PAPER

KEFIRS MANUFACTURED FROM CAMEL (*CAMELUS DRAMEDARIUS*) MILK AND COW MILK: COMPARISON OF SOME CHEMICAL AND MICROBIAL PROPERTIES

G. KAVAS
Department of Dairy Technology, Faculty of Agriculture, Ege University, 35100 İzmir, Turkey
*Corresponding author: Tel. +90 232 3111420, email: gokhan.kavas@ege.edu.tr

ABSTRACT

This study examined the production possibilities of kefir from fresh camel milk fermented with grain. The findings were then compared with kefir manufactured from cow's milk. Cow's milk was fermented with 2.5% grains. The 1% (v/w) glucose enriched camel's milk was fermented with 10% grains and left in an incubator at 25°C. Physical-chemical and sensorial analyses of the kefir samples were measured on day one (18 hours) of storage and microbiological analyses were measured on days one, three and five. Some physical-chemical parameters were found to be higher in camel milk and its kefir than in cow milk and its kefir, some were found to be close and some were found to be lower. Addition of 1% glucose and 10% grains to the camel milk affected the titration acidity and viscosity of kefir to significant levels. The kefir produced from camel milk was perceived as sourer, whereas its other properties were found to be close to those of cow milk. The cholesterol levels of camel milk and its kefir were detected to be higher when compared to those of cow milk and its kefir, but the cholesterol level decreased in both examples after the production of kefir. In terms of the composition of fatty acids, it was determined that SFA and the small, medium chain fatty acids ratio was low in camel milk and its kefir, but MUFA and the long chain fatty acids ratio was high. PUFA ratio was high in camel milk but low in its kefir. In microbiological analysis, yeast levels increased in kefir samples with the *Lactobacillus ssp.* strains, and the increase in the number of yeasts was higher than in the cow milk kefir. In kefir samples, *Lactobacillus ssp.* strains increased on day one and three of storage, but diminished after day three.

- Keywords: camel milk, kefir, grain, traditional method, chemical properties, microbial properties, flavor profile analysis -

INTRODUCTION

Kefir is a dairy product that has been produced for years in Eastern Europe and Mongolia, before spreading to Caucasia (GAWARE *et al.*, 2011). Kefir is produced by adding specific amounts of the kefir grain (traditional method) or the modified culture (industrial method) manufactured from this grain (POGAČIĆ *et al.*, 2013) into the milk of various animals. Ethyl alcohol and lactic acid fermentations are developed together during the product formation, thus causing it to taste somewhat acidic. Kefir grains are off-white and slightly yellowish, irregular in shape and with a circumference taken up by polysaccharide matrixes that (JIANZHONG *et al.*, 2009) compose 25% of the dry weight soluble in water (POGAČIĆ *et al.*, 2013), and a diameter of 0.3cm -2 cm (BESHKOVA *et al.*, 2002). Homofermentative lactobacilli make up 65-80% of the flora. In the grain flora, homofermentative and heterofermentative lactic acid streptococci make up 20%, and lactose-fermentative and non-fermentative yeasts make up a further 5%. The percentage of acetic acid bacteria (in production with grain) is relatively small (IRIGOYEN *et al.*, 2005). Species of the microorganisms in the grain, their proportion to each other and their numbers change according to the origin of the grain and conditions of use (FERREIRA *et al.*, 2010). Today, kefir is regarded as a fermented dairy beverage that is anti-bacterial and anti-inflammatory (LOPITZ-OTSOA *et al.*, 2006**)**, anti-tumoral (SHIOMI *et al.*, 1982), anti-apoptotic **(**MATSUU *et al.*, 2003), anti-allergic **(**UMEDA *et al.*, 2005), anti-oxidant, and anti-mutagenic (LIU *et al.*, 2005). It also lowers systolic and diastolic blood pressure and bad cholesterol (AGERBAEK *et al.*, 1995), adjusts lactose dyspepsia (HERTZLER and CLANCY, 2003), and contains bioactive peptides, exopolysaccharides and their bacteriosis, and has a strong probiotic effect on human health (RATTRAY and O'CONNELL, 2011).

Camel milk differs from the milk of other ruminant animals in its composition and physiological properties. Camel milk is rich in long chain fatty acids, but contains low amounts of short chain fatty acids (GORBAN and IZZELDIN 1999). Vitamins A, B2, E, C and minerals Ca, Na, K, Zn, Mg and Fe are far more abundant in camel's milk than in cow's milk. Lactose intolerant people (EL-HATMI *et al.*, 2007) can consume camel milk. Due to camel milk not containing β-lactoglobulin and some casein derivatives, it is similar to human milk with its hypoallergenic (SHABO *et al.*, 2005), immunoglobulin content. It is anti-diabetic effective (HAMAD *et al.*, 2011) and because it contains more peptidoglycan recognition proteins (PGRP) and natural protective proteins than other ruminant milk, it has an antimicrobial and antiviral effect (EL-AGAMY *et al.*, 1992). Not to mention that camel milk is anti-carcinogenic and anti-hypertensive (HAMAD *et al.*, 2011) and renoprotective, it reinforces immunity, increases metabolism and muscle mass, is bone-forming and also has therapeutic effects on some diseases such as hepatitis B, autism (LAILA *et al.*, 2013) and tuberculosis (AGRAWAL *et al.*, 2004). Today, we know that yoghurt, probiotic yoghurt (ATTIA *et al.*, 2001; EL-AGAMY *et al.*, 1992), stabilizer augmented yoghurt (MULIOR *et al.*, 2013) and many mild cheeses whose clotting is poor due to enzymatic coagulation (MEHAIA, 1993; RAMET, 1987) can be produced from camel milk.

Our research utilized kefir that was manufactured from camel (*Camelus dramedarius)* milk (CaM). Kefir made from cow's milk (CoM) was used as the control sample. The physical-chemical properties in raw milks were analyzed, along with these properties in the cow milk kefir (CoMK) and camel milk kefir (CaMK) samples. Sensorial tests were conducted as of the eighteenth hour of day one and microbiological analyses were made on day one, three and five of storage.

MATERIALS AND METHODS

Camel milk, kefir grain

Camel (*Camelus dramedarius)* milk was procured from a native camel farm in Denizli Sarayköy (Turkey). Cow milk and kefir grain were procured from the Department of Dairy Technology Pilot Dairy Plant, Ege University Agricultural Faculty.

Kefir production

In this study, kefir was produced from camel and cow milk using the traditional (grain) method as shown in Fig. 1.

Physical-chemical analyses

In the raw milk and kefir samples, dry matter (Binder ED-53 Germany) and ash (Protherm PFL 110/6 Turkey) were calculated via a gravimeter, fat with the Gerber method, pH value of the titration acidity in terms of lactic acid with a SS-3 Zeromatic (Beckman Instruments Inc., California, USA) brand pH meter, protein with the Kjeldahl method (AOAC, 1990), lactose value with an Atago Polax x 2L (Japan) model polarimeter (HORWITZ, 1965), viscosity value with a Brookfield Digital Viscometer, MODEL DV-II+PRO (USA) model viscometer as cP [at speed 180 mPa, between 15.7% and 67.7% Torque].

Determining the fatty acid composition in samples and preparation of fat extraction and fatty acid methyl esters

Each homogenized sample was extracted using the Gerber method, thus fat was obtained

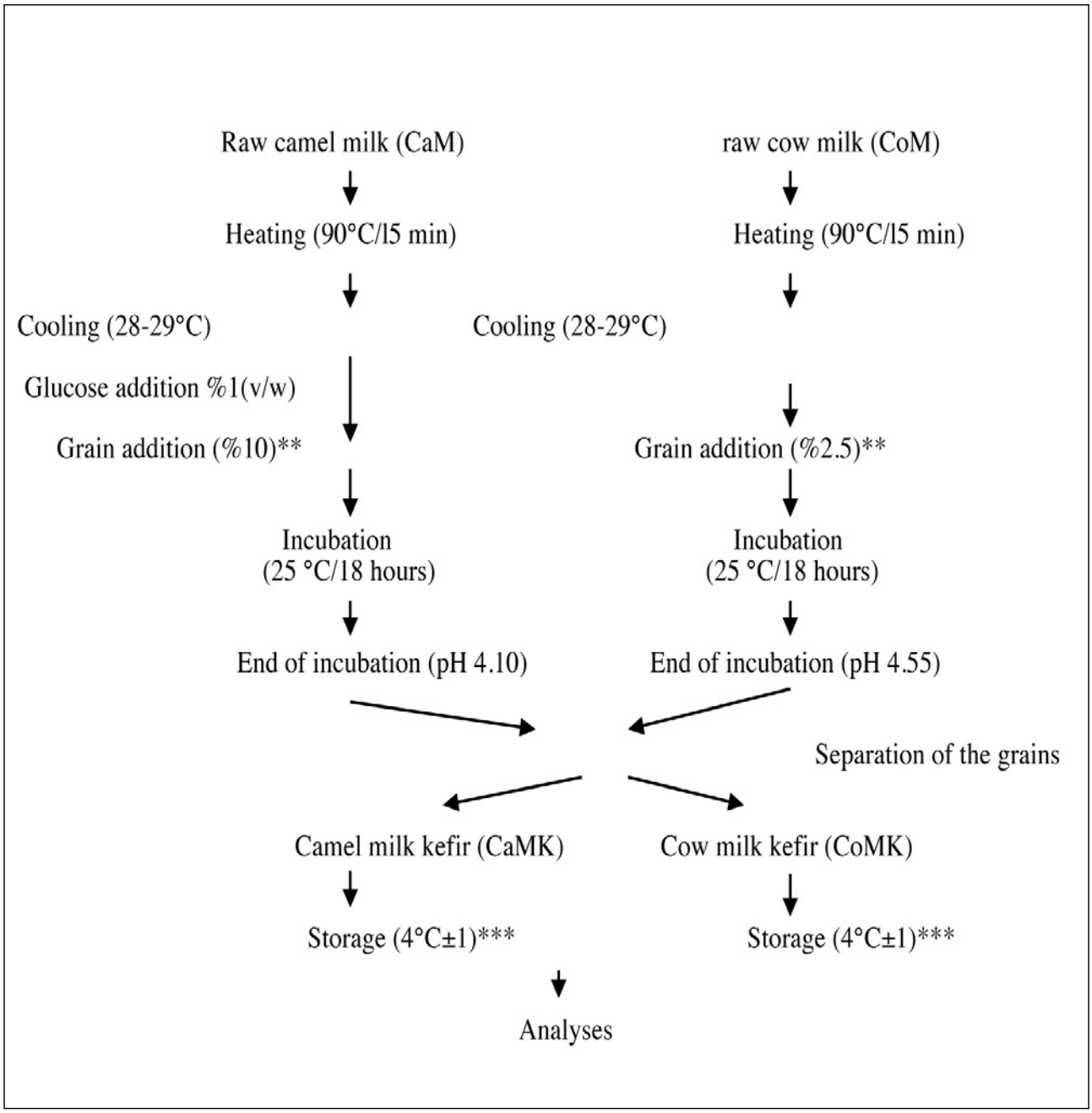

Fig. 1 - Kefir Production with the Traditional (Grain) Method.
** The glucose and grain ratio added to camel milk and cow milk was determined as a result of preliminary study.
***physical-chemical and sensorial analyses were measured at day one (18 hours) of storage and microbiological analyses were measured at days one, three and five.

(ISO 11870:2009 - IDF 152:2009) and fatty acid methyl esters were prepared pursuant to AOCS (2009), after which they were examined in the gas chromatograph (GC). [Chromatography is a Supelco SP-2380 fused silica capillary column (60 m 0.25 mm i.d., 0.2 mm film thickness; Supelco Inc., Bellefonte, PA, USA) and flame ionization detector Hewlett-Packard GC (model 6890). Injection volume was 1 μL. GC furnace temperature was set to reach 220°C from 100°C when 4°C/minute. Injector and detector temperature was 300°C, carrier gas was Helium and the flow rate was 1 mL/min].

Determining the cholesterol level in samples

In samples, the cholesterol level was analyzed according to the findings of OSSA *et al.*, (1995); and then examined by gas chromatography (GC). [Chromatography was a HP-5 silica capillary column (25 m 0.32 mm i.d., 0.52 mm film thickness; Hewlett-Packard, USA) and FID

(flame ionization detector) Hewlett-Packard GC (model 6890). Injection volume was 1µl. GC furnace temperature was set to 300°C, injector temperature to 280°C, colon temperature to 270°C for 15 minutes. Carrier gas was Helium and the flow rate was 1.5 mL/min.

Microbiological analyses

For counting *Lactobacillus* ssp., De Mann Rogosa Sharpe (MRS) Agara (Merck Darmstadt, Germany) (SHARPE *et al.*, 1966) was used. *Lactococcus* ssp. was cultured on M_{17} Agara (Merck Darmstadt, Germany) (TERZAGHI and SANDINE, 1975). For yeast, Glucose-Salt Agara (ANONYMOUS, 1990) plantation was done. Isolation and census of lactic acid bacteria were conducted according to IDF Standard 149 A (1997) and IDF Standard 163 (1992). Yeasts were incubated at 25°C for three to five days. After this period, colonies that had developed in petri dishes were counted as cfu/mL on days one, three and five of storage.

Sensory evaluation

The sensory evaluation was made by a panel of nine individuals who evaluated kefir samples in terms of consistency and flavor on a scale from 1 to 5. For ALTUĞ and ELMACI (2011), the method of Flavor Profile Analysis was utilized.

Statistics

Two different milk and two different kefir samples were analyzed in three parallels and two repetitions. SPSS statistics analysis software (IBM SPSS Statistics) was used. Data that gained importance were analyzed using the variance analysis ANOVA based on the Duncan multiple comparison test on a $p<0.01$ level.

RESULTS AND CONCLUSIONS

In the CaM sample, compared to the CoM sample, fat and lactose values were found to be higher; there was twice as much ash and similar pH and dry matter values. In addition, protein, titration acidity in terms of lactic acid (Table 1) and viscosity values were detected to be lower.

In the research, it was determined that results regarding the pH value 6.46 pH, fat (3.60%), protein (3.05%), lactose (6.22%), total dry matter (12.73%), ash (2.932%) and titratable acidity in terms of lactic acid (0.12%) of camel milk were within the boundaries found in the literature, and that the lactose and ash levels were higher in our studies (FAO, 1982; EL-AMIN and WILCOX, 1992). PH values of kefir samples were determined to correspond with the Turkish Food Codex (2009/25) and WSZOLEK *et al.* (2006). Lactic acid was detected to be higher in the CaMK sample (0.92%LA) than in the CoMK sample (0.81%LA), whereas for viscosity, it was vice versa. With the addition of 1% (v/w) glucose into the CaM sample, simulating the development of lactic acid bacteria, we aimed to increase the titration acidity and viscosity. To this end, the effect that the addition of 1% glucose (v/w) and 10% grain into the CaM sample has on titration acidity and viscosity was found to be significant ($p<0.01$), and lactic acid and viscosity were detected to have increased. However, viscosity in the CaMK sample was lower than the CoMK sample. In addition, the glucose and grain ratio added to camel milk was determined as a result of preliminary study. In that preliminary study, some portion of the CaM sample was inoculated with yeast grains in ratios of 2.5%, 5%, 7.5% and 10% without the addition of glucose, while the other portion of the sample had the same process with the addition of glucose. Afterwards, viscosity values and titration acidity were detected in kefir samples, and viscosity values are given in Tables 2 and 3. Grain being added into camel milk by 2.5% did not have a major effect, and since the 2.5% grain addition into the CoMK sample provided the desired viscosity value, other grain ratios were not tested. All in all, with the 1% glucose (v/w) and 10% grain addition into camel milk, a four times greater increase was reached in viscosity than in the one with just the grain addition, and the titration acidity diminished from

Table 1 - Physical-chemical properties of raw camel milk, raw cow milk and of kefirs produced from these milks.

Analyses	Milk samples		Kefir samples	
	CaM	CoM	CaMK	CoMK
Dry matter	12.73±0.12^{A}	12.80±0.09^{B}	11.10±0.02^{C}	10.70±0.03^{D}
Fat (%)	3.60±0.08^{A}	3.50±0.06^{B}	3.20±0.02^{C}	3.30±0.01^{D}
Titratable Acidity	0.127±0.02^{A}	0.132±0.02^{B}	0.92±0.01^{C}	0.81±0.02^{D}
pH	6.46±0.32^{A}	6.44±0.27^{B}	4.10±0.10^{C}	4.55±0.14^{D}
Protein (%)	3.05±0.03^{A}	3.21±0.03^{B}	2.82±0.03^{C}	3.09±0.03^{D}
Ash (%)	2.932±0.10^{A}	1.461±0.09^{B}	1.423±0.05^{C}	1.068±0.05^{D}
Lactose (%)	6.22±0.05^{A}	6.20±0.51^{B}	3.45±0.07^{C}	3.54±0.02^{D}

$^{A, B, C, D}$: The differences between the values in the same rows are statistically significant ($p < 0.01$).

Table 2 - Viscosity values of the kefir samples produced by injecting grain in certain amounts in CaM with/without glucose addition and the ones produced from CoM without glucose addition (cP).

Grain ratio (%)	CaMK (Gra) viscosity (cP)	CaMK (Gra+G) viscosity (cP)	CoMK (Gra) viscosity (cP)
2.5	5.21^{aA}	5.87^{aB}	111.475^{C}
5	5.46^{bA}	8.44^{bB}	NT
7.5	7.12^{cA}	18.81^{cB}	NT
10	9.28^{dA}	37.18^{dB}	NT

NT:Not-tested ; Gra: Grain ;G+Gra: Glucose +Grain

a, b, c, d, e: The differences between the values in the same column are statistically significant ($p < 0.01$).

A, B, C, D: The differences between the values in the same rows are statistically significant ($p < 0.01$).

Table 3 - Fatty acid compositions of kefir samples made from Camel/Cow milk (g/100g)

Name of Fatty Acid Methyl Ester and Formula of Molecule	(g/100g)			
	CoM	CoMK	CaM	CaMK
Butyric Acid Methyl Ester (C4:0)	0.064	0.043	ND	ND
Caproic Acid Methyl Ester (C6:0)	0.264	0.422	0.140	0.121
Caprylic Acid Methyl Ester (C8:0)	0.037	0.024	0.003	0.002
Capric Acid Methyl Ester (C10:0)	0.085	0.061	0.004	0.003
Undecanoic Acid Methyl Ester (C11:0)	0.007	0.009	ND	ND
Lauric Acid Methyl Ester (C12:0)	0.127	0.101	0.021	0.021
Tridecanoic Acid Methyl Ester (C13:0)	0.002	0.017	0.005	0.004
Myristic Acid Methyl Ester (C14:0)	0.386	0.303	0.321	0.309
Myristoleic Acid Methyl Ester (C14:1)	0.051	0.034	0.050	0.050
Pentadecanoic Acid Methyl Ester (C15:0)	0.021	0.013	0.029	0.029
cis-10- Pentadecanoic Acid Methyl Ester (C15:1)	0.012	0.036	0.013	0.010
Palmitic Acid Methyl Ester (C16:0)	0.901	0.740	1.049	0.967
Palmitoleic Acid Methyl Ester (C16:1)	0.063	0.027	0.292	0.268
Heptadecanoic (Margaric) Acid Methyl Ester (C17:0)	0.015	0.011	0.020	0.018
cis-10-Heptadecanoic Acid Methyl Ester (C17:1)	0.016	0.074	0.024	0.019
Stearic Acid Methyl Ester (C18:0)	0.430	0.361	0.507	0.457
Oleic Acid Methyl Ester (C18:1n9c)	0.840	0.581	0.843	0.715
Linoleic Acid Methyl Ester (C18:2 n6c)	0.088	0.072	0.107	0.099
γ-Linolenic Acid Methyl Ester (C18:3 n6)	0.034	0.177	0.053	0.036
Arachidic Acid Methyl Ester (C20:0)	0.028	0.017	0.028	0.023
cis-11- Eicosenoic Acid Methyl Ester (C20:1)	ND	ND	0.013	0.010
cis-11,14-Eicosadienoic Acid Methyl Ester (C20:2)	ND	ND	0.009	0.005
Arachidonic Acid Methyl Ester (C20:4n6)	0.012	0.067	0.028	0.017
Behenic Acid Methyl Ester (C22:0)	0.016	0.094	0.023	0.009
Other fatty acids	ND	0.017	0.017	0.007
Short-chain fatty acids (4-6C)	0.33	0.46	0.14	0.12
Medium-chain fatty acids (8-12C)	0.26	0.20	0.03	0.03
Long-chain fatty acids (>12C)	2.92	2.62	3.41	3.05
Saturated fatty acids (SFA)	2.38	2.22	2.15	1.96
Monounsaturated fatty acids (MUFA)	0.98	0.75	1.24	1.07
Polyunsaturated fatty acids (PUFA)	0.13	0.32	0.20	0.16

ND: Non-detected.

4.78 pH (in the sample with grain addition only) to 4.10 pH. Results correspond with the literature (LEWIS, 1986).

In this study, problems that might occur in fermentation were associated with low viscosity value obtained from the CaMK sample, lower serum protein content of camel milk than cow milk (FARAH, 1996), poor interaction between denature serum proteins of camel milk and κ-casein, lack of β-lactoglobulin from serum proteins and different derivatives of β-casein, low amounts of casein and its derivatives (LALEYE *et al.*, 2008) and the anti-bacterial effect of camel milk (HASHIM and KHALIL, 2004). Many factors (content of protein and denature serum proteins, casein ratio and its content, interactions between denature serum proteins and k-casein) may affect viscosity (PUVANENTHIRAN *et al.*, 2002). Based on the pH change, these factors might also affect the micelle surface area and size, micelle content and water binding capability in casein micelles (ANEMA and KLOSTMEYER, 1996; DALGLEISH and

LAW, 1988, 1989). The drop in pH causes the interaction between serum proteins and case micelles and the viscosity to increase (ANEMA *et al.*, 2004). However, in the current study it was determined that based on the drop in pH (4.10 pH) in the CaMK sample, the viscosity value was lower than in the CoMK samples. This is thought to result from the effect of one or more of the parameters given above (ANEMA and LI, 2003) Also, the camel milk is low in casein and serum proteins and the composition of these. It was found that the milk type in kefir samples has an important effect on titration acidity, pH and viscosity; the effect of titration acidity on viscosity is vital as well ($p<0.01$). Protein, lactose and fat in the CaMK sample were found to be higher than in the CoMK sample, whereas dry matter and ash were found to be lower. In general, effect of the milk type on dry matter, fat, protein and lactose was established as significant, as well as the effect of glucose addition into milk and grain ratio on titration acidity ($p<0.01$).

CaM and CoM, and fatty acid compositions of kefirs produced from these milks are given in Table 3. In CaM and CaMK samples, it was determined that the short (C4:0-C6:0) and medium (C8:0-C12:0) chain fatty acids ratio, as well as the saturated fatty acids (SFA) ratio were lower than in CoM and CoMK samples, but the long chain fatty acids ratio and the monounsaturated fatty acids (MUFA) ratio were higher. It was also established that the ratio of polyunsaturated fatty acids (PUFA) in the CaM sample was higher than the CoM sample; however, its ratio in the CaMK sample (0.16 g/100 g) was lower than in the CoMK sample (0.32 g/100 g). Thus, the conclusion: Camel milk and its kefir contain some fatty acids that affect our health positively in terms of fatty acid composition in higher amounts than cow milk and its kefir.

The camel milk fatty acid composition changes pursuant to the species and the diet of that specific camel, as well as its region and the climate of that region (CHILLIARD *et al.*, 2000; KONUSPAYEVA *et al.*, 2008). The results we obtained from this research were similar to the results of other researchers (AGRAWAL *et al.*, 2004; SHAMSIA, 2009).

Table 4 - Cholesterol levels of kefirs samples made from Camel/Cow milk (mg/100g).

Cholesterol levels (mg/100g)	
CoM	**CoMK**
14.60^{aA}	7.97^{aB}
CaM	**CaMK**
21.28^{bA}	18.24^{bB}

[a, b, c, d, e]: The differences between the values in the same column are statistically significant ($p < 0.01$).
[A, B, C, D]: The differences between the values in the same rows are statistically significant ($p < 0.01$).

In the CaM, CoM, CaMK and CoMK samples, cholesterol levels were different and an important relationship between the milk type and the cholesterol level was detected ($p<0.01$) (Table 4). Along with this, it was determined in the research that the cholesterol level decreased after production of kefir by using different milks, and the effect that kefir production has on the drop in cholesterol levels was regarded as significant ($p<0.01$). According to some researchers (GORBAN and IZZELDIN, 1999; GOUDJIL *et al.*, 2003; KONUSPAYEVA *et al.*, 2008; SIEBER, 2005), cholesterol level of kefir production was higher than cow milk, but it was also found to be lower according to some other researchers (ALABDULKARIM, 2012; AGRAWAL *et al.*, 2004).

Initially, in the grain, *Lactobacillus ssp.* strains were found to be as 1.93×10^7 cfu/mL, *Lactococcus ssp.* strains as 5.54×10^7 cfu/mL and yeast as 1.68×10^6 cfu/mL. In the study, *Lactobacillus ssp.* strains (Fig. 2a) and yeast levels (Fig. 2b) increased in both kefir samples throughout the storage process. In addition, the increase in the *Lactobacillus ssp.* strains in the CaMK sample was found to be higher. *Lactococcus ssp.* strains (Fig. 2c) were detected to have increased in kefir samples at day one and three of storage, but to have decreased after day three. Levels of *Lactobacillus ssp.* strains in kefir samples were close to one another at the inception of storage, but the one in the CaMK sample took the lead after day one of storage. *Lactobacillus ssp.* strains in the CaMK sample at days one, three and five of storage increased, in comparison with the starting level, respectively at levels of 0.99 cfu/mL, 1.71 cfu/ml and 2.59 cfu/mL. However, in the CoMK sample, it was respectively: 0.91 cfu/mL, 1.28 cfu/mL and 2.18 cfu/mL. *Lactococcus ssp.* strains in the CoMK sample at days one and three of storage increased, in comparison with the starting level, respectively at levels of 0.05 cfu/mL and 1.02 cfu/mL. However, this lessened in day five by 0.41 cfu/mL compared to day three of storage. Development of *Lactococcus ssp.* strains in the CaMK sample was the same as the CoMK sample at day one; however, its increase after day one of storage was lower than the one in the CoMK sample. In the CaMK sample, an increase respectively at levels 0.04 cfu/mL and 0.8 cfu/mL was detected in day one and three of storage in comparison with the starting level, whereas after day five, a decrease took place. This decrease was ten times more than the CoMK sample. Yeast level increased in both kefir samples throughout the storage process, but the one in the CoMK sample was approximately three times higher than the CaMK's. Generally, it was concluded that microorganism levels in CaMK and CoMK samples in storage were above the minimum values set forth by "Turkish Food Codex, Communiqué on Fermented Milks" (Turkish Food Codex, Communiqué no: 2009/25).

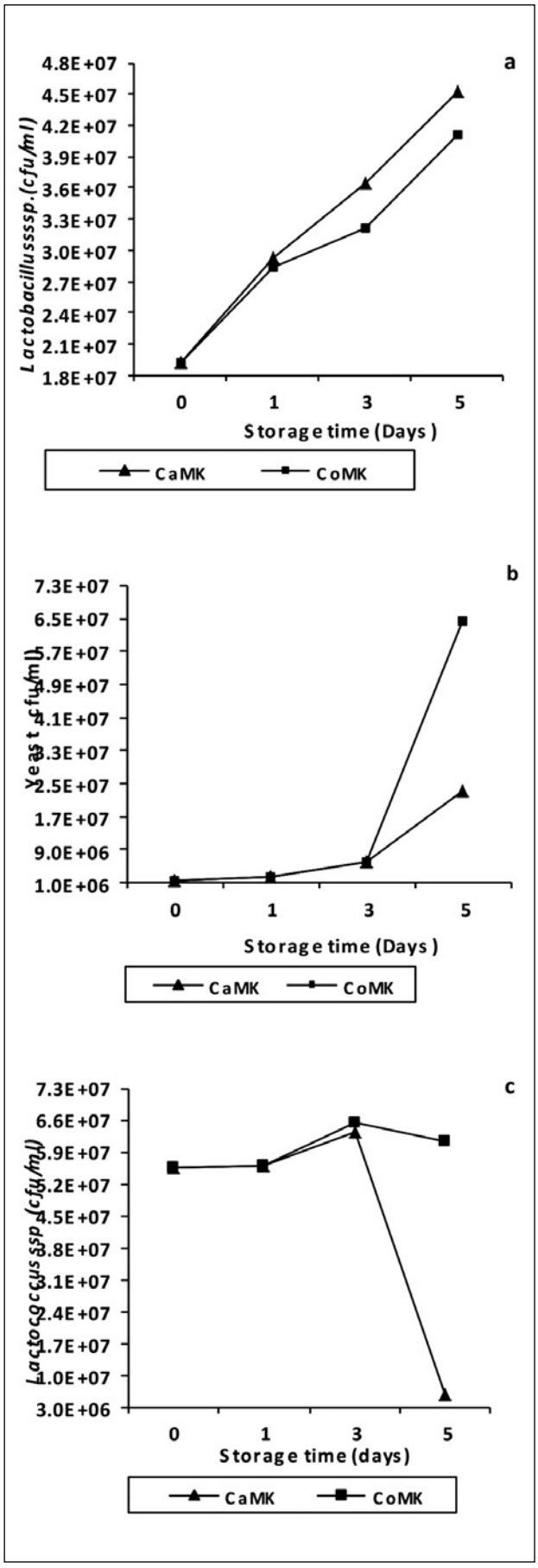

Fig. 2 - *Lactobacillus ssp.* (a), yeast (b) and *Lactococcus ssp.* (c) levels in kefirs produced from camel and cow milks.

Research helped discover an important relationship between the milk type and the storage period on microorganism levels. In addition, the effect that glucose has on microorganism development was established as significant ($p<0.01$). In the CaMK sample produced with the addition of 1% glucose, increase in the *Lactobacillus ssp.* strains was higher than in the CoMK sample, but this was vice versa for the increase in the yeast level. Progress of the increase (*Lactobacillus ssp.*, yeast), also the decrease (*Lactococcus ssp.*) in the microorganism levels in the CaMK sample after day three of storage show parallels with the CoMK sample (KOROLEVA *et al.*, 1978; KOROLEVA and BAVINA, 1978; ONER *et al.*, 2010). In the research, microbial flora in the CaMK sample went through a different development. This result corresponds with the literature data regarding other fermented dairy products of camel milk (ABU-TARBOUSH, 1996; ATTIA *et al.*, 2001; JUMAH *et al.*, 2001; ABDEL RAHMAN *et al.*, 2009). In addition, the research pinpointed that the usage of grain in producing kefir from camel milk was more effective (ABU-TARBOUSH, 1996; ABDEL RAHMAN *et al.*, 2009; MEHAIA, 1993).

In the flavor profile evaluation of kefir samples, panelists determined that sour, sweet, salty, bitter, fermented milk, cream, greasy, cheesy, sharp, gas, alcohol, metallic and burnt milk flavor densities were perceived differently between the CaMK and CoMK samples (Fig. 3). In the flavor profile evaluation, it was detected that the CaMK sample was sourer, cheesier and had a sharper aroma than the CoMK sample. Consistency and appearance in the CaMK sample were detected to be lower than the CoMK sample. In general, the CaMK sample was appreciated by the panelists and was defined as "sourer" than the CoMK sample.

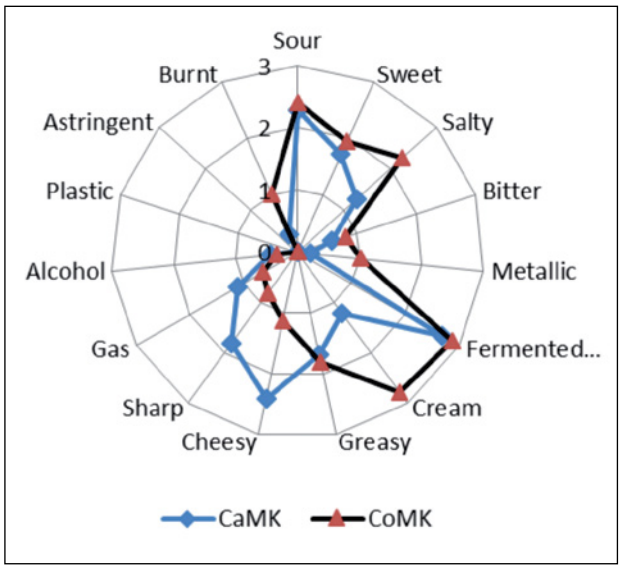

Fig. 3 - Flavor profile evaluation of the CaMK and CoMK samples.

CONCLUSIONS

In the current research, an increase was obtained in the viscosity value in the kefir produced by adding 1% (v/w) glucose and 10% grain into camel milk. Dry matter, ash and titratable acidity in the camel milk kefirs were higher than in cow milk kefirs; whereas fat, pH, protein and lactose values were lower. Cholesterol level of camel milk and its kefir product was found to be higher than that of cow milk and its kefir. Along with this, it was detected in this study that proportion of camel milk and its kefir to cow milk and its kefir in terms of SFA is low. However, it is high in terms of MUFA. The PUFA ratio of camel milk is high compared to cow milk. However, the PUFA ratio in the camel milk kefir was defined to be lower than the one in the cow milk kefir. Lastly, it was also confirmed in the study that some compounds, which have positive effects upon metabolism in camel milk and its kefir, have a higher impact than on the cow milk kefir's metabolism.

REFERENCES

Abdel Rahman İ.A., Dirar, H.A. and Osman M.A. 2009. Microbiological and biochemical changes and sensory evaluation of camel milk fermented by selected bacterial starter cultures. Afr. J. Food Sci. (12)3: 398-405

Abu-Tarboush H.M. 1996. Comparison of associative growth of yogurt starter in whole milk from camels and cows. J. Dairy Sci. 79 (3): 366-371.

Agerbaek M., Gerdes L.U. and Richelsen B. 1995. Hypocholesterolaemic effect of a new fermented milk product in healthy middle-aged men. Eur. J. Clin. Nutr. 49: 346-52.

Agrawal R.P., Kochar D.K., Sahani M.S., Tuteja F.C. and Ghrui S.K. 2004. Hypoglycaemic activity of camel milk in streptozotocin induced diabetic rats. Int. J. Diab. Dev. Countries. 24: 47-49.

Alabdulkarim B. 2012. Effect of camel milk on blood glucose, cholesterol, triglyceride and liver enzymes activities in female albino rats. World App. Sci. J. 17 (11): 1394-1397.

Altuğ T. and Elmacı Y. 2011. Sensorial evaluation in food. No :010-1B. Sidas Medya Ltd.Sti., İzmir, Turkey 27s.

Anema S.G. and Klostmeyer H. 1996. ð Potentials of Casein Micelles from Reconstitued Skim milk Heated at 120°C. I. Dairy J. 6: 673-687.

Anema S.G. and Li Y. 2003. Association of Denaturated Whey Proteins with Casein Micelles in Heated Reconstituted Skim milk and Its Effect on Casein Micelle Size. J. Dairy Res. 70: 73-83.

Anema S.G., Lowe E.K. and Li Y. 2004. Effect of pH on the viscosity of heated reconstituted skim milk. I. Dairy J. 14: 541-548.

Anonymous. 2001. FAO/WHO. CODEX Standard for Fermented Milks. 243.

Anonymous. 1990. Milk and milk products enumeration of yeast and moulds colony count technique at 25°C. IDF Standart 94.

AOAC (Association of Official Analytical Chemists) 1990. Official Methods of Analysis of the Association of Official Analytical Chemists. Thirteenth Edition. Association of Official Analytical Chemists (publisher), Washington, DC 20044, USA, 1018 p.

AOCS, 2009. AOCS American Oil Chemists' Society Official Method. Ce 2-66. Preparation of Methyl Esters of Fatty Acids.

Attia H., Kherouatou N. and Dhouib A. 2001. Dromedary milk lactic acid fermentation: microbiological and rheological characteristics. J. Industrial Microbiol. Biotechnol. 26(5): 263-270.

Beshkova D.M., Simova E.D., Simov Z.I., Frengova, G.I. and Spasov Z.N. 2002. Pure Cultures for Making kefir. Food Microbiol. 19: 537-544.

Chilliard Y., Ferlay A., Mansbridge R.M. and Doreau M. 2000. Ruminant milk fat plasticity: nutritional control of saturated, polyunsaturated, trans and conjugated fatty acids, Ann. Zootech. 49: 181-205.

Dalgleish D.G. and Law A.J.R. 1988. pH induced dissociation of casein micelles. I. Analysis of liberated caseins. J. Dairy Res. 55: 529-538

Dalgleish D.G. and Law A.J.R. 1989. pH induced dissociation of casein micelles. II. Mineral solubilization and its relation to casein release. J. Dairy Res. 56: 727-735

El-Agamy E.I., Ruppanner R., Ismail A., Champagene C.P. and Assaf R. 1992. Antimicrobial and antiviral activity of camel milk protective proteins. J. Dairy Res., 59: 169-175.

El-Amin F.M. and Wilcox C.J. 1992. Milk composition of Majaheem camels. J. Dairy Sci. 75: 3153-3157.

El-Hatmi H., Girardet J.M., Gaillard J.L., Yahyaoui M.H. and Attia H. 2007. Characterisation of whey proteins of camel (*Camelus dromedarius*) milk and colostrum. Small Rum. Res. 70: 267-271.

FAO. 1982. Camels and camel milk. Food and agrıculture organızatıon of the Unıted Nations. Rome.

Farah Z. 1996. Camel milk properties and products, 1st Edition. Swiss Centre for Development. Cooperation in Technology and Management, Vadianstrasse 42, CH- 9000 St. Gallen, Switzerland.

Ferreira I.M., Pinho O., Monteiro D., Faria S., Cruz S., Perreira A., Roque A.C and Tavares P. 2010. Effect of kefir grains on protolysis of major milk protins. J. Dairy Sci. 93: 27-31.

Gaware V., Kotade R. and Dolas K. 2011. The magic of kefir: a Review History of Kefir. Pharmacologyonline. 1: 376-386.

Gorban A.M.S. and Izzeldin O.M. 1999. Study on cholesteryl ester fatty acids in camel and cow milk lipid, Int. J. Food Sci. Technol. 34: 229-234.

Goudjil H., Torrado S., Fontecha J.,Martinez-Castro I., Fraga J. and Juarez M. 2003. Composition of cholesterol and its precursor in ovine milk, Lait 83: 153-160.

Hamad E.M., Abdel-Rahim E.A. and Romeih E.A. 2011. Beneficial Effect of Camel milk Liver and kidneys function in diabetic sprague-dawles rats. I. J. Dairy Sci. 6 (3): 190-197.

Hashim I.B. and Khalil A.H. 2004. Dairy Sci. J. 87 suppl. 1: 282-386. International Dairy Federation (IDF) (1988). Fermented milks, Science and Technology. IDF Bulletin 227.

Hertzler S.R. and Clancy S.M. 2003. Kefir improves lactose digestion and tolerance in adults with lactose maldigestion. J. Am. Diet. Assoc. 103: 582-7.

Horwitz W. 1965. Official methods of analysis of the association of official agricultural chemists. 10th Ed., p. 224, Publishing by the association official agricultural chemists. Benjamin Franklin Station, Washington D.C. 20044.

IDF Standard 149 A. 1997. Dairy Starter Cultures of Lactic Acid Bacteria (LAB) – Standard of Identity. Brussels, Belgium: International Dairy Federation.

IDF Standard 163 1992. General Standard of Identity for Fermented Milks. Brussels, Belgium: International Dairy Federation.

Irigoyen A., Arana I., Castiella M., Torre P. and Ibánez F.C. 2005. Microbiological, Physicochemical and Sensory Characteristic of Kefir During Storage. Food Chem. 90: 613-620.

ISO 11870:2009 (IDF 152:2009). Milk and milk products-Determination of fat content-General guidance on the use of butyrometric methods.

Jianzhong Z., Xiaoli L., Hanhu J. and Mingsheng D. 2009. Analysis of the microflora in Tibetan kefir grains using denaturing gradient gel electrophoresis Food Microbiol. 26: 770-775.

Jumah R.Y, Shaker R.R. and Abu-Jdayil B. 2001. Effect of milk source on the rheological properties of yoghurt during the gelation process. J. Dairy Tech. 54(3): 89.

Konuspayeva G., Lemarie E., Faye B., Loiseau G. and Montet D. 2008. Fatty acid and cholesterol composition of camel's (*Camelus bactrianus*, *Camelus dromedarius* and hybrids) milk in Kazakhstan. Dairy Sci. Technol. 88: 327-340.

Koroleva N.S., Bavına N.A. and Rozhkova I.V. 1978. Changes in the Microflora of kefir during storage XX. Int. Dairy Cong France-1978 Publishing by Congrilait Paris 1978 Vol. E. (844).

Koroleva N.S. and Bavina N.A. 1978. Basıc Factors Affecting The Microflora and Quality of Kefir. XX Int. Dairy Cong France 1978. Publishıng by Congrılait Paris 1978. Vol. E (844).

Laila Y. Ayadhi A.L. and Elamin N.E. 2013. Camel Milk as a Potential Therapy as an Antioxidant in Autism Spectrum Disorder (ASD). Evidence Based Complementary and Alternative Medicine 8: 11-17

Laleye L.C., Jobe B. And Wasesa A.A.H. 2008. Comparative study on heat stability and functionality of camel and bovine milk whey proteins. J. Dairy Sci. 91: 4527-4534.

Lewis J.M. 1986. Physical properties of dairy products. In: Modern dairy technology (Ed. R.K. Robinson) Elsevier Applied Science Publishers, London, UK.

Liu J.R., Chen M.J. and Lin C.W.2005. Antimutagenic and antioxidant properties of milk-kefir and soymilk-kefir. J. Agric. Food Chem. 53: 2467-74.

Lopitz-Otsoa F., Rementeria A., Elguezabal N. and Garaizar J. 2006. Kefir: A symbiotic yeast-bacteria commu¬nity with alleged healthy capabilities. Revista Iberoamericana de Micologia. 23: 67-74.

Maeda H., Zhu X., Suzuki S., Suzuki K. and Kitamura S. 2004. Structural characterization and biological activities of an exopolysaccharide kefiran produced by *Lactobacillus kefiranofaciens* WT-2bT. J. Agric. Food Chem. 52: 5533-5538

Marshall V.M. and Cole W.M. 1985. Methods for making kefir and fermented milks Based on kefir. J. Dairy Res. 52: 451-456

Matsuu M., Shichijo K., Okaichi K., Wen C.Y., Fukuda E., Nakashima M., Nakayama, T., Shirahata S., Tokumaru S. and Sekine I. 2003. Theprotective effect of fermented milk kefir on radiation-induced apoptosis incolonic crypt cells of rats. J. Dairy Res. (Tokyo) 44(2): 111-115.

Mehaia M.A. 1993. Fresh soft white cheese (Domiati type) from camel's milk: composition, yield and sensory evaluation. J. Dairy Sci. 20: 2845-2855.

Muliro P.S., Shalo P.L. and Kutima P.M. 2013. Optimization of camel milk coagulum formation and consumer preference. Afr. J. Food Sci. and Tech. 4(8): 176-181.

Oner Z. and Karahan A.G., Çakmakçı M.L. 2010. Effects of different milk types and starter cultures on kefir. Food J. 35 (3): 177-182.

Ossa E.M., Huber W., Molero A. and Pereyra C. 1995. Determination of cholesterol in milk fat by supercritical fluid chromatography. J. Chromatography A. 715:333-336.

Pogačić T., ŠinkoS., Zamberlin S. and Samaržija D. 2013. Microbiota of kefir grains. Mljekarstvo 63(1): 3-14.

Puvanenthiran A., Williams R.P.W. and Augustin M.A. 2002. Structure and visco-elastic properties of set yoghurt with altered casein to whey protein ratios. I. Dairy J. 12: 383-391

Ramet J.P. 1987. Use of bovine calf rennet to coagulate raw camel milk. World Anim. Rev. 61: 11-26.

Rattray F.P. and O'Connell M.J. 2011. Kefir. Encyclopedia of Dairy Science., Elsevier, Ltd. 518-524.

Shabo Y., Barzel R., Margoulis M. and Yagil R. 2005. Camel milk for food allergies in children. Immunol. and Allergy .7 :796-798.

Shamsia S.M. 2009. Nutritional and therapeutic properties of camel and human milks. I. J. Genetics and Molecular Biol. 1(2): 052-058.

Sharpe M.E., Fryer T.F. and Smith D.C. 1966. Identification of the Lactic Acid Bacteria. In: Gibbs B.M. and Skinner P.A.: Identification Methods for Microbiologists, Part A, 65-79.

Shiomi M., Sasaki K., Murofushi M. and Aibara K. 1982. Antitumor activity in mice of orally administered polysaccharide from Kefir grain. Jpn. J. Med. Sci. Biol. 35: 75-80.

Sieber R. 2005. Oxidised cholesterol in milk and dairy products. Int. Dairy J. 15:191-206.

Terzaghi B.E. and Sandine W.E. 1975. Improved medium for Lactic Streptococci and their bacteriophages. App. Microbiol. 29 (6): 807-8l3.

Turkish Food Codex. 2009. Communiqué no: 2009/25. Femented milk product. 6.02.2009-27143 Teblig No: 2009/25

Umeda C., Sonoyama K., Yamaguchi N., Saito R., Akashi K., Motoshima, H. and Kawabata J. 2005. Oral administration of freeze-dried kefir reduces intestinal permeation of and oral sensitization to ovalbumin in mice. Biosci Biotechnol Biochem. 69(1): 249-251.

Wszolek M., Kupiec-Teahan B., Skov Guldager H. and Tamime A.Y. 2006. Production of kefir, koumiss and other related products. In: Tamime A.Y. (Ed.) Fermented milks. Blackwell Science Ltd, Oxford, pp. 174-198.

Paper Received September 4, 2014 Accepted November 5, 2014