International Journal of
Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946 DOI: 10.31015/jaefs.2021.4.28

www.jaefs.com

Research Article Int J Agric Environ Food Sci 5 (4):666-674 (2021)

Aroma profiles and mineral composition of Buffalo kaymak collected from markets in the Çukurova region of Turkey

Çağla Özbek[1,*] Nuray Güzeler[2] Murat Kalender[3]

[1]Gastronomy and Culinary Arts Department, Faculty of Fine Arts, Design and Architecture, Toros University, Mersin, Turkey
[2]Food Engineering Department, Faculty of Agriculture, Cukurova University, Adana, Turkey
[3]Veterinary Department, Eleskirt Vocational School, Agri Ibrahim Cecen University, Agri, Turkey

[*]Corresponding Author: cagla.ozbek@toros.edu.tr

Abstract

The aim of this study was to analyze the chemical composition in terms of dry matter, protein, fat and ash contents, mineral content by laser ablation inductively coupled plasma mass spectrometry and atomic absorption spectroscopy methods and aroma profile by solid phase microextraction (SPME) method of buffalo kaymak (clotted cream) samples collected from the Çukurova region in Turkey. The results of our analyses showed that the kaymak samples contained an average of 85.31% dry matter, 78.00% fat, 4.01% protein, and 0.44% ash. Forty volatile compounds were identified comprising four aldehydes, three ketones, eight acids, five alcohols, six esters, six amines, and eight miscellaneous compounds. The average compositions of Ca, K, Na, Mg, Cu, Fe, Mn, and Zn were 408.96 mg L^{-1}, 542.42 mg L^{-1}, 238.84 mg L^{-1}, 289.39 mg L^{-1}, 0.12 ppm, 5.65 ppm, 0.08 ppm, and 14.70 ppm, respectively. When comparing these results with those in the literature using of kaymak samples from different locations, the samples from the Çukurova region had higher dry matter, fat, Ca, K, Na, Mg, and Fe contents and lower Mn content.

Keywords: Traditional dairy product, Flavor, Mineral content

Introduction

Kaymak is a traditional dairy product that is produced mainly in eastern Turkey and central Anatolia (especially in Afyonkarahisar province) and is generally from either buffalo or cow milk. Kaymak is also known as “kajmak”, “kaimak”, “gemagh”, or “geymar” in some countries in the Middle East, Central Asia, India, and the Balkans (Simsek et al., 2018). The origin of kaymak, which has an important place in Turkish culinary culture, is based on the Ottoman Cuisine and it was a food sent as a gift to the rulers of other countries in that period (Demirgul, 2018). In Turkish cuisine, this product can be served at breakfast as plain (Çekal and Doğan, 2021), or can accompany some desserts (Zengin and Gürkan, 2019), as well as used instead of butter or oil in the preparation of some dishes (Sandikci and Ozkan, 2017), and used in the production of traditional desserts such as “Ekmek kadayıfı”, “Baklava” and “Lokum” (Demirgul, 2018). Especially “Afyon kaymağı” which is produced by buffalo milk in Afyonkarahisar province, is a product that revives gastronomy tourism today (Zengin and Gürkan, 2019). Kaymak is one of the most popular dairy products made from buffalo milk (Yaman et al., 2017) and contains at least 60% milk fat by weight (Kara and Ince, 2018). To produce kaymak, buffalo milk is heated to 95°C for 30 min and cooled to room temperature. One day after preheating, the milk is placed into a perforated container used to separate the cream layer from the milk. During this step, the milk is slowly heated again to 95°C for 45 min and cooled to room temperature, after which it is refrigerated for 1 night and the kaymak layer, which forms at the top, is separated (Saglam and Seker, 2018).

The Anatolian water buffalo (*Bubalus bubalis*) reared in Turkey are from the Mediterranean buffalo and are a subgroup of river buffalo (Gecgel et al., 2019). According to regional statistics, the total number of buffalo in Turkey in 2020 was 192,489 (head), of which 3,557 were in the Mediterranean region, which has the least number of head in Turkey. There were 437 and 55, respectively, head of buffalo in Adana and Mersin Provinces, or the Çukurova

Cite this article as:
Özbek, Ç., Güzeler, N., Kalender, M. (2021). Aroma profiles and mineral composition of buffalo kaymak collected from markets in the Çukurova region of Turkey. International Journal of Agriculture, Environment and Food Sciences, 5(4), 666-674
Doi: https://doi.org/10.31015/jaefs.2021.4.28
Orcid: Çağla Özbek: https://orcid.org/0000-0002-3577-1599 , Nuray Güzeler: https://orcid.org/0000-0001-5246-2491 , Murat Kalender: https://orcid.org/0000-0002-1934-9101
Received: 25 August 2021 **Accepted:** 12 December 2021 **Published Online:** 29 December 2021
Year: 2021 **Volume:** 5 **Issue:** 4 (December) **Pages:** 666-674
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

region located in the eastern Mediterranean, in 2020. The total amount of buffalo milk in 2019 was 79341 T in Turkey, 1181 T in the Mediterranean region, 155 T in Adana, and 24 T in Mersin. Thus, the production of buffalo milk and its dairy products is limited; therefore, these products are valuable in the Çukurova region.

Geographical location can result in differences in compositions of buffalo milk and its dairy products. Location affects the steps in processing the milk and the overall quality of the final product (Akgun et al., 2016). There are only a few studies on buffalo milk and dairy products from specific regions in Turkey. Bulut et al. (2010, 2011) have investigated organochlorine pesticide residues buffalo milk, buffalo butter, and kaymak samples from Afyonkarahisar Province. Kara and Ince (2014, 2018) have determined aflatoxin M1 levels in buffalo milk and kaymak samples from the same province. Kara and Ince (2016) have also researched malathion and malaoxon contaminations in buffalo milk samples from Afyonkarahisar province. Çınar et al. (2019) have studied the compositions of general and fatty acids in buffalo milk samples from six different provinces.

Only a few studies have been conducted on buffalo kaymak, especially on their mineral contents and aroma profiles. Kan and Küçükkurt (2018) have investigated the amount of heavy metals and Şenel (2011) has studied the aroma characteristics of Afyon kaymak samples.

In the Çukurova region, buffalo milk and its products are produced from very few family businesses; therefore, the number of products on the market is quite low. Buffalo milk is not easily accessible, especially in cities such as Adana and Mersin; therefore, these products are quite valuable in this region. With the slow food movement, the gastronomic value of these products is increasing in the region (Çavuş et al., 2019; Guzeler et al., 2020). There is no information on the characteristics of buffalo dairy products in the Çukurova region and limited published data on the mineral composition and aroma profile of buffalo kaymak samples; therefore, the present study was conducted to determine the mineral compositions and aroma profiles of kaymak samples collected from Çukurova markets. In terms of ensuring the sustainability of traditional products, it is thought that it is important to determine the chemical and aromatic components of these products. This study also provides information on some general compositional properties of kaymak samples.

Materials and Methods

The present study used 20 samples of buffalo (*Bubalus bubalis*) kaymak collected from 20 different local producers in Mersin and Adana Provinces in the Çukurova region in spring season in 2019. Samples were transported to Çukurova University, Faculty of Agriculture, Department of Food Engineering, Milk Technology Laboratory, and some of the compositional properties, mineral contents, and aroma profiles were assessed.

Chemical composition

The amount of dry matter was determined gravimetrically by drying the samples at 100°C until the weight was constant (IDF, 2005). Fat ratios of the samples were determined using the Gerber method (TSE, 2002). The micro Kjeldahl method was used to determine total nitrogen content, and total nitrogen results were multiplied by 6.38 to determine protein content (IDF, 2014). The percentage of ash content was calculated using ~5 g samples placed into porcelain crucibles, drying in an oven, and cooling in a desiccator before burning the samples at 550°C, cooling again in the desiccator, and weighing (Kurt et al., 2007).

Aroma profile analyses

Solid phase microextraction (SPME) fibers were preconditioned by placing on an injection port of the Agilent 7890B gas chromatograph (Agilent Technologies, Agilent, Avondale, USA) at 250°C for 5 min and then placed in a gas-phase flask for extraction for 60 min. Desorption from cheese samples was conducted at 250° for 3 min and a programmed temperature route was used for chromatography. The temperature was kept at 35°C for 3 min and then increased to 140°C at 4°C min^{-1}. The temperature was maintained at 140°C for 1 min and then increased to 250°C over 3 min. The transfer line temperature was set at 250°C. Helium was used as the carrier gas at a flow rate of 1.0 mL min^{-1}. For mass spectroscopy, electron ionization was conducted at 70 eV, the ion source temperature was 230°C, the mass scanning range was m/z 33–450 AMU, and the emission current was 100 µA (Dan et al., 2019).

Mineral composition

The concentrations of Cu, Fe, Mn, and Zn in the samples were determined using laser ablation inductively coupled plasma mass spectrometry (LA-ICP/MS) (Perkin Elmer Nexion 2000 P) as applied by Khan et al. (2014). For this task, 2 mg sample was placed into Teflon tubes and 5 mL 65% HNO_3 and 1 mL 30% H_2O_2 were added to the tube. The samples were heated in a microwave oven (Berghof Speedwave MWS-2, Eningen, Germany) at 170°C for 10 min, 200°C for 15 min, and 100°C for 10 min, after which 1 mL distillate obtained by heating in the microwave was removed and increased to 10 mL using distilled water. The mineral content was determined using LA-ICP/MS.

The Perkin Elmer PinAAcle 900T atomic absorption spectroscopy device (AAS, Norwalk, CT, USA) was used to determine Ca, Mg, K, and Na concentrations. Three grams of the sample were placed into Teflon cups and 5 mL deionized water and 5 mL concentrated HNO_3 were added. The cups were shaken to mix the solution and then placed into a microwave mineralization device. After heating, the samples were filtered through filter paper and completed to 50 cm^3 using deionized water. The samples were measured using the AAS device at specific wavelengths (Capcarova et al., 2017).

Results and Discussion

Chemical Composition

The mean values for the chemical compositions of the kaymak samples collected from Çukurova markets are provided in the Figure 1.

The average dry matter content in the kaymak samples from the Çukurova region was 85.31%, which was higher than that in buffalo kaymak samples assessed by Şenel (2011) from Afyonkarahisar Province (65.92%) and Kocatürk et al. (2019) from Kütahya Province (57.48–64.41%). Siddique et al. (2011) and Parmar and Khamrui (2017) have determined similar percentages (83.00–89.00 and 87.00%, respectively) for the dry matter contents in buffalo kaymak samples produced in Rawalpindi and Islamabad in Pakistan and Karnal in India.

The fat content of the buffalo kaymak samples from Afyonkarahisar and Kütahya in Turkey that were assessed by other researchers was quite a bit lower (at ~5.00–40.00% lower) than those in samples from the Çukurova region (Siriken and Erol, 2009; Kocatürk et al., 2019).

The protein content of the kaymak samples was similar to the findings (0.83–5.90, 3.30, and 3.50%, respectively) of other researchers from Afyonkarahisar Province (İzmen and Eralp, 1967; Yılmaz Baytok, 1999; Anon., 2005).

The ash content of the kaymak samples was also similar to the findings of other researchers (0.50 and 0.40%, respectively) from Afyonkarahisar Province (Yılmaz Baytok, 1999; Anon., 2005).

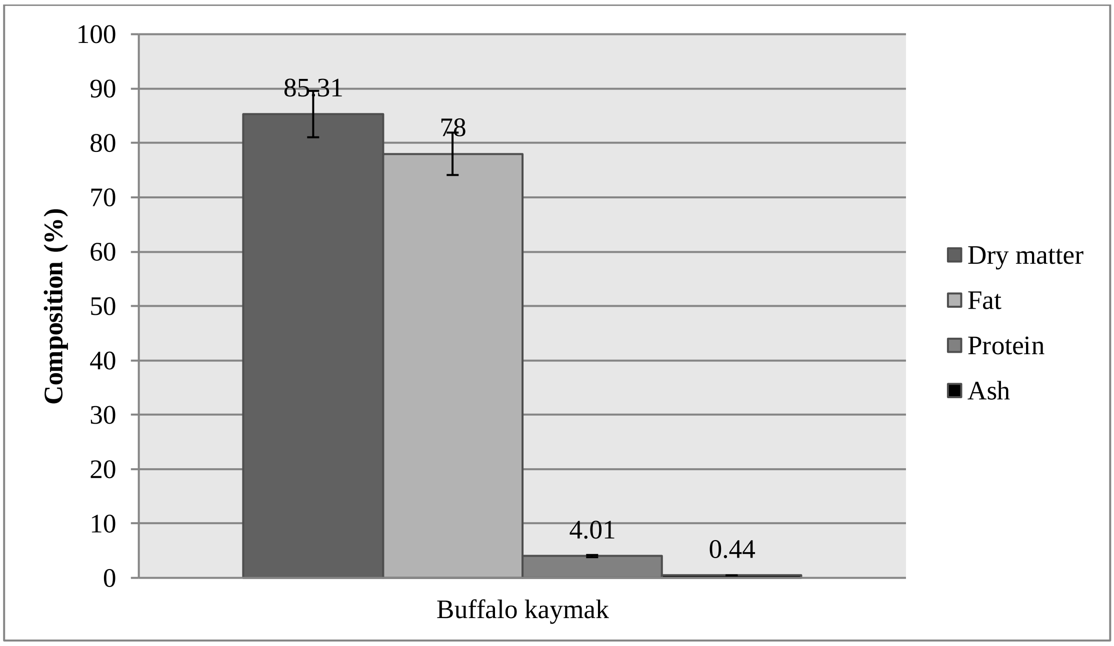

Figure 1. Chemical composition of buffalo kaymak samples collected from Çukurova markets.

Volatile aroma profile.

Forty volatiles comprising four aldehydes, three ketones, eight acids, five alcohols, six esters, six amines, and eight miscellaneous compounds were identified in the buffalo kaymak samples from the Çukurova region (Table 1).

Aldehydes

Aldehydes were not major compounds in the buffalo kaymak samples. Acetaldehyde had the highest level among the aldehydes; however, it was at lower levels than other volatiles in the samples. Acetaldehyde is produced by the activities of *Lactobacillus bulgaricus* in the mixed starter cultures (Chen, 2017), and these cultures are not used to produce kaymak; therefore, the level of acetaldehyde in buffalo kaymak is low. According to Tamime and Robinson (2007), acetaldehyde contributes a unique flavor in butter and cream products. Şenel (2011) has also identified acetaldehyde in Afyon kaymak samples made with buffalo milk and has stated that Afyon kaymak samples have low acetaldehyde concentrations that is close to that of butter because of the high fat content in kaymak. Peterson and Reineccius (2003), and Karaca et al. (2018) have reported acetaldehyde in butter samples. The presence of 3-methylbutanal depends on the activities of *Streptococcus lactis* var. *maltigenes* and causes a malty off-flavor in butter (Mallia et al., 2018). Lee et al. (1991), and Peterson and Reineccius (2003) have identified 3-methylbutanal in butter samples. Çakmakçı and Hayaloğlu (2011) have identified hexanal in Ispir kaymak samples made with cow milk.

Table 1. Flavor compounds of buffalo kaymak samples supplied from Çukurova markets.

Compounds		Relative peak area (%)	RT (min)	Molecular formula
Aldehydes	Acetaldehyde	1.210±0.254	4.466	C_2H_4O
	3-Methylbutanal	0.460±0.420	6.315	$C_5H_{10}O$
	Hexanal	0.163±0.022	14.751	$C_6H_{12}O$
	3-Hydroxybutanal	0.189±0.119	45.087	$C_4H_8O_2$
Ketones	2-Heptanone	5.102±3.024	16.330	$C_7H_{14}O$
	Acetoin	7.484±5.865	20.836	$C_4H_8O_2$
	2-Nonanone	0.778±0.255	25.466	$C_9H_{18}O$
Acids	3,4-Bis(methoxycarbonyl)benzoic acid	0.382±0.184	4.997	$C_{11}H_{10}O_6$
	Acetyl acetate;formic acid	0.214±0.034	27.904	$C_5H_8O_5$
	Butyric acid	11.855±7.785	34.176	$C_4H_8O_2$
	1,3,4-Trihydroxy-5-oxo-cyclohexanecarboxylic acid	0.213±0.118	36.251	$C_7H_{10}O_6$
	Hexanoic acid	9.825±6.095	41.994	$C_6H_{12}O_2$
	Heptanoic acid	0.176±0.020	44.981	$C_7H_{14}O_2$
	Caprylic acid	3.593±1.948	47.425	$C_8H_{16}O_2$
	Capric acid	0.743±0.376	51.813	$C_{10}H_{20}O_2$
Alcohols	Cyclobutanol	0.283±0.044	3.047	C_4H_8O
	3-Phenyl-2-butanol	0.128±0.035	14.379	$C_{10}H_{14}O$
	Isoamyl alcohol	4.073±3.120	17.597	$C_5H_{12}O$
	2-Ethyl-4-methylpentan-1-ol	0.242±0.067	29.181	$C_8H_{18}O$
	2,3-Butanediol	0.300±0.214	30.733	$C_4H_{10}O_2$
Esters	Ethyl acetate	19.578±5.225	5.655	$C_4H_8O_2$
	Vinyl formate	0.842±0.490	5.911	$C_3H_4O_2$
	Vinyl acetate	3.336±1.055	7.990	$C_4H_6O_2$
	Methyl butyrate	0.239±0.033	8.303	$C_5H_{10}O_2$
	Ethyl butyrate	4.046±1.775	10.143	$C_6H_{12}O_2$
	Ethyl hexanoate	1.804±0.741	18.812	$C_8H_{16}O_2$
Amines	sec-Butylamine	0.315±0.104	3.158	$C_4H_{11}N$
	1-Cyclohexylethanamine	0.385±0.109	3.277	$C_8H_{17}N$
	2-Amino-5-methylhexane	1.904±1.519	3.798	$C_7H_{17}N$
	1-Aziridineethanamine	0.182±0.026	4.349	$C_4H_{10}N_2$
	Octodrine	0.130±0.010	7.124	$C_8H_{19}N$
	2-Formylhistamine	0.289±0.117	24.037	$C_6H_9N_3O$
Miscellaneous	Carbon dioxide	10.531±2.701	2.901	CO_2
	Ethylene oxide	0.209±0.090	3.501	C_2H_4O
	Formamide	6.366±4.238	6.855	CH_3NO
	2-(Methylamino)ethanol	0.362±0.122	7.455	C_3H_9NO
	4,7,7-Trimethylbicyclo[4.1.0]hept-2-ene	0.139±0.049	9.614	$C_{10}H_{16}$
	D-Limonene	0.409±0.231	17.194	$C_{10}H_{16}$
	Oxime-, methoxy-phenyl-	0.527±0.111	39.196	$C_8H_9NO_2$
	1-Deoxy-d-mannitol	0.151±0.062	49.763	$C_6H_{14}O_5$

RT: Retention time

The values are expressed as the average ± standard deviation.

Ketones

Acetoin and 2-heptanone were the major ketones in the aroma compounds. Acetoin is a reduced form of diacetyl and produces a mild flavor and creamy consistency (Cheng, 2010). Diacetyl and acetoin are known as "butter aroma compounds" (Oberman et al., 1982). Ergöz (2017) has also identified acetoin, 2-heptanone (milk flavor), and 2-nonanone (cooked milk flavor) in buffalo butter and has suggested that acetoin contributes to form the characteristic aroma of butter from buffalo cream. Gokce et al. (2014) and Roosta et al. (2014) have reported the presence of acetoin in butter samples. Çakmakçı and Hayaloğlu (2011) have stated that 2-pentanone, 2-heptanone, and 2-nonanone are the most abundant ketones in Ispir kaymak samples. The presence of 2-pentanone was not observed in buffalo kaymak collected from the Çukurova region, but 2-heptanone and 2-nonanone were detected in all samples. Şenel (2011) has detected acetone, 2-butanone, and diacetyl in Afyon kaymak made from buffalo milk and none of these compounds were identified in buffalo kaymak samples collected from the Çukurova region; consequently, it is possible that the aroma profile and volatile compounds of these products can vary by location.

Acids

Acids were the largest group of volatile compounds in the buffalo kaymak, with butyric acid, hexanoic acid, and caprylic acid being the most abundant. Butyric acid contributes to the flavor of butter and cream and has many health benefits, such as anticancer properties (Kwak et al., 2013). Şenel (2011) has identified butyric, stearic, oleic, linoleic, and linolenic acids as the characteristic free fatty acids in Afyon kaymak and has identified hexanoic, caprylic, and capric acids in the samples. Hashemi et al. (2017) and Kocatürk et al. (2019) have detected butyric, hexanoic, caprylic, and capric acids in kaymak samples made from cow milk and buffalo kaymak samples produced in Kütahya, Turkey. Çakmakçı and Hayaloğlu (2011) have identified butyric and hexanoic acids in Ispir kaymak. Erfani et al. (2020) have reported that butyric acid and heptanoic acid produce the buttery, sweet, cheesy, and rancid flavors, while hexanoic acid and caprylic acid produce the pungent, musty, cheesy, and rancid flavors in ghee. Ergöz (2017) has also identified butyric, hexanoic, and caprylic acids in buffalo butter samples.

Alcohols

Alcohols were not major compounds in the buffalo kaymak samples, the most abundant of which was isoamyl alcohol. This alcohol produces the fruity flavor in dairy products (Costa et al., 2019); however, no study was found on the presence of isoamyl alcohol in kaymak or butter samples. Çakmakçı and Hayaloğlu (2011) have reported the presence of ethanol, 2-furanmethanol, 2-pentanol, 1-pentanol, 2-heptanol, 2-propanol, 1-hexanol, 2-nonanol, and terpinen 4-ol in Ispir kaymak. Ergöz (2017) has identified butanol, n-hexanol, 2-pentadecanol, n-octanol, n-hexadecanol, and benzyl alcohol in buffalo butter samples. None of those alcohols were detected in the buffalo kaymak samples from the Çukurova region.

Esters

Esters were a large group of compounds in the buffalo kaymak, with ethyl acetate being at the highest level among all volatile compounds. Erkaya and Şengül (2011) have reported that ethyl acetate contributes a pineapple flavor. Ethyl butyrate and vinyl acetate were also important esters in buffalo kaymak. Çakmakçı and Hayaloğlu (2011) have reported that ethyl acetate, methyl butyrate, ethyl butyrate, and ethyl hexanoate were detected in Ispir kaymak samples. We could not find any study on the presence of vinyl acetate in the buffalo kaymak, cream, or butter.

Amines

Amines were not major compounds in the buffalo kaymak samples. It is known that in dairy products, lactic acid bacteria are the primary producers of amines (Perin and Nero, 2017). No studies were identified on the presence of amine groups in kaymak, cream, butter, or ghee samples, which could indicate their low concentrations and the absence of a starter culture in these products.

Miscellaneous

Carbon dioxide and formamide were the major miscellaneous compounds. It has been suggested that formamide contributes an ammonia-like flavor (Hohn, 1999). Li et al. (2020) have identified D-limonene in samples of butter made from cow milk. Demirkol et al. (2016) have detected oxime-, methoxy-phenyl- in butter samples collected from Çanakkale, Turkey. No information was found in the literature on the presence of other miscellaneous compounds in buffalo kaymak.

Mineral composition

The mineral contents in milk and dairy products vary depending on the animal species, breed, nutrition, lactation stage, and health (Paszczyk et al., 2019). The data on mineral composition in terms of major and minor elements in buffalo kaymak is provided in Table 2.

Ateteallah and Hassan (2017) have assessed the Na, Ca, and K levels of some dairy products made with buffalo milk, such as fermented milk beverage, cream, and cheeses, collected from Egypt. They have found that the average Na, Ca, and K levels in buffalo creams are 165, 176, and 242 ppm, respectively. The kaymak samples from Çukurova had higher levels of these minerals than cream samples from Egypt.

Kan and Küçükkurt (2018) have determined the levels of heavy metals in Afyon kaymak samples made from buffalo milk. According to their study, Afyon kaymak samples contained 0.09 mg kg^{-1} Cu, 2.72 mg kg^{-1} Fe, 0.56 mg kg^{-1} Mn, and 8.27 mg kg^{-1} Zn. The kaymak samples from the Çukurova region had higher Cu, Fe, and Zn levels and lower Mn levels than the Afyon kaymak samples.

Enb et al. (2009) have also investigated the heavy metal compositions in buffalo milk and milk products from Egypt. They found that Cu, Fe, Mn, and Zn levels in the buffalo cream samples were 0.922, 4.520, 0.360, and 19.570 mg kg^{-1}, respectively. They have also found that buffalo cream had higher Cu, Fe, Mn, and Zn levels than cream made from cow milk. The levels of Cu, Mn, and Zn in the kaymak samples from the Çukurova region were lower than those in creams from Egypt, while the Fe level was higher.

Table 2. Mineral contents of buffalo kaymak samples collected from Çukurova markets.

Minerals	Mean	SD	Min.	Max.
Ca (mg L^{-1})	408.96	47.36	361.14	455.85
K (mg L^{-1})	542.42	106.02	440.66	652.24
Mg (mg L^{-1})	289.39	33.58	255.40	322.55
Na (mg L^{-1})	238.84	73.82	153.61	281.92
Cu (ppm)	0.12	0.14	0.03	0.28
Fe (ppm)	5.65	3.31	2.22	8.84
Mn (ppm)	0.08	0.08	0.00	0.17
Zn (ppm)	14.70	7.01	8.55	22.34

Sayed et al. (2012) have also investigated the heavy metal composition in buffalo milk and some dairy products, such as cream, butter, ghee, and cheese, from Egypt. They have determined that the Mg levels in cream, butter, and ghee are 0.016, 0.010, and 0.0012 mg kg^{-1}; Cu levels are 0.986, 1.040, and 0.86 mg kg^{-1}; and Fe levels are 2.470, 2.54, and 3.91 mg kg^{-1}, respectively. They have indicated that Mn levels are 0 mg kg^{-1} in buffalo cream, butter, and ghee samples. When the results were compared with these compositions in the kaymak samples, Mg and Fe levels in the buffalo kaymak were quite higher than that in the buffalo cream, butter, and ghee samples, while the Cu level was lower. Tokuşoğlu et al. (2004) have indicated that the Cu level in kaymak made from cow milk is 0.098 mg kg^{-1}, which is lower than that in buffalo kaymak from the Çukurova region.

Conclusion

Kaymak is a valuable product for Turkish cuisine in terms of gastronomy and culinary culture. It is very important to know the aromatic properties, chemical composition and mineral contents of this product in order to define the properties well and to ensure the sustainability of local variations of this product.

In this research, kaymak samples obtained from the milk of buffaloes grown in Çukurova region were examined, compared with other regions and countries and recorded. As a result of the research, it was determined that Çukurova buffalo kaymak has a higher dry matter and fat content than the kaymak of other regions and countries in the literature. Thus, the nutritional value of desserts, meals or commercial products obtained by using this kaymak will be higher. Kaymak is a product with a very short shelf life. For this reason, it is consumed by drying in some regions. The drying efficiency of Çukurova buffalo kaymak with high dry matter is much higher and the drying cost is less. Çukurova buffalo kaymak, which is close to the kaymak of other regions and countries in terms of protein content, can be put on the market as a functional product with increased nutritional value if it is enriched in protein.

It has been determined that the aromatic compounds of kaymak differ according to the regions. This is due to the milk composition that changes depending on the health status of buffaloes, lactation period, feeding, climatic and seasonal conditions. Unlike other regions, isoamyl alcohol, which gives the product a fruity aroma, has been detected in Çukurova buffalo kaymak. The presence of vinyl acetate in buffalo kaymak indicates an undesirable aroma originating from the packaging material. For this reason, we suggest that different packages than polypropylene packages can be used for these products on the market.

As a result of mineral analysis, it is thought that Çukurova buffalo kaymak can be enriched in terms of copper, manganese and zinc. Thus, an alternative functional product can be brought to the market.

Compliance with Ethical Standards

Conflict of interest

The authors declared that for this research article, they have no actual, potential or perceived conflict of interest.

Author contribution

The contribution of the authors to the present study is equal. All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

Ethical approval

Not applicable.

Funding

This work was supported by Çukurova University BAP (Scientific Research Projects) Department, Adana, Turkey [FBA-2019-11600].

Data availability

Not applicable.

Consent for publication

Not applicable.

Acknowledgements

Authors are thankful to Cukurova University, The Scientific Research Projects Coordination Unit for their financial supports.

References

Akgun, A., Yazici, F., & Gulec, H.A. (2016). Effect of reduced fat content on the physicochemical and microbiological properties of buffalo milk yoghurt. LWT - Food Science and Technology, 74,521-527. http://dx.doi.org/10.1016/j.lwt.2016.08.015.

Anonymous, (2005). Turkish Patent Institute Geographical Sign Registration Certificate: Afyon Kaymak. https://www.turkpatent.gov.tr/TURKPATENT/resources/temp/71213309-31B3-4C6D-A6F0-905F25F6FAE4.pdf;jsessionid=D4A25138816BEA6C0DE8E48AA06002F3, (20.05.2020).

Ateteallah, H.A., & Hassan, M.F. (2017). Assessment of sodium, calcium and potassium in buffalo's raw milk and its rural products in some centers of Sohag Governorates, Egypt. J. Food and Dairy Sci., Mansoura Univ., 8(8),331-334. https://dx.doi.org/10.21608/jfds.2017.38893.

Bulut, S., Akkaya, L., Gök, V., & Konuk, M., (2010). Organochlorine pesticide residues in butter and kaymak in Afyonkarahisar, Turkey. Journal of Animal and Veterinary Advances, 9(22),2797-2801.

Bulut, S., Akkaya, L., Gök, V., & Konuk, M., (2011). Organochlorine pesticide (OCP) residues in cow's, buffalo's, and sheep's milk from Afyonkarahisar region, Turkey. Environmental Monitoring and Assessment, 181,555–562. https://doi.org/10.1007/s10661-010-1849-x.

Capcarova, M., Harangozo, L., Toth, T., Schwarczova, L., Bobkova, A., Stawarz, R., Guidi, A., & Massanyi, P. (2017). Detection of selected trace elements in yogurt components. Journal of Environmental Science and Health, Part B. 52(12),858-863. https://doi.org/10.1080/03601234.2017.1359029.

Chen, C., Zhao, S., Hao, G., Yu, H., Tian, H., & Zhao, G. (2017). Role of lactic acid bacteria on the yogurt flavour: A review. International Journal of Food Properties, 20(S1), S316–S330. https://doi.org/10.1080/10942912.2017.1295988.

Cheng, H. (2010). Volatile flavor compounds in yogurt: A review. Critical Reviews in Food Science and Nutrition, 50(10),938–950. https://doi.org/10.1080/10408390903044081.

Costa, M.F., Pimentel, T.C., Guimaraes, J.T., Balthazar, C.F., Rocha, R.S., Cavalcanti, R.N., Esmerino, E.A., Freitas, M.Q., Raices, R.S.L., Silva, M.C., & Cruz, A.G. (2019). Impact of prebiotics on the rheological characteristics and volatile compounds of Greek yogurt. LWT - Food Science and Technology, 105,371–376. https://doi.org/10.1016/j.lwt.2019.02.007.

Çakmakçı, S., & Hayaloğlu, A.A. (2011). Evaluation of the chemical, microbiological and volatile aroma characteristics of Ispir Kaymak, a traditional Turkish dairy product. International Journal of Dairy Technology, 64(3), 444-447. https://doi.org/10.1111/j.1471-0307.2011.00687.x.

Çavuş, Ş., Kaya, B., Demirtaş, B., (2019). Sürdürülebilir turizm açisindan slow food hareketine bakiş ve Türkiye uygulamalari (In Turkish). International Black Sea Coastline Countries Symposium, May 2-5, 2019, Batumi, Georgia, p.364-375.

Çekal, N., & Doğan, E., (2021). Türk ve dünya mutfaklarinda kahvalti üzerine bir çalişma (In Turkish) [A study on breakfast in Turkish and international cuisines]. Humanities Sciences, 16(1), 71-88, DOI: 10.12739/NWSA.2021.16.1.4C0244.

Çınar, M.U., Özsoy, T., Beyzi, S.B., Kaliber, M., & Konca, Y. (2019). Milk and fatty acid composition of Anatolian water buffalo (*Bubalus bubalis*) from different provinces. Buffalo Bulletin, 38(1), 107-118.

Dan, T., Chen, H., Li, T., Tian, J., Ren, W., Zhang, H., & Sun, T., (2019). Influence of *Lactobacillus plantarum* P-8 on fermented milk flavor and storage stability. Frontiers in Microbiology, 9, 3133. https://doi.org/10.3389/fmicb.2018.03133.

Demirgul, F., (2018). Çadırdan saraya Turk mutfağı (In Turkish). Uluslararası Türk Dünyası Turizm Araştırmaları Dergisi, 3(1),105-125. https://dergipark.org.tr/en/pub/tdtad/issue/38069/368568, Access date:19.08.2021.

Demirkol, A., Guneser, O., & Karagul Yuceer, Y. (2016). Volatile compounds, chemical and sensory properties of butters sold in Çanakkale. Journal of Agricultural Sciences, 22, 99-108. https://doi.org/10.15832/tbd.16868.

Enb, A., Abou Donia, M.A., Abd-Rabou, N.S., Abou-Arab, A.A.K., & El-Senaity, M.H. (2009). Chemical composition of raw milk and heavy metals behavior during processing of milk products. Global Veterinaria, 3 (3), 268-275.

Erfani, S.H., Ghavami, M., Shoeibi, S., Zand-Moghaddam, A., & Rastegar, H. (2020). Evaluation of fatty acids and volatile compounds in Iranian ghee by head space-solid phase microextraction coupled with gas chromatography/mass spectroscopy. J. Agr. Sci. Tech., 22(1), 147-158. http://journals.modares.ac.ir/article-23-18636-en.html.

Ergöz, E. (2017). Some properties of Yayik and cream butters produced from buffalo milk. Master thesis, Ankara University Graduate School of Natural and Applied Sciences Department of Dairy Technology, p. 40. 15.02.2021. https://dspace.ankara.edu.tr/xmlui/bitstream/handle/20.500.12575/33789/Ezgi_Ergoz.pdf?sequence=1&isAllowed=y

Erkaya, T., & Şengül, M. (2011). Comparison of volatile compounds in yoghurts made from cows', buffaloes', ewes' and goats' milks. International Journal of Dairy Technology, 64(2), 240-246. https://doi.org/10.1111/j.1471-0307.2010.00655.x.

Gecgel, U., Yilmaz, I., Soysal, M.I., Gurcan, E.K., & Kok, S. (2019). Investigating proximate composition and fatty acid profile of Longissimus dorsi from Anatolian water buffaloes (Bubalus bubalis) raised in similar conditions. Food Science and Technology, 39(4), 830-836. https://doi.org/10.1590/fst.08918.

Gokce, R., Akdogan, A., Divriklib, U., & Elci, L. (2014). Simultaneous determination of diacetyl and acetoin in traditional Turkish butter stored in sheep's rumen (Karinyagi). Grasas y Aceites, 65 (1), e010. http://dx.doi.org/10.3989/gya.074113.

Guzeler, N., Koboyeva, F., & Özbek, Ç., (2020). Food products considered within the scope of slow food movement: a case of Adana province. 3rd International New York Conference on Evolving Trends in Interdisciplinary Research & Practices, November 13-15, 2020, Manhattan, New York City, p.80-92.

Hashemi, S.M.B., Khaneghah, A.M., Kontominas, M.G., Eş, I., Sant'Ana, A.S., Martinez, R.R., & Drider, D. (2017). Fermentation of sarshir (kaymak) by lactic acid bacteria: antibacterial activity, antioxidant properties, lipid and protein oxidation and fatty acid profile. J Sci Food Agric, 97, 4595–4603. https://doi.org/10.1002/jsfa.8329.

Hohn, A. (1999). Formamide. Kroschwitz, Jacqueline I. (Ed.). Kirk-Othmer Concise Encylclopedia of Chemical Technology (4th ed.). New York: John Wiley and Sons, Inc. ss. 943–944. ISBN 978-0471419617.

IDF, (2005). Yogurt-determination of total solids content. (Reference method). ISO 13580:2005 (IDF 151:2005), International Organization for Standardization.

IDF, (2014). Milk and milk products. determination of nitrogen content. Part 1: Kjeldahl principle and crude protein calculation. ISO 8968-1:2014 (IDF 20-1:2014). International Organization for Standardization.

İzmen ER., & Eralp M. (1967). Lüle kaymağı üzerine araştırmalar (In Turkish). Ankara Üniversitesi Ziraat Fakültesi Yayınları, Ankara.

Kan, F., & Küçükkurt, I. (2018). Investigation of some heavy metals with ICP – MS in Afyon buffalo kaymak and skimmed milk. Kocatepe Veterinary Journal, 11(4), 447-453. https://doi.org/10.30607/kvj.449912.

Kara, R., & Ince, S. (2014). Aflatoxin M1 in buffalo and cow milk in Afyonkarahisar, Turkey. Food Additives and Contaminants: Part B, 7(1), 7-10. https://doi.org/10.1080/19393210.2013.825646.

Kara, R., & Ince, S. (2016). Evaluation of malathion and malaoxon contamination in buffalo and cow milk from Afyonkarahisar region, Turkey, using liquid chromatography/tandem mass spectrometry – a short report. Polish Journal of Food and Nutrition Sciences, 66(1), 57-60. https://doi.org/10.1515/pjfns-2015-0017.

Kara, R., & Ince, S. (2018). Presence of Aflatoxin M1 in Kaymak produced in Afyonkarahisar province. Fresenius Environmental Bulletin, 27(7), 5033-5036.

Karaca, Y., Gün, I., Seydim, A.C., & Guzel-Seydim, Z.B. (2018). Production and quality of kefir cultured butter. Mljekarstvo, 68 (1), 64-72. https://doi.org/10.15567/mljekarstvo.2018.0108.

Khan, N., Choi, J.Y., Nho, E.Y., Hwang, I.M., Habte, G., Khan, M.A., Park, K.S., & Kim, K.S., (2014). Determination of mineral elements in milk products by inductively coupled plasma-optical emission spectrometry. Analytical Letters, 4(79), 1606-1613. https://doi.org/10.1080/00032719.2013.878842.

Kocatürk, K., Gökçe, Ö., Ergin, F., Küçükçetin, A., & Gürsoy, O. (2019). Some properties and conjugated linoleic acid contents of products produced by traditional methods and marketed as buffalo cream. Akademik Gıda, 17(4), 476-484. https://doi.org/10.24323/akademik-gida.667260.

Kurt, A., Çakmakçı, S., & Çağlar, A. (2007). Süt ve mamülleri muayene ve analiz metotları rehberi (In Turkish). Atatürk Üniversitesi Yayınları, No: 252/D, p.254.

Kwak, H.S., Ganesan, P., & Mijan, M.A. (2013). Butter, ghee, and cream products. In: Milk and Dairy Products in Human Nutrition: Production, Composition and Health, First Edition. Edited by Young W. Park and George F.W. Haenlein. John Wiley and Sons, Ltd., p.390-411.

Lee, S.R., Macku, C., & Shibamoto, T. (1991). Isolation and identification of headspace volatiles formed in heated butter. J. Agric. Food Chem., 39, 1972-1975. https://doi.org/10.1021/jf00011a017.

Li, Y., Wang, Y., Yuan, D., Li, Y., & Zhang, L. (2020). Comparison of SDE and SPME for the analysis of volatile compounds in butters. Food Sci Biotechnol, 29(1), 55–62. https://doi.org/10.1007/s10068-019-00647-z.

Mallia, S., Escher, F., & Schlichtherle-Cerny, H. (2008). Aroma-active compounds of butter: a review. Eur Food Res Technol, 226, 315–325. https://doi.org/10.1007/s00217-006-0555-y

Oberman, H., Piątkiewicz, A., & Libudzisz, Z. (1982). Production of diacetyl and acetoin by lactic acid bacteria. Molecular Nutrition and Food Research, 26(7-8), 615-623. https://doi.org/10.1002/food.19820260706.

Parmar, P., & Khamrui, K. (2017). Development of process for the production of arjuna herbal ghee from buffalo milk. Indian Journal of Animal Sciences, 87 (2), 203–207.

Paszczyk, B., Tońska, E., & Łuczyńska, J. (2019). Health-promoting value of cow, sheep and goat milk and yogurts. Mljekarstvo, 69 (3), 182-192. https://doi.org/10.15567/mljekarstvo.2019.0304.

Perin, L.M., & Nero, L.A. (2017). The relevance of biogenic amines in dairy products. In: Dairy in Human Health and Disease across the Lifespan. Editor(s): Ronald Ross Watson, Robert J. Collier, Victor R. Preedy, Academic Press, ISBN 9780128098684, p. 169-182. https://doi.org/10.1016/B978-0-12-809868-4.00012-1.

Peterson, D.G., & Reineccius, G.A. (2003). Characterization of the volatile compounds that constitute fresh sweet cream butter aroma. Flavour and Fragrance Journal, 18, 215–220. https://doi.org/10.1002/ffj.1192.

Roosta, M., Ghaedi, M., & Daneshfar, A. (2014). Optimisation of ultrasound-assisted reverse micelles dispersive liquid–liquid micro-extraction by Box–Behnken design for determination of acetoin in butter followed by high performance liquid chromatography. Food Chemistry, 161, 120–126. http://dx.doi.org/10.1016/j.foodchem.2014.03.043.

Saglam, D., & Seker, E. (2018). First report of *Escherichia coli* O157 from traditional Turkish dairy product Kaymak. Kocatepe Veterinary Journal, 11(1), 11-17.

Sandikci, M., & Ozkan, F., (2017). Afyon kaymaği ve afyonkarahisar mutfağindaki yeri (In Turkish). 1st International Sustainable Tourism Congress, November 23-25, 2017, Kastamonu, Turkey, p.852-859.

Sayed, M., Zaky, Z., & Shaban, W. (2012). Residues behavior of some heavy metals during manufacturing of some milk products. Assiut Vet. Med. J., 58(133), 163-173.

Siddique, F., Khan, K.S., Ahmad, A., Ahmed, A., Gulfraz, M., & Wattoo, F.H. (2011). Development and optimization of sweet cream butter from buffaloes at cottage scale. African Journal of Biotechnology, 10(75), 17265-17274. https://doi.org/10.5897/AJB11.2049.

Siriken, B., & Erol, I. (2009). Microbiological and chemical quality of Afyon clotted cream. Journal of Animal and Veterinary Advances, 8(10), 2022-2026.

Şenel, E. (2011). Some carbonyl compounds and free fatty acid composition of Afyon Kaymagı (clotted cream) and their effects on aroma and flavor. Grasas y Aceites, 62 (4), 418-427. https://doi.org/10.3989/gya.011611.

Simsek, B., Gün, I., & Ekinci, M.B. (2018). Effects of plasmin and plasminogen on textural biochemical and microbiological properties of clotted cream. Journal of Food Safety, 38, e12554. https://doi.org/10.1111/jfs.12554.

Tamime, A.Y., & Robinson, R.K. (2007). Tamime and Robinson's Yoghurt, Science and Technology. Third edition, Woodhead Publishing Limited, Abington Hall, Abington, Cambridge CB21 6AH, England.
TSE, (2002). TS 1018/T2, Raw Cow Milk Standard. Turkish Standardization Institute, Ankara, p.14.
Tokuşoğlu, Ö., Aycan, Ş., Akalın, S., Koçak, S., & Ersoy, N. (2004). Simultaneous differential pulse polarographic determination of cadmium, lead, and copper in milk and dairy products. Journal of Agricultural and Food Chemistry, 52, 1795−1799. https://doi.org/10.1021/jf034860l.
Yaman, Y., Karadağ, O., & Ün, C. (2017). Investigation of the prion protein gene (PRNP) polymorphisms in Anatolian, Murrah, and crossbred water buffaloes (*Bubalus bubalis*). Tropical Animal Health and Production, 49, 427–430. https://doi.org/10.1007/s11250-016-1185-4.
Yılmaz Baytok, M. (1999). Production of Afyon cream and candy with cream. Afyon Kocatepe Üniversitesi Fen Bilimleri Dergisi, 1(2), 35-40.
Zengin, B. &Gürkan, A.S., (2019). Afyonkarahisar mutfağinin gastronomi turizmi açisindan değerlendirilmesi (In Turkish) [Evaluation of Afyonkarahisar cuisine in terms of gastronomy tourism]. Saffron Journal of Culture and Tourism Research, 2(2), 225-240. https://dergipark.org.tr/en/pub/saktad/issue/48413/585863, Access date:19.08.2021.