and end of the ripening time varied between 0.03-17.30 mg/kg, respectively. Etil ester composition of the cheese samples changed during ripening.

The amount of ethyl acetate determined in kashar cheese was found higher than 11 different kinds of cheese available for consumption in Turkey (0.54-20.74 mg/100 g) by Hayaloglu and Karabulut [28] and Eroğlu et al.[24] have noticed as 2.21-4.18% in kashar cheese.

Aldehydes originate from the degradation of amino acids [35]. Acetaldehyde was the aldehyde compound found in the cheese samples. The concentration of the acetaldehyde compounds in kashar cheese was in the range from 0.23-84.60 mg/kg at the beginning of the ripening. The determined amount of acetaldehyde in cheese samples, Dolaz cheese (0.05 mg/kg) by Okur and Güzel-Seydim [22] and in Greek goat cheese (0.09-4.21 mg/kg) by Bontinis et al.[25] were found to be higher.

Ketone compounds are formed by enzymic oxidation of free fatty acids to β-ketoacids, followed by decarboxylation to ketones [7]. The initial and final acetone concentration of the cheeses ranged between 0.07-0.57 mg/kg and 0.00-6.03 mg/kg, respectively.

The determined amount of acetone, in Dolaz cheese (0.0018 mg/kg) by Okur and Güzel-Seydim [22] and in Brine white cheese (5.8-29.6 g/100 g) by Şahangil et al.[29] was found to be lower.

Compatible with Kashar cheese, in different kinds of cheese, important components in the base taste and aroma such as acetaldehyde, acetone, ethanol, butanol were determined [22,29]. Factors such as the type of cheese, the type of milk used, the lack of standard production methods, the storage process and the characteristics of the packaging material have an effect on higher determined volatile compounds rates in kashar cheese samples, compared to other kinds of cheese.

Sensory perception is a complex process influenced by factors such as the level of flavor compounds, the texture and appearance of cheese [29].

The colour scores were found to be within the score interval indicated in Kashar Cheese Standard [12] on the 30th and 120th days of maturation. The color scores of the vacuum packed cheese samples were higher than the colour scores of the cheese samples coated with wax. The colour scores of the cheese samples salted in boiler were higher than the colour scores of the cheese samples salted in brine. The highest color scores were given to the cheese samples which were salted in brine, waxed and were not packed. Colour scores of Kashar cheese samples are higher than scores (7.52) Ürkek [16] obtained. Factors such as the composition of the milk used in cheese production, the maturation time of the cheese may be the reasons for the difference in the color scores of the cheese samples.

Cross section and appearance scores of K (salting in boiler) cheese samples were higher than that of S (salting in brine) cheese samples.

Scores of vacuum packed cheese samples were higher than the scores of the wax coated cheese samples. The scores obtained in the sensory evaluation are consistent with the score interval indicated in the Kashar Cheese Standard [12]. The scores obtained are higher than the cross section and appearance scores Arslaner [36] identified for Tulum cheese. Differences in cross section and appearance scores may be due to factors such as the moisture content of the cheeses, the packaging material and the maturation time.

The taste and odour scores of the kashar cheese samples were higher for the cheese samples salted in boiler than that of cheese samples salted with brine method. The taste and odour scores of the samples covered with wax were higher than that of the vacuum packaged samples. The values obtained are higher than the odor scores determined by Yılmaz [15]. The differences in taste and odour scores may be due to the chemical and biochemical events occurring during the maturation of cheese or the type of milk used in production.

Structure scores were higher in cheese samples salted with brine method. Structure scores of vacuum packaged cheese samples are higher than that of the samples covered with wax. The structure scores given during the sensory evaluations are consistent with the score interval indicated in the TS 3272 Kashar Cheese Standard. Structure scores are higher than scores determined by Çürük [14] (2.17-4.65) for kashar cheese, higher than the lower limit of the scores determined by Arslaner [36] (8.75-22.50) and lower than the upper limit of Arslaner's scores. Factors such as the fat rate, moisture content, packing material and proteolysis ratio of cheese may be the source of the difference in the structure scores in cheese samples.

In this study, changes in the volatile compounds during production and ripening period in Kashar cheese, which is produced by traditional techniques, were determined. It was found that the concentration of acetaldehyde, acetone, ethanol, methyl alcohol, 2-propanol, ethyl acetate, 2-butanol, and 1-butanol, which are the volatile compounds determined in Kashar cheese, showed differences in salting and packaging methods. It is thought that these differences can be caused by the packaging material and salting methods used. The alcohol content was the highest in all samples at 60th day and it was determined that the ratios of ethyl alcohol, 2-butanol and 2-propanol were higher. The ethyl alcohol, 2-propanol rates in vacuum packed cheese samples were higher than wax-coated and the control group cheese samples. Also, the amount of ethyl acetate in vacuum packed cheese samples were higher than the wax-coated samples. The amount of acetone in the wax-coated and boiler-salted control groups was higher than the vacuum packaged samples.

According to the obtained results, the volatile aroma compounds which affect the taste, smell and customer taste of the cheese as a whole include many interrelated complex events that occur during the ripening of cheese. The diversity in these compounds is an expression of cheese quality. It was determined that the volatile compounds were determined to a certain extent in cheese samples which were vacuum packed and coated with cheese wax, these packaging methods did not have a negative effect on the quality of cheese and did not delay the ripening of cheese.

Cheese wax can be used as a different packaging material in Kashar cheese storage in order to prevent flavour changes due to its soft, non-cracking property when it cools it takes the shape of coated cheese to protect the cheese surface from microbial contamination and to prevent light changes.

It was observed that some volatile compounds determined in cheese samples produced by brine salting method were higher than salting method in boiler. In addition to salting in the commonly used cauldron, we can state that the use of brine salting in kashar cheese can be condensed. This study demonstrates the fact that the production technique, packaging method and ripening conditions of cheeses play an important role in the formation of volatile compounds in cheeses.

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