Changes in cholesterol and free fatty acid content of Kars Gravyer Cheese (A Turkish dairy product produced by the traditional method)

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Abstract

Introduction. This study was carried out to determine changing in the ratio of free fatty acids and cholesterol depended on the maturation period of Kars Graiver cheese produced in the traditional way, and the affect of the duration of maturation on the fatty acids composition and cholesterol levels.

Materials and methods. The fat content of the cheese samples was determined by Gerber's method. Flame Ionization Detector–Gas Chromatography (GC/FID) was used to determine the fatty acids composition and cholesterol content.

Results and discussion. It was found the fat content of Kars Gravyer Cheese samples was between 27.0–38.50%. The cholesterol content in the cheese samples ranged from 45.70 to 55.80 mg/100g during 90 days of maturation. In Kars Gravyer Cheese samples, 16 saturated and unsaturated fatty acids were identified. In Gravyer Cheese samples, the content of volatile fatty acids (Butyric acid and myristic acid) increase up to 25th day ($P < 0.01$) and decrease from 45th day to 90th day. While levels of free fatty acids (palmitic acid and linoleic acid) generally decrease to 25th day, they begin increasing again until the end of the maturation period. In the 90 days period of storage of Kars Gravyer Cheese, palmitic, oleic, myristic and stearic acids were found to constitute 74.29% of the total free fatty acids content. In the samples studied, the most abundant saturated fatty acids were identified as palmitic and stearic acids. Oleic acid was found to be the most abundant unsaturated fatty acid. In cheese samples, the content of monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) ranged 28.38–32.37% and 1.59–1.84%, respectively. In Kars Gravyer Cheese sample, the Atherogenicity (AI) index was defined as 2.57–3.04.

Conclusion. Fatty acids are precursors of aroma compounds like short and medium chain free fatty acids, ethyl ketones, esters and thioesters, formed in cheese in a result of various biochemical processes. The detection of large amounts of fatty acids with short and medium chains in Gravyer Cheese samples providing aroma, indicate that this cheese is flavorful cheese.

Introduction

Today there are about 4000 different varieties of cheese in the world with different aroma and textural properties [1]. The most important factors affecting cheese quality are flavor and aroma of cheese, texture, and appearance. Unique characteristic properties of cheese are formed by biochemical reactions such as glycolysis, proteolysis, and lipolysis occurring during maturation. Free fatty acid (FFA), which emerges as a result of lipolysis reaction, is effective on the flavor and aroma of cheese. FFA is an important, volatile precursor of catabolic reactions, producing compounds that contribute to aroma [2]. The presence of short, medium and long-chain fatty acids is considered the most important indicator of cheese maturation after the compounds formed by glycolytic and proteolytic reactions [3].

The amount of free fatty acids in dairy products has potential effects not only on the taste and texture of dairy products but also on nutrition and health as antimicrobial agents. Determination of fatty acid profile of cheese is also important in terms of these negativities [4]. Cheese, which is an important source of fat in human nutrition, contains a high level of various fatty acids. From a nutritional point of view, different types of cheese contain a high level of digestible fat. Its digestibility is in the range of 88–94% [5]. However, cheese is usually presented with a negative nutritional image due to the relationship between saturated fatty acids (SFA), the main fatty acids of cheese, and cholesterol, leading to cardiovascular diseases. Although many researchers view SFA as one of the contributing factors in heart disease, there has been no direct link between cardiovascular disease and milk fat, or a real study indicating dairy products' role in heart disease [6]. Cheese is a rich source of some trans-fatty acids and short-chain fatty acids that can be considered as part of a healthy diet [7]. The World Health Organization and the American Heart association have advised that consumers limit their intake of saturated fatty acids and cholesterol to prevent coronary heart disease. The reduction of cholesterol level in dairy products will be an attractive alternative to satisfy consumer’s concerns and demands [8]. Gravyer cheese is one of the few European-style cheese that has economic value and is appreciated by consumers like domestic cheese varieties in Turkey [9]. Gravyer Cheese, one of the 18 varieties of cheese that is economically important in the world, is in the same group as Emmental (Switzerland), Gruyere (France), Fontina (Italy), Samso (Denmark), Gouda and Edam (Netherlands) [10]. Approximately 90% (544 tons) of the production of Gravyer, which is mostly produced in the Eastern Anatolia Region especially in Kars Province and its surroundings, is carried out in Kars [11]. The industrial production of Kars Grayver Cheese is quite low. Production is mostly carried out by traditional methods in dairy farms [12]. Gravyer Cheese is produced in and around Kars Province and takes the first place after kashar, tulum and white cheese production. It has economic value for the people of the region and Kars Gravyer Cheese has brand awareness throughout the country [9].

Although there are many studies on the fatty acid composition and cholesterol content of various cheeses, no studies have been conducted on the determination of changes in cholesterol and fatty acid content during the production and maturation of Kars Gravyer Cheese. However, there are few studies in which the chemical and microbiological properties of Kars Gravyer Cheese, bought from a point of purchase, are revealed [9,13]. Therefore, the aim of this study is to determine the fatty acid composition and cholesterol level of Kars Gravyer Cheese, which will be produced by traditional methods in dairy conditions, and to determine the effect of different maturation periods on fatty acid composition and cholesterol level.

Materials and methods

Sample preparation

Gravyer cheese was produced in a dairy farm in central Boğatepe village of Kars Province according to the flow diagram given in Figure 1. Gravyer cheese production was done in two repetitions. Samples were taken on different maturation days (0th,10th, 25th, 45th, 60th and 90th days) from the produced cheeses and brought to the laboratories under cold chain conditions and fat content, fatty acid composition and cholesterol analyses were performed.

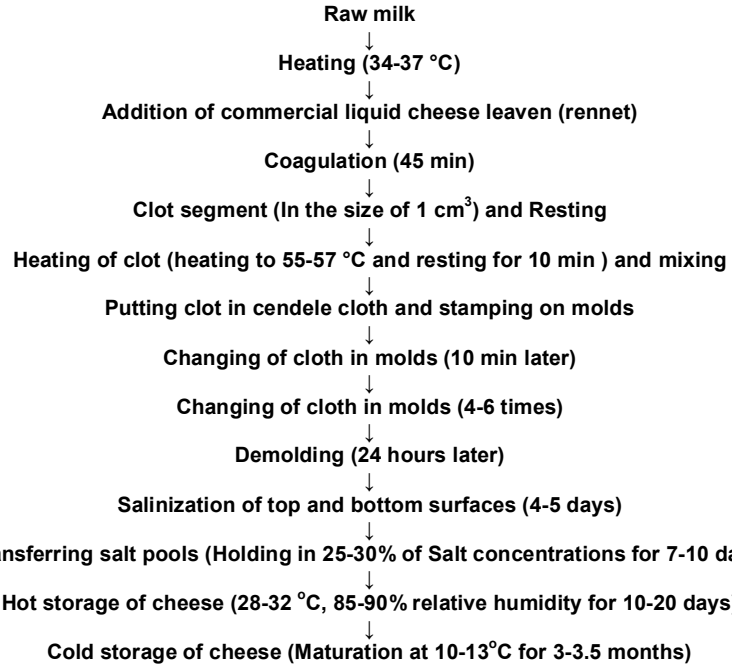

Figure 1. Production flowchart of Gravyer cheese

Methods

Determination of fat

The fat content of the samples was determined using Gerber method [14].

Determination of fatty acid composition

The fatty acid composition of the samples was determined according to the fatty acid methyl ester method (FAME) (AOAC 1996.01) [15]. Approximately 0.1 g of fat obtained as a result of fat determination method was mixed and shaken with 10 ml of n-hexane and mixed again with a 0.5 ml 2 N potassium hydroxide solution with methanol. After standing for 1-2 hours in the dark, 1 µl of the supernatant was taken and directly injected into the gas chromatograph.

GC Conditions for the analysis of fatty Acid composition

For the fats, the FAME composition was analyzed using a Restek RTX-2330 capillary column (60 m, 0.25 mm id, 0.1 μm film thickness, Bellefonte, PA, USA) in Shimadzu brand gas chromatography (model QP2010 Plus) and a flame ionization detector. The device was given 1 μl as the injection volume from the sample. The column furnace temperature was programmed to reach 240 ° C with an increase of 4 °C/min after kept for 3 minutes at 100 °C and to wait 18 minutes at the last temperature value. The injection temperature was set at 250 °C and the detector temperature was set at 255 °C. Helium was used as a carrier gas. Injection split ratio was used at 1:80 ratio. For the control of the GC/FID system, the LabSolution computer program and FAME Mix standard (37 components) (Restek) were used. FAME peaks were identified by comparing the chain lengths and retention times of the fatty acids specified in the FAME standard.

Determination of cholesterol level

Cholesterol analysis of samples was done according to [16] with some modifications. According to the method, 1 ml of internal standard (stigmasterol, 0.5 mg/ml) and 0.5 ml of 2 N alcoholic potassium hydroxide solution were added to 0.5 g of fat and the mixture is left to stand in a water bath at 80 °C for 15 minutes. Then, after cooling to room temperature, 1 ml of distilled water and 5 ml of n-hexane were added to it and shaken for 1 min. it was then centrifuged at 2000 g for 1 min and 1 mL of the supernatant was removed and injected directly into the gas chromatography device.

GC Conditions for cholesterol analysis

Cholesterol analysis of samples was performed on a Shimadzu brand gas chromatography (model QP2010 plus) device using Restek Rtx-65TG (30 m x 0.32 mm ID, film thickness 0.1 μm) (Restek international, Bellefonte, PA, USA) silica column (65% diphenyl—35% dimethyl-polysiloxane) and flame ionization detector (FID). The column oven temperature was raised to 150 °C with an increase of 30 °C/min and then to 360 °C with an increase of 15 °C/min and kept at this temperature for 3 minutes. Injection port temperature was set at 300 °C and detector temperature was set at 370 °C, helium was used as the carrier gas. The injection split ratio was used at 1:25.

Lipid quality index

Unsaturated/saturated fatty acids (USFA / SFA) ratios and desired fatty acids (DFA) were calculated from the fatty acid profiles of the cheeses.

In addition, in order to correlate the fatty acids profile with the risk of cardiovascular disease, the atherogenicity indices (AI) were calculated according to the following equation suggested by the equation by [17].

AI, shows the relationship between the sum of the main saturated FAs and the main classes of unsaturated FAs. The former is considered as proatherogenic (favouring the adhesion of lipids to cells of the immunological and circulatory system), and the latter as anti-atherogenic (inhibiting the aggregation of plaque and diminishing the levels of esterified fatty acid, cholesterol, and phospholipids, thereby preventing the appearance of micro-and macrocoronary diseases) [18].

Statistical analysis

In the evaluation of the obtained results, mean values and standard errors of the samples were determined using SPSS package program, and differences in the fatty acid composition and cholesterol level between fresh and mature Gravyer Cheese samples were analyzed by t-test.

Results and discussions

Fat ratios of Kars Gravyer Cheese samples are given in Table 1 and cholesterol ratios in Table 2.

Table 1

Fat proportion of Kars Gravyer Cheese during ripening ($\bar{X} \pm S_x$)

Parameter (%)	**Ripening Period (Day)**							
	0	10	25	45	**60**	90	F value	P
Fat	27.0 ±0.00a	28.0 ±0.51b	29.5 ±0.70c	33 ±0.71d	35.57 ±0.72e	38.5 ±0.71f	789.97	***

Results are expressed as mean ± standard deviation of means
*** ^{a,b,c,d,e,,f,} : Different letters in the same line refers significant differences between the averages ($P<$ 0.001)

Table 2

Cholesterol level of Kars Gravyer Cheese during ripening (mg /100g)

Ripening period (Day)					
0	**10**	**25**	**45**	**60**	**90**
45.70 ±3.18	48.54 ±6.32	58.36 ±9.27	155.80 ±6.32	104.72 ±16.51	101.52 ±0.89

Depending on the type of cheese, ripening time varies from a few weeks to three years. The cholesterol ratio of cheese samples ranged from 45.70 to 155.80 mg /100g during 90 days of maturation. Health lipid indices and the ratio double-carbon saturated of and unsaturated fatty acids in Kars Gravyer Cheese samples is given in Table 3–5.

Table 3

Health lipid indices of Kars Gravyer cheese (mg /100 g)

	Kars Gravyer cheese*						
Fatty Acids	**0**	**10**	**25**	**45**	**60**	**90**	**Total**
Satured fatty acid	98.22	98.45	98.56	98.44	98.36	98.49	410.93
SCSFA C4:0-C8:0	5.35	6.12	6.15	5.90	5.63	4.84	33.99
MCFA C10:0-C14:0	17.34	19.47	19.24	18.48	17.59	15.95	108.07
LCSFAC 16:0-C18:2	75.53	72.86	73.17	74.06	75.14	77.70	448.46
MUFA	30.15	28.38	28.59	29.97	32.37	31.30	180.76
PUFA	1.84	1.84	1.84	1.76	1.80	1.59	10.64
DFA	45.52	43.46	44.16	45.31	47.98	48.05	274.48
AI	2.79	3.04	3.01	2.83	2.57	2.71	16.95
USFA/SFA	0.47	0.43	0.44	0.46	0.49	0.46	2.75

*Data were presented as average values; AI – atherogenicity index;

Table 4

Changes in satured fatty acid content (mg/100g) during ripening of Kars Gravyer cheese

Satured fatty acid	Ripening period (Day) ripening ($\overline{X} \pm S_x$)						F Value	P
	0	10	25	45	60	90		
Butyric acid (C4:0)	2.56±0.20 a	2.71±0.04 b	2.74±0.10 b	2.70±0.05 b	2.58±0.01 b	2.64±0.36 b	22.23	***
Caproic acid (C6:0)	1.72±0.23 bc	2.04±0.02 d	2.03±0.06 cd	1.95±0.14 cd	1.86±0.01 cd	1.46±0.07 ab	10.32	**
Caprylic acid (C8:0)	1.07±0.15	1.37±0.01	1.38±0.02	1.25±0.17	1.19±0.02	0.74±0.34	3.49	> 0.05
Capric acid (C10:0)	2.55±0.59 ab	3.18±0.02 bc	3.15±0.01 bc	2.90±0.40 abc	2.71±0.17 abc	2.17±0.16 a	3.98	*
Lauric acid (C12:0)	3.10±0.65	3.72±0.04	3.64±0.03	3.46±0.40	3.24±0.02	2.67±0.17	3.51	> 0.05
Myristic acid (C14:0)	11.69±0.96 b	12.57±0.08 a	12.45±0.31 a	12.12±0.79 a	11.64±0.02 a	11.11±0.35 a	8.69	**
Pentadecanoic acid (C15:0)	1.72±0.34	1.47±0.02	1.48±0.01	1.57±0.11	1.60±0.01	1.45±0.31	1.01	> 0.05
Palmitic acid (C16:0)	29.10±1.03 a	28.61±0.04 b	28.27±0.08 b	27.98±0.85 b	27.73±0.07 b	29.81±0.99 b	7.40	**
Heptadecanoic acid (C17:0)	0.91±0.23	0.79±0.03	0.74±0.01	0.77±0.02	0.82±0.04	0.97±0.01	1.80	> 0.05
Stearic acid (C18:0)	13.53±0.43 a	13.24±0.2 b	13.73±0.18 b	13.58±0.55 b	13.81±0.02 b	15.16±0.25 b	11.87	**

Results are expressed as mean ± standard deviation of mean

*** ^{a,b,c,d,} : Different letters in the same line refers significant differences between the averages ($P< 0.001$, $P< 0.01$)

Table 5

Changes in unsatured fatty acid content (mg/100g) during ripening of Kars Gravyer cheese

Unsatured fatty acid	Ripening period (Day) ($\overline{X} \pm S_x$)						F Value	P
	0	10	25	45	60	90		
Myristoleic acid (C14:1)	0.91±0.05 b	0.90±0.01 b	0.86±0.01 b	0.92±0.02 b	0.88±0.01 b	0.66±0.12 a	84.82	***
Palmitoleic acid (C16:1)	1.92±0.41 a	1.72±0.01 b	1.77±0.12 b	1.73±0.08 b	1.78±0.01 b	1.64±0.28 b	16.32	**
Oleic acid (C18:1n9c)	23.12±3.68 a	20.22±0.28 b	20.19±0.03 b	21.29±1.64 b	22.05±0.04 b	22.91±0.03 b	58.38	***
Elaidic acid (C18:1n9t)	4.20±2.53a	5.54±0.12 b	5.77±0.12 b	6.03±0.70 b	6.27±0.11 b	4.96±0.19 b	9.53	**
Linoleic acid (C18:2 n6c)	0.42±0.01	0.41±0.01	0.43±0.04	0.33±0.14	0.41±0.01	0.46±0.05	0.88	> 0.05
Cis-11- eicosenoic acid (C20:1)	1.42±0.00	1.43±0.01	1.41±0.02	1.43±0.04	1.39±0.03	1.13±0.29	1.90	> 0.05

Results are expressed as mean ± standard deviation of mean
*** a,b,c,d, : Different letters in the same line refers significant differences between the averages (P< 0.001, P< 0.01)

Cheese ripening is a slow and complex biochemical process that is costly due to the long storage period. The formation of biochemical and physical reactions during ripening plays an important role in the texture and taste of matured cheese [19]. The cholesterol ratio of cheese samples increased until the 45th day, decreased by 60th and 90th day. The average amount of cholesterol in cheese samples was found as 85.77 mg/100g. The value found is higher than the value found in Kars Gravyer Cheese (54.23 mg/100) by Karagözlü et al. [20] between the values (44.6–147.769 mg/100) found in some local Turkish by Dönmez et al. [21] and close to values (82.52 mg /100 g) in Gouda cheese by Ho-Jung et al. [8].

As a result of the literature review, no research was found related to the determination of fatty acids profile in the production and storage stages of Kars Gravyer Cheese. For this reason, the results obtained from this research will be interpreted taking into consideration the studies conducted in other cheese varieties. Table 4 and 5 show that the fatty acid ratios of the Kars Gravyer Cheese samples changed during the maturation period from the production stage. This may be due to biochemical processes occurring in different maturity periods of the cheeses. Double carbon saturated and unsaturated 16 fatty acids were identified in Kars Gravyer Cheese samples. According to the results of the analysis, the highest fatty acids in the cheese samples were palmitic, oleic, stearic and myristic fatty acids. Ratios of butyric (C4: 0), caproic (C6:0), caprylic (C8:0), capric (C10:0), lauric (C12:0), myristic (C14:0), pentadekanoic (C15:0), palmitic (C16:0), heptadecanoic (C17:0), stearic (C18:0), myristoleic acid (C14:1), palmitoleic (C16:1), oleic (C18:1), elaidic (C18:1 (trans 9), linoleic (C18: 2) and 11 –eicosenoic (C20: 1) acid identified in cheese samples ranged between 2.56–2.74 mg/100g, 1.46–2.04 mg/ 100g, 0.74–1.38 mg/100g, 2.17–3.18 mg/100g, 2.67–3.72 mg/100g, 11.11–12.57 mg/100g, 1.45–1.72 mg/100g, 27.73–29.81 mg/100g, 0.74–0.97 mg/100g, 13.24–15.16 mg/100g, 0.66–0.92 mg/100g, 1.64–1.92mg/100g, 20.19–23.12 mg 100g, 4.20–6.27 mg/100g, 0.33–0.46 mg/ 100g and 1.13–1.43 mg/100g respectively.

Changes in the total free fatty acids C4, C6, C10, C14, C16, C18, C14:1, C16:1, C18:1N9T and C18:1 n9C values of all cheese samples during the ripening period were statistically significant (P <0.001, P <0.01, P <0.05) and the changes in C8, C12, C17, C18:2 and C20:1n9 values were statistically insignificant (P> 0.05).

Abd El-Salam [22] reported that milk varieties, maturation temperature, salt concentration, milk lipase, starter bacteria and other microbial lipases were also effective on the formation of free fatty acids in cheese such as Feta and Teleme. Free fatty acids are primarily formed by the enzymatic breakdown of glycerides in dairy products [23]. Free fatty acids, as they directly contribute to the flavor of the cheese, also play a role in many types of reactions leading to the formation of methyl ketones, secondary alcohols, aliphatic and aromatic esters [24]. The free volatile fatty acids found in cheeses are closely related to flavor and aroma, and acetic, butyric, caproic, caprylic and capric acids are the most important free fatty acids affecting the cheese flavor [24].

In Kars Gravyer Cheese samples, the amount of volatile fatty acids (C4: 0-C14: 0) increased up to 25th day (P <0.01) and decreased from 45th day to 90th day. While levels of free fatty acids (C16: 0-C18: 2) generally decrease at day 25, they have begun to increase again until the end of the ripening period. Kara et al. [25] stated that the proportion of fatty acids in tulum cheese increased until the 30th day and then decreased until the 90th day. In the studies carried out by different researchers [26–28]. the level of volatile fatty acids has been reported to rise during maturation. Unlike other studies, free fatty acids increased up to the 25th day and then decreased periodically (45–90 days). The reason for the decline in free fatty acids between 45 and 90 days is that some of the free fatty acids that occur at the

end of maturation are converted into β-oxidation and methyl ketones, carbonyl compounds and other decomposition products [29].

Short and mid-chain saturated free fatty acids such as butyric, caproic, caprylic and capric acid are often the result of lipolysis of triglycerides by molds. However, in some cases, fatty acids containing up to six carbon atoms can be formed by the reduction of lactose and amino acids or the oxidation of ketones, aldehydes, and esters ([30]. Short and medium chain fatty acids have a low sensory perception threshold and have a more significant effect on the flavor development of cheese than long chain fatty acids.

In this study, the average values of butyric, caproic, caprylic and capricic acid during 90 days maturation period in Kars Gravyer cheese were found as 2.56–2.74 mg/100g, 1.72–2.04 mg/100g, 1.07–1.38 mg/100g and 2.55–3.18 mg/100g respectively. The values obtained are higher than the values found by Türkoğlu, [27], in braided cheese and by Atasoy et al. [26], in Urfa cheese and lower than the values found in Van Otlu Cheese by Ocak et al. [31], and the values found in 11 different cheese varieties by Hayaloğlu et al. [32], Palmitic, oleic, myristic and stearic acid formed in gravyer cheese during maturation accounted for 74.29 % of the total free fatty acids content. The most abundant fatty acids in fresh and ripe gravyer cheeses are palmitic acid (C16:0). This ratio varied between 27.73–29.81 mg/100g. Other acids following this fatty acid are oleic (C18:1) (20.19–23.12 mg/100g) stearic acid (C18:0) (13.24-15.16) and myristic acid (C14:0) (11.11–12.57) respectively. This may be due to the presence of large amounts of palmitic, oleic, stearic and myristic fatty acids in milk fat [33]. The values identified in gravyer cheese are higher than the values obtained by Atasoy et al. [26], in Urfa cheese (myristic acid 6.37-12.40 mg/100g, palmitic acid 18.0-26.9 mg/100g and oleic acid 12.7–19.00 mg/100g) and lower than the values found in 11 different cheese varieties (myristic acid 6.2-139.7 mg/100g, palmitic acid 19.9–356.7 mg/100g and 17.6–386.3 mg/100g) by Hayaloğlu et al. [32], Mallatou et al. [34], reported that although palmitic, stearic and oleic fatty acids form dominant fatty acids in feta cheese, these fatty acids were not as effective as short-chain fatty acids on cheese flavor. Lauric acid (C12:0) is the predominant fatty acid (2.67–3.72 mg/100g) among short and medium-chain fatty acids. Aminifar et al. [35], Marrone et al. [36], and Ocak, et al. [31]. Şengül et al. [3], and Arslaner et al. [28], reported that palmitic, myristic, stearic and oleic fatty acids had the highest proportion among the fatty acids in Lighvan cheese, in Pecorino Carmastiano cheese, in fresh and ripe Herbed cheeses, in Karın kaymağı cheese samples and in Tulum cheese respectively. In addition, Ocak et al. [31], stated that lauric acid (C12:0) was the predominant fatty acid among short and medium-chain fatty acids. The amounts of oleic and especially linoleic acid, which are very important in terms of nutrition physiology and which cause certain dermatological diseases and increase in the water permeability of cells in their deficiency or absence in the diet are determined as 20.19–23.12 mg /100g and 0.33–0.46 mg/ 100g respectively.

Elaidic acid (C18:1) acid level increased up to 60 days during maturation but decreased for 90 days. The contents of linoleic acid (C18: 2) (0.33–0.46 mg/100g) and cis-11-eicosenoic acid (C20:1) (1.13–1.43 mg/100g) of fresh and ripe Gravyer cheeses were found to vary within a narrow range. Cheese fat contains saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids. Milk fat generally contains approximately 66% saturated (SFA) (57.4% palmitic, 21.6% myristic and 17.6% stearic), 30% monounsaturated (MUFA) and 4% polyunsaturated fatty acids (PUFA) (López-Expósito, Amigo, & Recio, 2012). Of the fatty acids identified in the cheese samples, 68.22% were saturated fatty acids and 31.77% were unsaturated fatty acids. Dönmezet al. [21], determined saturated fatty acid ratio as 60.80–76.57%. Short, medium and long chain fatty acids were determined as 4.84–6.15%, 15.95–19.47% and 71.43-76.57% in Kars

Gravyer Cheese samples, respectively. According to values determined in Gravyer Cheese: Atasoy et al. [26], in Urfa cheese (7–8%, 20–23% and 70–72%) and Sert et al. [38], found in tulum cheese (15.08–22.51%, 39.13–42.62% and 30.92–38.56%), Turkoglu [27], found in braided cheese (medium and long chain fatty acids 24–27% and 63–72%) that short chain (SCSFA) and medium-chain (MCSFA) fatty acids were low and low-chain fatty acids (LCSFA) were high in concentration. In cheese samples, the proportions of monounsaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA) were found to be 28.38–32.37% and 1.59–1.84%, respectively Dönmez et al. [21], found in some traditional Turkish cheeses, that MUFA was 21.42–34.05% and PUFA 1.47–3.59% and Kınık et al. [39]. In 29 different hard and soft cheese varieties, MUFA was determined as 24.14–27.63 and PUFA as 0.72–1.58%. The values found in Gravyer cheese were higher than found by Kınık, et al. [39], approximately around the same MUFA value range found by Dönmez et al. [21], and lower than the PUFA values of the same study.

The Atherogenicity (AI) index, desired fatty acids (DFA) and ASFA / SFA ratios were determined as 2.57–3.04, 43.46–48.05 and 0.43–0.49 in Kars Gravyer Cheese samples, respectively. The values found were higher than the AI value determined in traditional Serbian white cheese (1.89-3.06) by Barac et al. [5], in Serbian traditional white cheeses, higher than the lower limit of DFA (34.45–46.34), lower than the upper limit, and higher than USFA/SFA (0.30–0.51).

Conclusion

This study was the first to examine the changes in free fatty acids and cholesterol levels and examine the effect of ripening days on the change of fatty acid composition and cholesterol level during maturation starting from production. In the 90 day storage period of Kars Gravyer Cheese, palmitic, oleic, myristic and stearic acid constituted 74.29% of the total free fatty acids content and while the most abundant saturated fatty acids were palmitic and stearic acid, oleic acid was the most abundant unsaturated fatty acid. The cholesterol content of cheese samples ranged from 45.70 to 55.80 mg/100g during 90 days of maturation. In this study, the distribution of saturated and unsaturated fatty acids in milk fat, which is very important in terms of human nutrition, was determined in Kars Gravyer Cheese. In cheese samples, 10 saturated fatty acids and 6 unsaturated fatty acids were determined and medium and long-chain fatty acid ratios were found to be higher than short chain fatty acids. Conversion of triglycerides into free fatty acids by microorganisms and natural milk lipase plays an important role in the development of different aroma substances in ripe cheeses. Especially short and medium chain free fatty acids are used as precursors in the formation of aromatic products such as ethyl ketones, esters and thioesters [31, 40]. It can be said that Kars Gravyer Cheese is a very aromatic cheese because it contains short and medium chain fatty acids which have an important effect on the flavor and aroma of milk and dairy products. Having said that, this research is also important in terms of shedding light on the research to be carried out in the future.

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