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SHORT COMMUNICATION

Changes of Volatile Compounds of Herby Cheese During the Storage Period

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Summary

Changes in the composition of volatile compounds of the control and four different types of herby cheeses (Control, cheese with no added herbs; CH, cheese containing Helis (*Ferule* sp.); CK, cheese containing Kekik (*Thymus* sp.); CS, cheese containing Sirmo (*Allium* sp.) and CM, cheese containing Mendo (*Anhriscus* sp.)) were investigated during 28 days of storage at 4°C. A total of 60 compounds were tentatively identified during the storage period, including aldehydes, ketones, alcohols, acids, esters, terpenes, aliphatic hydrocarbons, aromatic hydrocarbons, furans and other compounds.

Keywords: *Herby cheese, Volatile compounds, SPME-GC/MS*

Otlu Peynirlere Ait Uçucu Bileşenler Profilinin Depolama Süresince Değişimi

Özet

Kontrol ve 4 farklı otlu peynirin (Kontrol, otsuz üretilen peynir; CH, Helis içeren peynir (*Ferule* sp.); CK, Kekik içeren peynir (*Thymus* sp.); CS, Sirmo içeren peynir (*Allium* sp.) ve CM, Mendo içeren peynir (*Anhriscus* sp.)) uçucu bileşenler profili 4°C'de 28 günlük depolama periyodu boyunca belirlenmiştir. Çalışmanın sonucunda aldehit, keton, alkol, asit, ester, terpen, alifatik hidrokarbon, aromatik hidrokarbon, furan ve diğer bileşenleri içeren toplam 60 bileşik tespit edilmiştir.

Anahtar sözcükler: *Otlu peynir, Uçucu bileşikler, SPME-GC/MS*

INTRODUCTION

Herby cheese, which is called "Otlu peynir" in Turkish, is mainly produced in eastern and south-eastern regions of Turkey [1]. The cheese is produced by adding specific aromatic herbs, which have been commonly used for many years [2]. Generally, more than 20 kinds of herbs have been used in the production of herby cheeses, with the most commonly used being *Allium* sp. (Sirmo), *Thymus* sp (Kekik), *Ferule* sp. (Helis), *Anhriscus* sp. (Mendo), *Rannunculus* sp. (Cünk), *Anethum* sp. (Dereotu) and *Mentha* sp. (Nane) [3]. Flavour is one of the most important characteristics that determine the quality of cheese. The flavour compounds in cheese are primarily derived from carbohydrate, citrate, protein and milk fat as a result of glycolysis, citrate fermentation, proteolysis and lipolysis by microorganisms [4].

Analysis of the volatile components of herby cheese samples were conducted by a purge and trap connected to a gas chromatography with a mass spectrometer and disclosed a total of 60 components belonging to the following chemical families aldehydes, ketones, alcohols, acids, esters, terpenes, aliphatic hydrocarbons, aromatic hydrocarbons, furans and other compounds. Therefore, the aim of this research was to determine the changes of volatile compounds during the storage period in five different batches of herby cheeses.

MATERIAL and METHODS

Materials

The milk that is used in the production of cheese

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was obtained from the pilot milk-processing plant of the Agricultural Collage of Atatürk University. Jars for the packaging of samples were bought from the local markets of Erzurum, Turkey. Herbs used for the production of herby cheeses were purchased from Van, Turkey.

Manufacture of Experimental Herby Cheese

For the production of cheese, a total of 75 kg of whole-fat milk was used. For the production of cheese, milk was left for 24 h to turn sour. Afterwards, the sour milk was heat-treated at 80-85°C for 15 min and the formed curd was cooled to 25-30°C. Afterwards, the cheese was divided into five equal parts and each herb was added to the curds at a ratio of 2%, with the exception of the control, and salted. For analyses, samples were packed into the sterile jars and stored at 4±1°C for 28 days and analysed for volatile compounds.

Analysis of Volatile Compounds

The extraction of headspace volatile compounds was carried out using a SPME device (Supelco, Bellefonte, PA), using fibres of 75 ml, carboxen/polydimethylsiloxane (CAR/PDMS). Before the analysis, the fibres were pre-conditioned in the injection port of the GC as indicated by the manufacturer's guidelines. For each analysis, 5 g of herby cheese was minced and weighed into a 40 ml headspace vial and sealed with a PTFE-faced silicone septum (Supelco, Bellefonte, PA, USA). The vial was left at 30°C in a thermo block (Supelco, Bellefonte PA, USA) for 1 hour to equilibrate its headspace. Next, the fibre was exposed to the head-space while maintaining the sample at 30°C for 1 h. Analyses were performed on a gas chromatograph (Agilent 6890 N) coupled to a mass selective detector (Agilent 5973) [5].

Statistical Analysis

The data were analysed statistically using the SPSS statistical software programme version 13 (SPSS Inc., Chicago, IL, USA). Analysis of Variance (ANOVA) [6] and Duncan's multiple range test was used to determine significant differences among results.

RESULTS

The mean values of volatile compounds of herby cheeses during the storage period are presented in *Table 1*. The most of volatile compounds showed significant differences at the levels of P<0.01, P<0.05 during storage at ±4°C.

DISCUSSION

In herby cheeses, acetaldehyde, pentanal, nonanal, hexanal, heptanal, benzaldehyde and octanal were detected during storage. However, the most important of these were acetaldehyde and hexanal in the cheese samples. The highest mean acetaldehyde percentage was detected in CM cheese, while the lowest mean percentage value was determined in CS. There were no significant (P>0.05) differences between the experimental cheeses in terms of acetaldehyde values. As can be seen *Table 1*, relative percentage of acetaldehyde decreased after 14 days of storage and this difference was found to be statistically significant (P<0.05). This result could be explained by the presence of antimicrobial effects of sirmo on bacteria because aldehydes are produced by microorganisms in cheeses [7,8]. The hexanal percentage of the CH had a higher value than those of other samples and this was found to be statistically significant (P<0.01). Generally, the lowest hexanal percentage was determined in CS. This situation can be explained as a result of the lower β-oxidation regarding the reduced microbial activity in CS [9,10]. As can be seen *Table 1*, a relative percentage of hexanal showed a decrease during the storage period and this was statistically significant (P <0.01) *(Table 1)*.

Herby cheeses were found to contain a range of ketones. All of these ketones were formed at different levels in all herby cheeses during storage at 4°C and showed significant differences (P<0.01, P<0.05) both among samples and during the storage periods statistically *(Table 1)*. The highest mean percentage value of acetoin was found in CC and the lowest mean percentage value was in CS. These results could be due to the antimicrobial effect of herbs. Conversely, the highest mean percentage amount of aceton was detected in CS and the lowest value was found in CC. The acetoin and aceton levels of the samples were completely different (P<0.01) from each other and the throughout ripening period *(Table 1)*. The fluctuations in the concentrations of the ketones in herby cheeses during ripening were conceivably the result of the inter-conversions of the methyl ketones and their corresponding secondary alcohols [11].

Ethanol was the principal and most abundant volatile aromatic compound produced during the storage of the experimental cheeses. Similar results were found by Kaminarides et al.[12], Bintsis and Robinson [13]. The highest mean percentage value of ethanol was found in CC, while the lowest mean percentage value was determined in CK *(Table 1)*, although the differences between the cheese samples were insignificant (P>0.05). This result could be due to the antimicrobial effects of kekik on lactic acid bacteria and yeasts. As can be seen *Table 1*, a relative percentage of ethanol showed irregular changes during storage and this was statistically significant (P<0.01).

Acetic and butyric acid were detected in all samples during the storage period. Acetic acid showed irregular changes among samples, which was statistically significant (P<0.01). The highest mean acetic acid percentage was determined in CM, whereas the lowest mean percentages were in CC and CH. It was observed that the acetic acid value increased (P<0.05) at the end of storage. These

Table 1. *The mean peak area ratio of volatile compounds in the control and herby cheese samples during storage*
Tablo 1. *Kontrol ve Otlu peynir örneklerine ait uçucu bileşenlerin ortalama pik alanlarının depolama süresince değişimi*

Volatile Compounds	Herby Cheese Samples					Days of Storage				
	CC	CH	CK	CS	CM	1.	7.	14.	21.	28.
Aldehydes										
Acetaldehyde	8.67±3.93a	8.42±4.07a	7.70±5.07a	6.43±3.15a	8.90±3.18a	7.84±4.61b*	8.69±3.48a*	10.51±3.91a*	6.39±2.76b*	6.69±3.71b*
Pentanal	0.95±1.06a**	0.93±0.91a**	nd**	0.49±0.64b**	0.87±1.01a**	1.75±0.69a**	1.50±0.55b**	0.40±0.46c**	0.08±0.12d**	0.00±0.01d**
Nonanal	0.30±0.46a	0.37±0.33a	0.23±0.32a	0.49±0.72a	0.52±0.48a	0.70±0.78a*	0.34±0.29b*	0.24±0.32b*	0.24±0.38b*	0.39ab*
Hexanal	5.09±5.62a**	6.26±4.89a**	1.40±1.82c**	1.39±1.63c**	3.15±3.75b**	7.91±4.56a**	6.19±4.32b**	2.24±2.88c**	0.61±0.65d**	0.35±0.21d**
Heptanal	0.33±0.39a*	0.28±0.15ab*	0.15±0.24bc*	0.09±0.14c*	0.26±0.41ab*	0.47±0.28a**	0.44±0.38a**	0.14±0.14b**	0.06±0.13b**	nd**
Benzaldehyde	0.42±0.46a**	0.01±0.04c**	1.37±0.36bc**	0.30±0.12ab**	0.30±0.33ab**	0.47±0.51a**	0.14±0.15b**	0.15±0.12b**	0.16±0.30b**	0.23±0.31b**
Octanal	0.12±0.28ab**	0.17±0.17a**	0.06±0.13c**	0.01±0.05c**	0.13±0.26ab**	0.32±0.28a**	0.13±0.20b**	nd**	0.03±0.06c**	nd**
Ketones										
2-propanone (Aceton)	0.48±0.31b**	0.88±0.87b**	1.33±2.65b**	3.56±613a**	0.99±1.69b**	0.48±0.25b**	0.55±0.75b**	0.71±1.43b**	3.98±5.97a**	1.52±2.67b**
2-butanone	0.78±1.28b**	0.76±1.58b**	0.85±1.40b**	0.16±0.14b**	2.42±3.67a**	0.06±0.07c**	0.05±0.10c**	2.23±3.91a**	1.83±1.59a**	0.81±0.69b**
2-pentanone	15.71±18.60bc**	9.41±11.35c**	35.06±34.15a**	25.36±24.20ab**	17.89±21.15bc**	2.14±0.67c**	2.64±1.69c**	23.47±19.10b**	45.30±28.67a**	29.89±20.83b**
2-butanone, 3-hydroxy (Acetoin)	0.40±0.36a**	0.30±0.28b**	0.23±0.26b**	0.20±0.28b**	0.22±0.29b**	0.62±0.22a**	0.42±0.25b**	0.25±0.26c**	0.06±0.09d**	nd**
2-hexanone	0.77±1.05bc*	1.00±1.30abc*	1.57±1.79a*	1.32±1.50ab*	0.59±0.82c*	0.05±0.08c**	0.07±0.13c**	0.84±0.68b**	2.25±1.59a**	2.05±1.35a**
2-heptanone	32.76±40.00b**	25.53±36.40b**	67.67±60.79a**	55.58±57.16a**	22.86±28.42a**	2.03±0.48c**	2.64±0.69c**	32.67±28.68b**	81.03±51.22a**	86.03±41.87a**
2-octanone	0.42±0.61b**	0.63±0.86b**	nd**	1.63±2.51a**	0.25±0.35b**	0.02±0.05b**	0.01±0.05b**	0.15±0.16b**	1.29±1.95a**	1.46±1.77a**
2-nonanone	10.78±14.81b*	14.94±22.70b*	22.36±28.40ab*	34.80±61.34a*	5.69±8.91b*	0.11±0.14c**	0.27±0.13c**	4.50±3.49c**	32.56±39.79b**	51.12±45.40a**
2-undecanone	0.41±0.62b**	0.78±1.24b**	0.73±1.22b**	3.16±5.29a**	0.24±0.37b**	nd**	nd**	0.06±0.18b**	1.97±3.31a**	3.31±4.10a**
Alcohols										
Ethanol	30.30±39.86a	17.70±9,94b	17.41±9.49b	17.54±12.13b	20.59±28.98ab	31.78±11.95b**	44.59±35.33a**	14.66±9.21c**	4.94±5.66c**	7.57±12.44c**
Butyl alchol	0.36±0.67a*	0.07±0.10b*	0.16±0.26ab*	0.08±0.14b*	0.29±0.40a*	0.30±0.19b**	0.52±0.71a**	0.11±0.14bc**	0.03±0.11c**	nd**
2-pentanol	0.26±0.57bc*	0.09±0.21c*	0.74±1.21a*	0.65±1.07ab*	0.44±0.68abc*	nd**	nd**	0.04±0.11c**	0.75±1.08b**	1.39±0.95a**
1-pentanol	0.13±0.39b*	0.46±0.54a*	0.21±0.30b*	0.21±0.33b*	0.16±0.40b*	0.33±0.41ab**	0.32±0.48ab**	0.39±0.57a**	0.11±0.17bc**	0.03±0.07c**
2-butanol	0.39±0.61a**	0.39±0.34a**	0.23±0.44b**	0.20±0.34b**	0.05±0.11c**	0.48±0.44a**	0.48±0.62a**	0.31±0.26b**	nd**	nd**
Nonanol	0.04±0.08b**	nd**	0.32±0.54a**	0.05±0.17b**	0.01±0.05b**	nd*	nd*	0.05±0.10b*	0.25±0.42a*	0.13±0.42a*
1-hexanol	0.10±0.17b**	0.51±0.49a**	0.74±1.16a**	0.07±0.12b**	0.12±0.18b**	0.06±0.11b*	0.03±0.08b*	0.35±0.59ab*	0.48±0.68a*	0.62±0.96a*
2-heptanol	0.45±0.81b**	0.57±1.22b**	3.11±4.51a**	4.45±6.41a**	0.41±0.58b**	nd**	nd**	0.16±0.28c**	3.23±4.36b**	5.61±5.68a**
Acids										
Acetic acid	0.23±0.40b**	0.23±0.17b**	0.42±0.89b**	0.91±1.04a**	1.13±1.49a**	0.60±0.61b*	0.42±0.77b*	0.49±0.70b*	0.30±0.38b*	1.12±1.72a*
Butyric acid	0.64±0.49b**	0.66±0.38b**	0.53±0.34b**	1.65±2.23a**	0.56±0.24b**	0.84±0.34a	0.71±0.28a	0.58±0.13a	1.14±2.22a	0.76±1.08a
Esters										
Ethyl acetate	6.83±6.26a	7.39±5.31a	5.08±4.08a	6.66±5.97a	4.92±5.15a	11.49±4.02a**	10.28±4.02a**	6.41±3.51b**	1.41±1.71c**	1.30±2.37c**
Methyl butyrate	0.56±0.47abc**	0.33±0.29bc**	0.62±0.46ab**	0.78±0.72a**	0.28±0.28c**	0.56±0.28a	0.52±0.27a	0.34±0.14a	0.56±0.80a	0.58±0.67a
Isobutylacetate	1.41±0.87ab	2.17±0.74a	1.81±2.45ab	0.55±1.52b	1.82±1.93ab	1.06±1.39a	1.64±1.97a	1.55±1.94a	1.54±1.94a	1.97±1.08a
Ethyl butyrate	0.44±0.40b**	0.44±0.14b**	1.62±0.74a**	1.58±1.70a**	0.36±0.32b**	0.84±0.50ab	1.05±0.84ab	1.16±0.91a	0.46±0.54b	0.91±1.77ab

Table 1. *The mean peak area ratio of volatile compounds in the control and herby cheese samples during storage (continue)*
Tablo 1. *Kontrol ve Otlu peynir örneklerine ait uçucu bileşenlerin ortalama pik alanlarının depolama süresince değişimi (devam)*

Volatile Compounds	Herby Cheese Samples					Days of Storage				
	CC	CH	CK	CS	CM	1.	7.	14.	21.	28.
Hexanoic acid, ethyl ester	0.07±0.09b**	0.15±0.12b**	0.72±0.39a**	0.69±0.73a**	0.06±0.10b**	0.26±0.38a	0.27±0.31a	0.46±0.45a	0.34±0.36a	0.37±0.78a
Ethyl octanoate	nd**	0.04±0.09bc**	0.23±0.18a**	0.09±0.20b**	nd**	0.01±0.05c**	0.05±0.11bc**	0.10±0.21ab**	0.07±0.12bc**	0.13±0.20a**
Terpenes										
1R-.alpha.-Pinene	1.59±2.46bc**	9.34±6.49a**	4.32±7.91b**	0.52±0.36c**	1.23±1.32bc**	3.88±5.85a	4.89±6.23a	2.76±3.69a	3.66±8.40a	1.82±2.40a
beta-Pinene	0.27±0.36ab	0.29±0.26ab	0.39±0.76a	0.08±0.13b	0.28±0.22ab	0.23±0.26ab	0.41±0.34a	0.33±0.22a	0.31±0.76ab	0.05±0.10b
.beta.-Myrcene	0.06±1.21b**	0.38±0.19b**	13.07±8.57a**	nd**	0.12±0.21b**	1.00±1.79b*	3.30±6.54ab*	4.69±9.51a*	2.39±6.27ab*	2.24±5.77b*
.DELTA. 3-Carene	1.07±2.48b**	3.09±3.59a**	1.18±0.54b**	0.22±0.29b**	0.19±0.37b**	0.26±0.45b**	0.54±0.71b**	1.98±3.33a**	1.19±2.11a**	1.77±2.62a**
.alpha.-Phellandrene	0.05±0.14c**	0.31±0.32b**	1.49±0.81a**	0.01±0.02c**	0.16±0.47bc**	0.08±0.21b**	0.52±0.73a**	0.49±0.76a**	0.46±0.70a**	0.45±0.94a**
.beta.-Phellandrene	0.23±0.62c**	2.08±0.54a**	0.91±0.51b**	0.16±0.35c**	0.28±0.38c**	0.34±0.60c**	0.69±0.90b**	0.76±0.95b**	0.71±0.96b**	1.15±0.82a**
D-limonene	0.58±0.73c**	3.15±0.67a**	2.11±0.93b**	0.41±0.27c**	3.60±1.15a**	1.49±1.16b**	2.44±1.85a**	1.94±1.38ab**	1.96±1.42ab**	2.01±1.75ab**
Benzene, 1-methyl-2-(1-methylethyl)	2.82±3.70b**	5.20±1.94b**	48.44±16.95a**	2.86±3.76b**	1.81±0.83b**	6.77±10.52b**	12.52±17.58a**	15.60±24.46a**	13.73±21.75a**	12.52±23.34a**
gamma-Terpinene	0.11±0.20a	0.06±0.07ab	nd	nd	0.06±0.16ab	nd	0.08±0.22a	0.00±0.01a	0.07±0.12a	0.07±0.10a
Eucalyptol	nd**	nd**	0.48±0.39a**	nd**	nd**	0.17±0.36a**	0.15±0.34a**	0.11±0.24ab**	0.05±0.19bc**	nd**
Linalool	nd**	nd**	0.38±0.31a**	nd**	nd**	0.07±0.16a	0.09±0.19a	0.14±0.33a	0.04±0.15a	0.04±0.16a
Aliphatic Hydrocarbons										
Hexane	27.87±35.40a**	11.47±13.99bc**	7.50±9.29c**	7.85±9.76c**	18.26±25.00b**	7.16±6.67b**	6.82±4.23b**	45.97±32.28a**	8.98±11.36b**	4.07±2.62b**
n-Octane	0.31±0.22b**	0.58±0.39a**	0.16±0.20c**	0.06±0.12d**	0.21±0.19c**	0.42±0.22ab**	0.44±0.35a**	0.33±0.33b**	0.05±0.14c**	0.09±0.14c**
Heptane	10.26±10.95a	6.99±8.29b	7.35±9.22b	8.83±10.84ab	7.94±9.10ab	18.41±5.73a**	19.29±6.28a**	2.68±2.21b**	0.65±0.69b**	0.33±0.39b**
Undecane	0.34±0.66a	0.22±0.39ab	0.13±0.19ab	0.22±0.47ab	0.07±0.11b	0.41±0.75a**	0.22±0.23ab**	0.26±0.40ab**	0.03±0.10b**	0.06±0.12b**
Dodecane	0.32±0.49a	0.44±0.53a	0.37±0.31a	0.24±0.31a	0.26±0.37a	0.47±0.52a**	0.43±0.43a**	0.36±0.45a**	0.30±0.26a**	0.06±0.18b**
Decane	0.08±0.15a	0.10±0.24a	0.13±0.13a	0.12±0.19a	0.09±0.07a	0.19±0.21a**	0.16±0.19ab**	0.07±0.17bc**	0.07±0.11bc**	0.04±0.07c**
n-Dodecane	0.07±0.13ab	0.08±0.23ab	nd	0.21±0.46a	0.13±0.33ab	0.31±0.48a	0.14±0.33b	0.04±0.10b	nd	0.01±0.02b
Tridecane (Eicosane)	0.73±0.72ab	0.86±0.61ab	1.07±0.44a	0.97±0.74ab	0.60±0.36b	1.13±0.68a**	0.81±0.46ab**	0.80±0.64ab**	0.89±0.72ab**	0.58±0.39b**
2-Decanone	0.06±0.12a	0.09±0.16a	nd	11.70±42.97a	0.03±0.08a	nd	nd	nd	0.39±0.70a	11.49±43.03a
Pentadecane	0.33±0.58cd**	0.69±0.70bc**	1.19±0.55a**	1.03±1.32ab**	0.25±0.37d**	0.32±0.60b**	0.35±0.53b**	0.45±0.71b**	1.25±0.98a**	1.12±0.88a**
Aromatic Hydrocarbons										
Toluene	6.64±5.42a	4.82±1.85a	6.50±4.51a	4.19±1.52a	5.10±1.93a	5.82±4.33a	6.17±5.27a	6.60±1.95a	4.68±2.56a	3.97±1.45a
Ethylbenzene	0.28±0.56a	0.14±0.16a	0.38±0.45a	0.11±0.13a	0.24±0.51a	0.38±0.42a**	0.51±0.66a**	0.10±0.14b**	0.12±0.22b**	0.04±0.11b**
Benzene, 1,2-dimethyl o-Xylene)	0.04±0.08b**	0.05±0.13b**	0.03±0.06b**	0.05±0.09b**	0.14±0.11a**	0.02±0.09bc**	nd**	0.08±0.14b**	0.08±0.10b**	0.14±0.08a**
p-Xylene	0.95±1.60a	0.60±0.44a	1.09±1.32a	0.46±0.23a	0.93±1.66a	1.07±1.30ab*	1.62±2.07a*	0.62±0.39b*	0.43±0.41b*	0.27±0.18b*
Styrene	0.77±1.46a	0.69±0.46a	1.14±1.21a	0.55±0.18a	1.15±1.84a	0.81±1.23b*	1.64±2.15a*	0.71±0.54b*	0.67±0.49b*	0.47±0.15b*
Furans										
Benzofuran	0.04±0.10b**	3.37±1.22a**	0.20±0.29b**	0.02±0.04b**	0.09±0.11b**	0.52±1.01b**	1.15±2.01a**	0.70±1.33b**	0.69±1.45b**	0.65±1.32b**

Mean values ± standard deviations of Conrol and Herby cheeses manufacturing with duplicate samples. The letters a, b, c and d indicate means that significantly differ at P<0.01 and P<0.05. nd, not detected results could be due to the microbial loads of the herbs added to the cheeses [11]. The highest mean percentage value of butyric acid was found in CS and the lowest mean value was in CK. Butyric acid concentrations of samples shown to be statistically different (P<0.01) to each other, although the storage period affected the butyric acid percentages and were found to be statistically insignificant (P>0.05) *(Table 1)*. This could be explained by the presence of diversified flora in the herbs used. Similar results were reported by Foda et al.[14].

Ethyl acetate was the principal and most abundant volatile aromatic compound produced during the storage of herby cheeses. The highest mean percentage value of ethyl acetate was found in CH and the lowest mean percentage value was in CM. Differences among the samples were found to be insignificant (P>0.05) statistically *(Table 1)*. However, ethylacetates percentage values showed a regular decrease during storage and the storage period's effect on this compound was found to be statistically significant. Isobutylacetate was the second highest ester found in experimental herby samples. It had the highest percentage in CH as with the ethylacetate percentage, although the lowest mean percentage value was detected in CS. Both the herb and storage period effect on the isobutylacetate percentage were found to be statistically insignificant (P>0.05) *(Table 1)*.

11 terpenes were identified in the control and herby cheeses during the storage period. Among the terpenes, 1R-.alpha.-pinene and benzene, 1-methyl-2-(1-methylethyl) were the most abundant compounds in the experimental cheeses. The highest mean percentage value of 1R-.alpha.-Pinene was found in CH and the lowest mean percentage value was in CS. Differences among the samples were significant (P<0.01) statistically, although the effect of the storage period was found to be insignificant (P>0.05) *(Table 1)*. This might be explained by the properties of the herbs used. The highest mean value of benzene, 1-methyl-2-(1-methylethyl) was found in CK and the lowest mean value was in CM. Differences between the samples and the storage period were found to be statistically significant (P<0.01) *(Table 1)*. The differences of terpenes in experimental cheeses can be probably derived from the pasture and herbs used in cheese production [15].

Hexane was the most abundant aliphatic hydrocarbon among the experimental cheeses during the storage period. The highest mean percentage value was found in CC, while the lowest mean value was found in CK. Differences among the samples and the storage period were found to be significant (P<0.01) statistically *(Table 1)*.

The main aromatic hydrocarbon was the toluene in herby cheese samples. Similarly, toluene had already been identified at high levels in Feta-type [13] cheese. The highest mean percentage value of toluene was determined in CC, while the lowest mean percentage was detected in CS. Differences between the control, herby samples and the storage period were found to be statistically insignificant (P>0.05). Conversely, toluene values generally showed an irregular change during the storage period *(Table 1)*. These results could be explained by the sample differences.

In this research study, 1 furan compound was only determined in cheeses during storage time. Benzofuran was found in all samples. This compound reached the highest mean percentage in CH, while the lowest mean percentage was determined in CS cheese. Differences among the samples and the storage period were found to be significant (P<0.01) statistically *(Table 1)*. Differences of furans in experimental cheeses can be derived from the herbs used in cheese production.

This study clearly indicates that the different herbs used in cheese production affected the volatile composition of the samples. The SPME GC/MS technique was used to analyse the aroma compounds in the experimental cheeses. During storage more than 60 volatile components were detected in all cheeses. At the same time, it was observed that the changes of ratios of compounds during storage were different. According to the results obtained, acetaldehyde, hexanal, ethanol, ethylacetate, 2-pentanone, 2-heptanone, 2-nonanone, hexane, heptane and toluene were considered to be the major compounds of experimental cheeses and they were detected in all samples during storage. These compounds showed differences among the samples due to the herbs used.

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