Some Properties of Kirklareli Ripened White Cheese

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Summary

Kirklareli ripened white cheese (KRWC) is a traditional cheese produced within the borders of Kirklareli province. KRWC is produced from sheep, goat and cow milk, which are blended at 30 %, 25 % and 45 %, respectively. The main objective of this study is to detect the properties of KRWC and to compare them with the properties of other ripened white cheese mentioned in literatures. For this purpose, volatile flavour compounds, fatty acid composition and some physico-chemical properties of 10 KRWC samples were investigated. A total of 10 cheeses were analysed. Accordingly, there was not observed a huge variation among the cheeses in terms of fat, salt, protein, dry matter, fat free dry matter, ash, calcium content, pH, titratable acidity. When the aroma compositions were analysed, there were 36 totally determined compounds in KRWC. Acids (14), alcohols (9), ketones (8), esters (4) and sulphur (1) compounds were determined in KRWC samples.

Keywords: Fatty acids, ripened white cheese, traditional cheese, volatile compounds.

Introduction

Kirklareli ripened white cheese (KRWC) is produced from sheep, goat and cow milk, which are blended at 30 %, 25% and 45 %, respectively. KRWC is produced in Kirklareli, located in Turkey's western border province. It differs from other ripened white cheeses from two important properties including the raw material properties and the rennet that is naturally farm-produced from animal abomasum. All of the milk used in KRWC production is provided only from Kirklareli. All types of milk obtained in here have ideal hygienic norms and therefore has higher microbial quality.

These milks of cow, sheep and goat, obtained from Kirklareli pastures, possess another major criterion for dairy products. They have low content of somatic cell count (SCC), which is commonly used as a measure of udder health and milk quality. Thus, it is legally determined as an indicator of somatic cell count raw milk and determines the level of payments from dairy plants to milk producers (farmers), to determine the milk quality standards in many countries. The present study investigated that the somatic cell count of raw milk is an indicator of udder health status, diagnosis of subclinical mastitis, health and quality of milk and milk products, its importance and effect factors on it [1]. Regarding to the parameters that determine the quality of milk by the European Union, the total cells in 1 ml of milk are required to be 100,000 and the somatic cells are maximum 400,000. According to the data from Kirklareli Directorate of Provincial Agriculture and Forestry, the annual geometric average of cow's milk produced in our province is 60,000 cells/ml and 150,000 cells/ml somatic cells. Milks with high SCC coagulate slowly and drip-dry poorly. They lead to low cheese yield that caused from fat losses in whey and higher moisture for cheese, which is associated with an increase in the proteolysis rate and modification of the proteolysis pattern [2]. All of them early result with lower overall acceptance and defections for flavour and texture [2].

The low microbial load from the natural flora of milk brings many advantages and differences in terms of cheese quality. First of all, low microbial load results in a difference in the pasteurization temperature to be used in cheese production. The difference in pasteurization norms of KRWC thus contributes to the cheese characteristics and distinguishes it from other white cheese types. Raw milk is pasteurized at its lowest heating norm of 62-64 °C for 30 min. and most of lactic acid bacteria occuring in natural flora of milk are not inhibited by these parameters [3]. Since the ripening of cheese occurs with these bacteria coming from the natural flora of milk, the taste, aroma and flavour are superior to the cheeses made in other regions [4]. Otherwise, a higher temperature for heating or pasteurization causes inhibition not only of pathogens but also most of the lactic acid bacteria. For this reason, industrial rennet used for the cheeses that produced from milks pasteurized at higher temperature. These cheeses can be ripened rapidly in short periods such as 2-3 months and also, higher yield content obtained from serum protein denaturation [3, 5, 6]. However, these cheeses have poorer flavour and have shorter shelf life because high serum protein content undergoes proteolytic and lipolytic reactions more rapidly than casein [5, 6]. The second difference comes from the rennet properties which is obtained traditionally by KRWC producers. Rennet for KRWC originating from young animals are produced from the fourth stomach, who have not yet started feeding with grass [7].

There is a procedure for obtained rennet from abomasum. It is cut into small pieces and kept in a solution containing 12-20 % salt and the yeast is obtained by extracting the enzyme. After the enzyme is extracted, minced pieces are filtered from the mixture and filtered to ensure complete cleaning. The mixture obtained as a result of this process is made ready for use after being subjected to necessary technical, hygienic, sensory and physiological processes [17, 39].

At the beginning of the study, it was assumed that KRWC had some differences in its quality characteristics. Besides, there would be no information available on aroma profile, fatty acid composition, calcium content and physico-chemical properties of KRWC. In this respect, the purpose of this study is to investigate the specific characteristics and to prove originality of KRWC.

Materials and Methods

Study Area: Kirklareli is a city situated in Turkey's western border province and located on Yildiz Mountains and Ergene Plain sections. The city is surrounded by Bulgaria in the north, Black Sea in the north east,

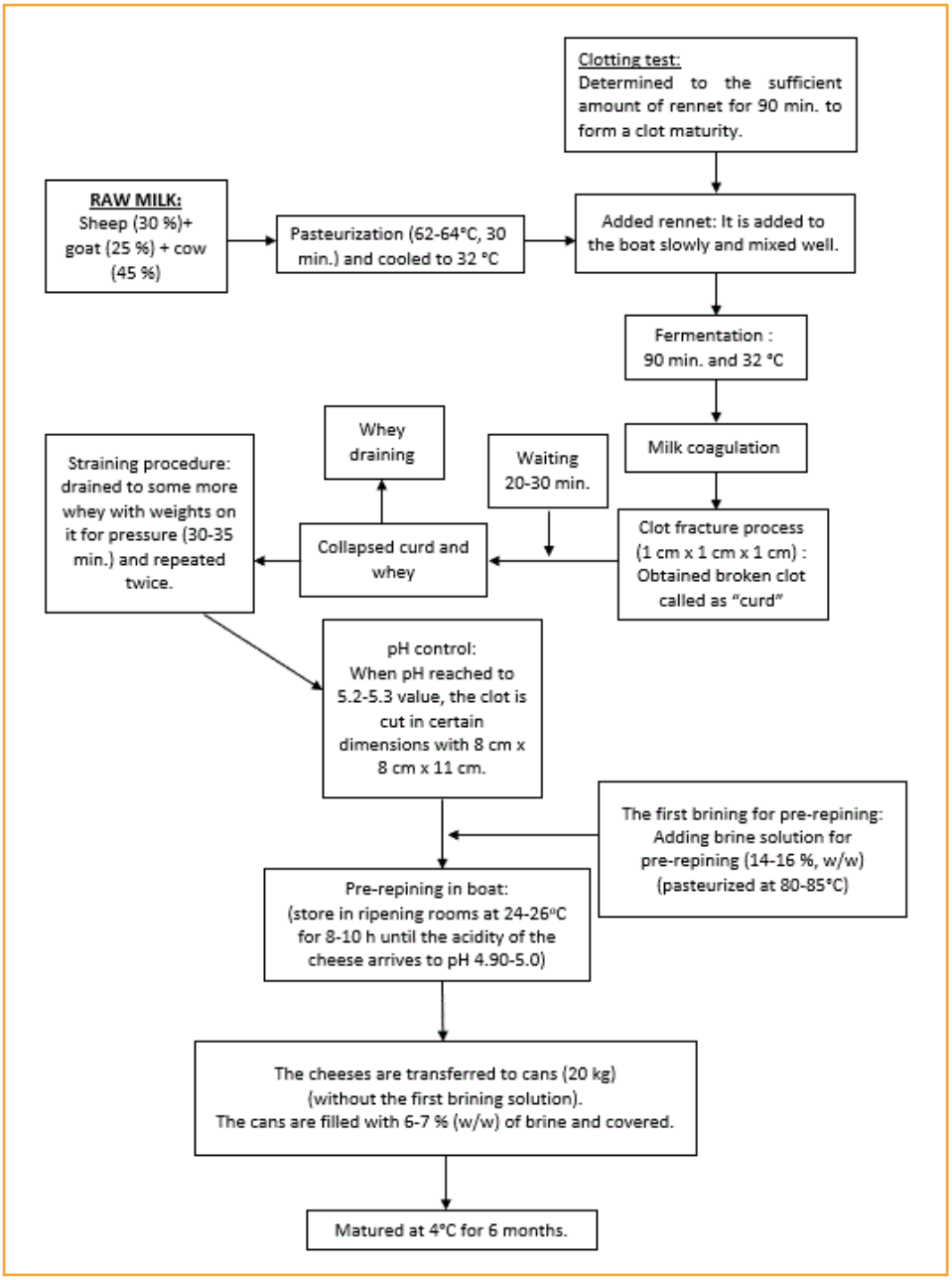

Figure 1: The flow chart of Kirklareli ripened white cheese production process

Istanbul in the south and southeast, and Edirne in the west.

Cheese samples: In total, 10 KRWC samples produced with blended milk (approximately 600 g per sample) were analysed in this study. The cheese samples were collected from certain dairy plants that produce KRWC with buying milk from different farms, which prefer to the traditional production method with same procedure. Besides, the production date for all collected cheese samples was January 2016, including maturation periods for 6 months; and their opening date was June 2016. These producers were located in Kirklareli. Cheese samples were frozen at -18 °C in vacuum packaging until they were analysed.

Processing Method of Kirklareli Ripened White Cheese (KRWC): The production was performed with traditional method that has been applied for decades. The production method was given in Figure 1. The raw material consists of the blended milk from sheep, goat and cow with 30 %, 25 % and 45 %, respectively. Milk was pasteurized at approximately 62-64 °C and then cooled to renneting temperature (32 °C) in stainless steel cheese boats were used for renneting. The rennet was added to the blended milk which cooled at 32 °C. The amount of rennet used was determined by the clotting test and was sufficient for 90 min. to form a clot maturity. Besides, the rennet was added to the boat slowly and mixed well. The clotting procedure took approximately 90 minutes at 32 ± 1 °C. At the end of this period, the milk coagulated, and the formed clot was cut in small size (1 cm x 1cm x 1 cm) with a stainless-steel knife. This step is called as clot fracture process. The broken clot that is defined as "curd" was thoroughly mixed. After waiting about 20-30 minutes, the curd was collapsed, and the whey was drained. The collapsed curd was pressed with weights on it for pressure. It was exposed to the straining procedure that drained to some more whey for 30-35 minutes. However, the clot was still including more whey than desired. Therefore, the clot was cracked by handing in order to easily remove any remaining whey in clot. This whey draining procedure was repeated twice. When pH reached to the optimum values (pH 5.2-5.3), the clot was cut in certain dimensions with 8 cm x 8 cm x 11 cm. The cheese boat was filled with 14-16 % (w/w) brine solution previously pasteurized at 80-85 °C and cheese

Table 1: Some Chemical properties of 10 different Kirklareli ripened white cheese samples and averages values with standard deviations

SAMPLE	pH	Titratable Acidity (%)	Dry Matter (%)	Ash (%)	Fat Content (%)	Protein (%)	Calcium (mg/1000 g)	Salt Content (%)	Water Activity (a_w)
1	4.73	1.94	49.30	2.18	27.73	17.43	6659	6.12	0.932
2	5.21	1.74	49.48	2.07	28.73	18.52	6689	4.93	0.909
3	5.11	1.56	49.36	3.33	26.98	18.60	6506	5.56	0.915
4	4.55	1.78	48.35	1.97	28.48	18.21	6424	6.01	0.920
5	4.26	1.63	52.42	2.86	29.73	19.60	6505	5.93	0.928
6	4.72	1.81	50.48	2.53	27.98	18.39	6450	5.12	0.918
7	4.21	1.87	50.15	2.27	29.23	17.73	6243	5.46	0.924
8	4.11	1.60	51.61	2.85	29.23	19.62	6593	5.99	0.922
9	5.14	1.85	49.55	2.19	28.48	17.45	6022	5.46	0.916
10	4.58	1.91	51.26	2.33	29.48	18.18	6125	5.41	0.925
AVRG±STDV	4.66±0.39	1.77±0.13	50.20±1.25	2.46±0.43	28.60±0.86	18.38± 0.77	6422± 224	5.59± 0.40	0.921± 0.01
Ref. Value*	< 5.00	< 2.7	40 %	-	>19 %	18 %	-	< 6.5 %	-

*** Ref. Value :** The reference values according to Turkish Food Codex Regulation belongs to Ministry of Agriculture and Forestry (2015).

moulds were kept in this brine solution for 8-10 hours. The next step was taking to the cheese moulds from the cheese fermentation boat and put them in cans (20 kg) without closing for pre-repining. These cheese cans were holt in the ripening rooms at 24-26 °C for 2-3 days until the acidity of the cheese arrived in pH 4.90-5.0. Finally, the cans were filled with 6-7 % (w/w) of brine and covered with a capping machine and matured at 4 °C for 6 months. Thus, KRWC completed the process that can be consumed.

Compositional and Chemical Analysis: Moisture and ash contents were performed by the gravimetric method according to AOAC 926.08 and AOAC 935.42 [10, 11]. Fat contents were determined by Gerber method (SR EN ISO (1735) (2005) [12] and protein contents of KRWCs were determined by Dumas (ISO-IDF (2002) method [13]. Acidity values, which expressed as lactic acid (%), were determined by titration method according to AOAC as 942.15 [14]. Besides, the salt content analyses in KRWCs were performed by potentiometric titration method, ISO-IDF (2006) [15]. pH measurements and water activity were done using a pH meter (Adwa AD1030) and water activity meter (Novasina LabSwift-a_w) according to the manufacturer's instructions, respectively. All compositional analyses were carried out in triplicate.

Fatty acid Composition: Fatty acid analyses were carried out using the IUPAC II.D.19 method [16] in TUBİTAK Marmara Research Centre Food Institute Laboratory. Fatty acids of the samples were analysed using a Perkin Elmer Auto System XL gas chromatograph (PerkinElmer, Eacosfield, UK) equipped with an SP2330 column and a flame ionization detector. Separation of fatty acid methyl esters was achieved using a fused silica capillary column (30 m x 0.25 mm x 0.20 µm film thickness). The oven temperature was set at 120 °C, then increased to 220 °C. The injector and detector temperatures were maintained at 240 and 250 °C, respectively. The carrier gas was 10 psi helium with a split ratio of 1/50. Results were expressed as the percentage of fatty acid with respect to the total fatty acids.

Volatile Compounds: Volatile compounds were determined using SPME-GC-MS in TUBİTAK Marmara Research Centre Food Institute Laboratory. Solid-phase microextraction (SPME) technique was used for the isolation and concentration of volatile compounds. Before analysis, frozen samples were thawed at 4 °C overnight. Ten millilitres were transferred to a 40 ml screw-top glass vial containing a micro stirring bar and capped with a cap with a silicon rubber/teflon membrane and a hole enabling SPME sampling. Vial was introduced in an aluminium block placed on a heater/stirrer (IKA, USA) and preheated at 40 °C for 10 min with an agitation speed of 250 r/min. Then, a SPME fiber (DVB/Car/PDMS 50/30 mm) (Supelco, USA) was inserted in the headspace of the vial and exposed at 40 °C for 30 min. Separation, identification, and determination of percentages analysis of volatile compounds by GC-FID/MS were made according to the procedure described in Qian and Reineccius (2003) [17]. For each volatile compound identified, results were expressed as means of two independent experiments analysed by triplicate.

Calcium Content: Content of calcium in cheese samples were investigated according to the AOAC 985.35 method in TUBİTAK Marmara Research Centre Food Institute Laboratory [18].

Statistical Analysis: Statistical analysis of the data was performed using the analysis of standard deviation in SPSS© v.9.05 (SPSS Inc., Chicago, USA). All analyses were performed twice.

Results and Discussion

Compositional and Chemical Analysis: The pH values, titratable acidity values, the total dry matter, ash, fat, protein, calcium and salt contents and the water activity values of KRWCs were given in Table 1 for each sample. The pH values and titratable acidity values of KRWCs ranged from 4.11 to 5.21 and 1.56 to 1.94, respectively. The data of the pH analyses in the samples are in compliance with literatures while the titratable acidity measurements were higher than of others [19, 20]. Lactic acid can be produced from lactose by lactic acid bacteria, which is found in raw milk, and therefore acidity increases in cheeses. Hayaloğlu et al. (2002) reported values in a range 0.7 to 3.8 % for titratable acidity of ripened Turkish white cheeses [21]. Besides, Gürses and Erdoğan (2006) mentioned that decreasing pH value in cheeses leads to the development of desired organoleptic properties and also prevents the development of pathogenic microorganisms [22]. For KRWC samples, dry matter and ash contents varied from 48.35 to 52.42 % and 1.97 to 3.33 %, respectively, presented in Table 1. The dry matter content of KRWC was determined as 50.20 % on average and it is 10 % above the minimum dry matter value required by the regulations. The fat contents of KRWC samples varied from mean of 26.98 to 29.73 % and these values were higher than those reported by some authors including literatures [20, 23].

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The least 6 months period of maturation has high importance for KRWC. In the study, moisture content decreased in a statistically significant way in the first maturation time, until the sixth month, while, later, a moisture decrease was less relevant in percentage. pH reached a maximum level around the third month, while afterwards equilibrium was established, as a result of the opposed proteolysis effect from which ammonia is produced while lipolysis led to a fatty acid release. A similar increase in the acidity of cheese was reported previously by Warsama et al. (2006) [8]. This increase was probably due to the growth of lactic acid bacteria in cheese [6, 8]. The lactic acid not only contributes to the taste of fresh cheese but also improves the cheese structure and protects it against a kind of microbiological spoilage [5, 9]. All of these changes can be observed in KRWC profile with volatile composition, fatty acid composition, moisture content and fat content. The protein contents between 17.43 and 19.62 % and these values also higher than other literatures about Turkish ripened white cheeses, which have protein contents as mean of 11 to 18 % [18]. The high protein content can be related with the geographic conditions of Kirklareli province, since the city is located at Yildiz Mountains, which has predominantly differed with legume family according to other pastures in Turkey [24]. Legumes meet the protein requirements of animals because of their rich raw protein content that caused also higher dry matter and fat content for cheeses [25, 26].

Table 2: Free fatty acid compositions (%) of Kirklareli ripened white cheese (KRWC) samples with average values of 10 KRWC samples

FATTY ACIDS	Percent, %
Butyric Acid (C4:0)	2.18 ± 0.21
Caproic Acid (C6:0)	1.85 ± 0.14
Caprylic Acid (C8:0)	1.68 ± 0.23
Capric Acid (C10:0)	5.02 ± 0.62
Undecanoic Acid (C11:0)	0.27 ± 0.11
Lauric Acid (C12:0)	3.52 ± 0.68
Tridecanoic Acid (C13:0)	0.08 ± 0.01
Miristic Acid (C14:0)	13.31 ± 0.89
Miristoleic Acid (C14:1)	0.56 ± 0.12
Pentadecanoic Acid (C15:0)	1.07 ± 0.16
Palmitic acid (C16:0)	31.36 ± 1.22
Palmitoleic Acid (C16:1)	0.94 ± 0.27
Heptadecanoic Acid (C17:0)	0.72 ± 0.19
Stearic acid (C18:0)	14.03 ± 1.14
Oleic Acid (C18:1n9c)	21.21 ± 1.32
Linoleic Ascid (C18:2n6c)	1.48 ± 0.33
Arachidic Acid (C20:0)	0.26 ± 0.09
Cis-11-Eicosenoic Acid (C20:1)	0.05 ± 0.06
α-Linolenic Acid (C18:3n3)	0.08 ± 0.01
Heneicosenoic Acid (C21:0)	0.03 ± 0.01
Cis-11,14-Eicosadienoic Acid (C20:2)	0.03 ± 0.01
Behenic Acid (C22:0)	0.12 ± 0.01
Cis-11,14,17-Eicosatrienoic Acid (C20:3n3)	0.04 ± 0.02
Arachidonic Acid (C20:4n6)	0.09 ± 0.02
Nervonic Acid (C24:1)	0.02±0.00

* Results expressed as percentage of total fatty acid methyl esters. Values are means a standard deviation.

KRWC has differences about salt content and water activity. The raw material and production method contribute to these characteristics. The milk used as raw material for KRWC supplies only Kirklareli and it has very low microbial load from the natural flora of milk bringing many advantages and differences in terms of KRWC quality. Firstly, it makes a difference in pasteurization temperature of the milk to be used in KRWC production. The difference in pasteurization norms of KRWC thus contributes to cheese characteristics and distinguishes it from other white cheese varieties. Firstly, calcium chloride ($CaCl_2$) is used for white cheeses produced from the pasteurized milk at a temperature higher than 65 °C in order to accelerate the maturation (100-150 g $CaCl_2$ 2/1,000 L milk). The salt contents primarily control water activity and thus affect microbial and enzymatic activities in cheese. It also changes some properties of biochemical, textural and sensorial characteristics during ripening period [27]. Salt, together with pH and calcium level, has a large effect on the extent of para-casein hydration, or aggregation, which in turn affects the water-binding capacity of the casein matrix, its tendency for syneresis, rheological and textural characteristics and its cooking properties. Generally, salt ($CaCl_2$) is added to the cheeses for stronger curd and longer shelf life. However, KRWC does not contain additional bacteria or calcium chloride for rapid maturation and yield enhance. KRWC matures naturally in a minimum 6 months and it has 2-year shelf life. Salt content of KRWC is added only with brine solution. The disadvantages of this situation are the high storage and raw material financing costs that occur due to low efficiency and long maturation.

According to results of this research, salt content in KRWC samples ranged from 4.93 to 6.12 % compliance with the Turkish Food Codex Regulation which defines less than 6.5 % value for the amount of salt content in ripened white cheeses (Ministry of Agriculture and Forestry 2015). With all these effects, KRWC produces a different rich aroma, delayed proteolytic and lipolytic reactions causing deterioration and prolonged shelf life. In addition, although the salt is not used in production, the amount of calcium decreases in the whey and increases in the cheese through a good homogenization process. These effects were also observed in the analysis results. Calcium values of 10 different KRWC samples (mg / kg) were determined from 6,022 mg to 6,689 mg as presented in Table 1. In the literature, the calcium content is mentioned as between 1,200 mg and 4,900 mg in white cheeses [28].

For all results, there are differences between individual samples because of the traditional producing process. This is due to the production and preservation of cheeses under different conditions.

Free Fatty Acids: Free Fatty acid (FFA) compositions of KRWC samples are given in Table 2. FFA contributed to the cheese flavour with especially short- and medium-chain fatty acids. These fatty acids, which have effect flavour directly or indirectly, are formed by lipolysis in cheese [20].

The acetic acid formed by lactate fermentation is used as a rough estimator of maturation in white cheeses. However, acetic acid can be found in high amounts in the white cheeses, therefore in addition to acidity value of white cheeses, fatty acid composition should be also determined [20]. However, acetic acid can also be produced from the metabolism of AA [29] and this may also be a factor due to the higher levels of available protein in the raw milks from grass and grass/clover [30]. Besides, some aroma compounds that are 1-octanol, undecanol and 2-nonanone were found in the milk of animals fed with fresh greens. Initial concentrations of 1-octanol, 1-undecanol and 2-nonanone were very high, then the decrease of content of 1-octanol,

1-undecanol and 2-nonanone could be caused by gradual metabolic conversion of these compounds to acetic acid which serves like the major precursor of milk fat in the mammary gland [31, 32]. Therefore, this is one reason that acetic acid, which is high in milk, is also found in cheese samples.

In literatures, several saturated short and medium chain fatty acid contents were found to be higher in white cheeses made from animal milks, which fed with the endemic plants from pastures [25]. Capric acid (C 10:0) with 5.02 %, caprylic acid (C8:0) with 1.68 %, caproic acid (C6:0) with 1.85 % and butyric acid (C4:0) with 2.18 % were the short and medium chain fatty acids in ten KRWC samples. The average value of butyric acid in white cheese was found to be between 0.40 - 0.80 % in literatures. The volatile FFAs with aliphatic tails from 4 to 10 carbons have remarkable effect on the flavour of cheese because of their low perception threshold [25].

Besides, the long chain fatty acids were stearic acid (C18:0) with 14.03, oleic acid (C18:1 n-9) with 21.21, palmitic acid (C16:0) with 31.36 and myristic acid (C14:0) with 13.31, which had the highest percent, in KRWC samples. Palmitic acid was found to be a major fatty acid in all KRWC samples. Palmitic and oleic acids are the principal saturated and unsaturated fatty acids in dairy products with high and low melting points, respectively. The ratio of oleic acid to palmitic acid has previously been used as an index of hardness in butter and cheese [33]. In this case the ratio of oleic to palmitic acid was not low value in KRWC samples. KRWC was neither spreadable nor hard cheese and the ratio of oleic to palmitic acid confirms this definition.

Mentioned before, FFAs may occur by lipolysis as a result of hydrolysis of triglycerides, as well as by bacteria, amino acid and carbohydrate metabolism. FFAs (especially short chain) directly contribute to the aroma of many types of cheese, and they also act as pioneers in many types of reactions that indirectly result in the formation of methyl ketones, aldehydes, lactones, secondary alcohols, aliphatic and aromatic esters. Although the most of FFAs in milk and dairy products is not desirable, they are important because they can form the characteristic cheese aroma together with other components [34].

Volatile Compounds: The volatile compounds were determined by SPME-GC-MS analysis in KRWC samples. There were determined as 36 main volatile compounds, and these were classified into 5 different chemical groups as esters (11.11 %), acids (38.88 %), ketones (22.22 %), alcohols (25 %) and sulfur (2.77 %) (Table 3). Percentage values of these compounds are given in Table 3 with the retention time (RT) in column. When KRWC was compared with some other traditional ripened cheese such as Edirne cheese and also Ezine cheese, it was obviously seen that KRWC had especially different flavour and fatty acid composition than them [35]. KRWC had very rich aroma and fatty acid composition. One of the dominant groups of KRWC volatile compounds composition was acids for all samples with different percentages varied from 0.06 % to 32.07 %. It was found that the percentage of hexanoic acid and butanoic acid were higher than all other compounds with 32.07 % and 26.65 %, respectively. In particular, octanoic acid and acetic acid were the other acids, which were the highest compounds in the samples presented as 6.11 % and 4.75 % of the total volatile compounds. The identified acids in white cheeses and also detected in the KRWC samples give different flavours, such as hexanoic (sour/dirty/sweet), butanoic (rancid), octanoic (sweaty/fatty/rancid/goat) and decanoic (waxy/rancid/cheese/dry) acids, which are formed by lipolysis and contribute to cheese flavour [27, 34, 36].

The other dominant volatile compounds were alcohols in KRWC samples, and 9 alcohols were detected in the KRWC samples (Table 3).

Table 3. Aroma compositions of Kirklareli ripened white cheese-samples (KRWC) with average values of 10 KRWC samples.

VOLATILES	RT*	Percent (%)
Acids		
Acetic Acid	14.13	4.75
Propionic Acid	17.44	0.27
Butanoic Acid	20.57	26.65
Pentanoic Acid	22.19	0.68
Pentanoic Acid	24.65	0.19
Hexanoic Acid	28.41	32.07
Heptanoic Acid	31.96	0.21
Octanoic Acid	35.41	6.11
Cyclohexanecarboxylic Acid	36.06	0.08
Nonanoic Acid	38.68	0.51
Decanoic Acid	41.84	1.09
Benzoic Acid	46.29	0.21
Dodecanoic Acid	47.77	0.06
Hexadecanoic Acid	58.39	0.07
Alcohols		
Ethanol	2.07	0.84
2-butanol	2.82	4.76
Iso-Butyl Alcohol	3.76	0.21
2-Pentanol	4.18	5.02
3-Methyl-1-Butanol	6.02	4.26
Heptanol	9.19	0.27
2,3-Butanediol	17.22	0.45
Benzenmethanol	29.12	0.11
Benzeneethanol	30.20	0.08
Ketones		
2-Pentanone	2.42	1.94
3-Benzyoxy-1-Bromo-3,8-Diene	3.03	3.54
2-Heptanone	5.37	1.11
2-Butanon-3-Hydroxy (Acetoin)	8.28	0.72
2-Nonanone	11.35	0.07
2-Methyl-1,1-Diphenyl-1-Propene	16.26	0.15
Cyclooctasiloaxane, Hexadecamethyl	23.52	0.04
Heptasiloxane, Hexadecamethyl-	29.42	0.05
Esters		
Hexanoic Acid, Ethyl Ester	6.56	1.80
Octanoic Acid, Ethyl Ester	12.97	0.14
1-Hexanol-2-Ethyl	15.17	0.14
Propionic Acid, 2-Methyl-, Methyl Ester	23.34	0.06
Sulphur		
Methane, Sulfinyl Bis	18.27	0.06

* Retention time is time interval between sample injection and the maximum of the peak.

Lactose metabolism, methyl ketone reduction, amino acid metabolism are the metabolic pathways for alcohol formation, and also linoleic and linolenic acids degradation is a method for this purpose [11]. The

predominant alcohols 2-pentanol with 5.02 %, and 2-butanol with 4.76 % were identified in all samples. Another marked alcohol was 3-methyl-1-butanol with 4.76 % and it is known as a primary alcohol, which is formed with the reduction of the aldehyde produced from leucine. Other prominent alcohols are the secondary alcohols that give fruity/floral aroma and formed from methyl ketones [20, 27]. Besides, the other alcohol compound to be the most abundant was detected as 3-methyl-1-butanol, which is identified in goat milks and cheeses produced from goat milk. Ethanol, 2-heptanol, benzene ethanol and other alcohols, which found in smaller amounts in KRWC samples in literatures, were also detected in goat and sheep milks and their cheeses [36]. Ethanol is generally produced with lactose fermentation and alanine catabolism has importance for formations of esters [21]. In that, one of the important aromatic alcohols is phenyl ethanol, is odorous and responsible for rose flower aroma [27]. Ketones are formed via β-oxidation of lipids and decarboxylation of fatty acids, and they also have characteristic flavour and low perception thresholds. Eight ketones in KRWC were identified shown in Table 4 with other volatile compounds. Methyl ketones are formed FFAs influence the cheese flavour. Some other ketones were 2-butanone-3-hydroxy, 2-heptanone and 2-nonanone in KRWC and they are also known to be in different goat cheese types [27, 29, 37]. Esters are important aroma compounds, which have effect for masking off-odours, sharpness and bitterness from short-chain FFAs, methyl ketones and amines. Besides, they have high importance with their high volatility. Ethyl esters can be got in cheeses with two different ways such as esterification and alcoholysis of primary and secondary alcohols [20]. In the study, there were determined four different ester compounds and three of them were fatty acid ethyl esters. Finally sulphur compounds contributed to the ripe cheese odours [37].

Conclusions

In this study, the initial research examined physicochemical properties, fatty acids and volatile compounds of KRWC that is a white cheese, which is manufactured with traditional techniques with blended of goat, sheep and cow milks and also ripened for the least 6 months. Accordingly, physico-chemical composition parameters such as dry matter, fat content, and protein content in KRWC were higher from other white cheeses. Capric acid, palmitic acid, oleic acid, stearic acid and myristic acid were the main FFAs. Besides, acids, alcohols and ketones were the dominant volatile compounds. It should be emphasized that natural vegetation due to the geographic structure and climatic conditions that give opportunities for feeding of the animals, affected to the milk properties, which is the raw material of cheese. Thus, many of the advantages gained with feeding animals from pastures were reflected to KRWC as higher and different quality. In this case, not only the pasture feeding was effective, but some other parameters, such as production method and low pasteurization norms caused by the microbial load also brought higher values for physico-chemical composition of KRWC. In the overall composition, parameters of the tested cheeses were in compliance with lots of characteristics of white ripened cheeses. However, it had differences about volatile compounds and fatty acid composition, especially. A number of factors were effective, such as the type and quality of milk used, heat treatment, maturation temperature, salt concentration in the brine, starter culture, lipase enzyme from raw milk and the rennet properties, on the fatty acid composition in ripened white cheeses. At this point, thorough information about the fatty acid profile of cheeses to determine its effect on flavour is crucial.

As mentioned, KRWC has different compositional and flavour properties than other ripened cheese varieties. However, no major differences were found between the different KRWC samples in our study. As in the literature, using pasteurized milk, with the same production method, producing with the same historical mastery in the same region is an optimization for the features of KRWC.

At the time this study was carried out, there is no research on any properties of KRWC. The literatures provided the characteristics of other ripened cheeses produced in nearby provinces. As a result of evaluating the data presented by this study, it can be suggested to examine the sensory, biochemical and microbiological characteristics of KRWC. In conclusion, we suggest conducting further research on improvement of examining KRWC, considering the maturation process, microbiological properties and their effects on sensorial differences of KRWC.

Compliance with Ethical Standards

The author declares no conflict of interest.

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References

1. Curioni PMG, Bosset JO. Key odorants in various cheese types as determined by gas chromatography-olfactometry. Int. Dairy J. 2002; 12: 959–984.
2. Grandison AS, Ford GD. Effects of variations in somatic-cell count on the rennet coagulation properties of milk and on the yield, composition and quality of cheddar cheese. J. Dairy Res. 2005; 534:645-655.
3. Evrendilek GA, Koca N, Harper JW, Balasubramaniam VM. High pressure processing of Turkish white cheese for microbial inactivation. J Food Protect 2008; 71:102-108.
4. Çakır A, Aşkın OO. Kırklareli White Cheese (In Turkish). Ankara, Detay Publishing, ISBN: 978-605-2323-66-3, 2018.
5. Renhe, IRT, Zhao Z, Corredig M. A comparison of the heat stability of fresh milk protein concentrates obtained by microfiltration, ultrafiltration and diafiltration. J Dairy Sci. 2019; 347-353.
6. Bilgin B. Milk technological properties and fermentation products of human origin Lactobacillus rhamnosus IF3 and L. paracasei ssp. paracasei IF10 as single culture. Milchwissenschaft, 2010; 65(2):187-189.
7. Choubaila, L, Sofiane, B, Nizar M, Mabrouk C. Traditional dairy products in Algeria: case of Klila cheese. Journal of Ethnic Foods, 2019; 6(7):1-14.
8. Warsama LM, El Zubeir IEM, El Owni OAO. Composition and hygienic quality of Sudanese white cheese in Khartoum North markets (Sudan). Int. J. Dairy Sci 2006; 1: 36- 43.
9. Ceylan A, Bayram E, Sahbaz N, Otan H, Karaman S. Yield performance and essential oil composition of individual plants and improved clones of Origanum onites L. grown in Aegean Region of Turkey. Israel Journal of Plant Sci. 2003; 51:285-290.
10. AOAC 926.08, Moisture in Cheese: Method I. Official methods of analysis of AOAC International (16th ed.). Gaithersburg Maryland: AOAC International.
11. AOAC 935.42, Ash of Cheese Gravimetric Method. Official methods of analysis of AOAC International (16th ed.). Gaithersburg Maryland: AOAC International.

12. SR EN ISO 1735 (2005) Cheese and processed products. Determination of fat content. Gravimetric method.
13. ISO 15323 IDF 173 (2002) Specifies a method for the determination of the nitrogen solubility index (NSI) of dried milk protein products. This determination is a means of assessing the solubility of nitrogen-containing compounds.
14. AOAC 942.15, Acidity (Titratable) of fruit products. Official methods of analysis of AOAC International (16th ed.). Gaithersburg Maryland: AOAC International.
15. ISO 5943 IDF 88 (2006) Specifies a potentiometric titration method for the determination of the chloride content of cheese and processed cheese products.
16. International Union of Pure and Applied Chemistry (IUPAC) (1987) Standard Methods for the Analysis of Oils and Fats and Derivatives,7th revised and enlarged edn., edited by C. Paquot and A. Hautfenne, Blackwell Scientific, London, Method 2. 301.
17. Qian M, Reineccius G. Aroma extract dilution analysis of Parmigiano Reggiano cheese. J Food Sci 2003; 68(3):794-798.
18. Yılmaz Y, Gürsoy O, Gökçe Ö, Ertan K. Potential Use of Milk Analyzer with Optical Infrared System for Determination of Dry Matter, Protein and Fat Contents of Cheeses. Academic Food, 2015; 13(1): 47-55.
19. Salum P, Goce G, Kendirci P, Bas D, Erbay Z. Composition, proteolysis, lipolysis, volatile compound profile and sensory characteristics of ripened white cheeses manufactured in different geographical regions of Turkey. Int Dairy J, 2018; 87:26-36.
20. Hayaloglu AA, Guven M, Fox PF. Microbiological, biochemical and technological properties of Turkish White cheese 'Beyaz Peynir (Review). Int Dairy J, 2002; 12:635-648.
21. Gurses M, Erdogan A. Identification of lactic acid bacteria isolated from Tulum cheese during ripening period. Int J Food Prop, 2006; 9:551-557.
22. Mondello L, Casilli A, Tranchida PQ, Dugo P. Comprehensive two dimensional GC for the analysis of citrus essential oils. Flavour Frag J 2000; 20:136-140.
23. Lejonklev J, Løkke MM, Larsen MK, Mortensen G, Petersen MA, Weisbjerg MR. Transfer of terpenes from essential oils into cow's milk. J Dairy Sci 2013; 96:4235-4241.
24. Aybeke M, Kurt C, Semerci A. Edirne Province Meadow Pasture Plants, Volume 1, 2008.
25. Martin B, Priolo A, Valvo MA, Micol D. Effects of grass feeding on milk, cheese and meat sensory properties. Options Méditerranéennes, Series A,2010; 67:213-223.
26. Gürsoy O, Küçükçetin A, Gökçe Ö, Ergin F, Kocatürk K. Physicochemistry, microbiology, fatty acids composition and volatile profile of traditional Söğle tulum (goat's skin bag) cheese. Anais da Academia Brasileira de Ciências, 2018; 90(4): 3661-3674.
27. Poveda JM, Pérez-Coello MS, Cabezas L. Seasonal variations in the free fatty acid composition of Manchego cheese and changes during ripening. Eur Food Res Technol, 2000; 210:314-317.
28. İşleten M, Uysal-Pala Ç, Yüceer Y. Mineral Content of Ezine Cheese. Food, 2007; 32(4): 173-179.
29. Ganesan B, Weimer BC. Amino acid metabolism in relationship to cheese flavor development. In Improving the Flavour of Cheese 2007; 70-101.
30. Mottram JC, Souza AE, Hutchison JE, Carter R, Frame MJ, Coombs GH. Evidence from disruption of the lmcpb gene array of Leishmania mexicana that cysteine proteinases are virulence factors. Proc Natl Acad Sci USA. 1996; 93:6008–6013.
31. Kováč, M. a kol. Výživa a kŕmenie hospodárskych zvierat. Príroda, Bratislava. 1989; 522. ISBN 80-07-00030-5.
32. Kudrna, V. a kol. Produkce krmiv a výživa skotu. Agrospoj Praha. 1998; 362. ISBN 80-239-4241-7.
33. Martin B, IVerdier-Metz I, Buchin S, Hurtaud C, Coulon JB. How does the nature of forages and pastures diversity influence the sensory quality of dairy livestock products? Anim. Sci 2005; 81:205-212
34. Ozmen TS, Guneser O, Yuceer YK. Evaluation of physicochemical, microbiological, sensory properties and aroma profiles of goat cheeses provided from Canakkale. Int J Dairy Technol 2017; 70(4): 514-525.
35. Karagul-Yuceer Y, Isleten M, Uysal-Pala C. Sensory characteristics of Ezine cheese. J Sensory Stud 2007; 22: 49-65.
36. Ozmen TS, Guneser O, Yuceer YK. Evaluation of physicochemical, microbiological, sensory properties and aroma profiles of goat cheeses provided from Canakkale. Int J Dairy Technol 2017; 70(4): 514-525.
37. Boltar I, Majhenic AC, Jug T I. Mujić, SJ, Kralj MB. The impact of some parameters on volatile compounds in hard type cheeses. Croat. J. Food Sci. Technol. 2016; 8(2):74-82.