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RESEARCH ARTICLE

Fatty Acid Composition and Conjugated Linoleic Acid (CLA) Content of Some Commercial Milk in Turkey [1]

Gokalp Ozmen GULER * Yavuz Selim CAKMAK ** Gokhan ZENGIN **
Abdurrahman AKTUMSEK ** Kazım AKYILDIZ **

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* Department of Biological Education, Ahmet Kelesoglu Education Faculty, Selcuk University, TR-42090 Konya - TURKEY
** Department of Biology, Science Faculty, Selcuk University, TR-42075 Konya - TURKEY

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Summary

In this study, conjugated linoleic acid (CLA) and *trans* fatty acid content and fatty acid composition of some commercial milk in Turkey were determined. Total 41 milk samples belonging to 23 different national milk brands were analyzed. These samples categorized as whole milk, light milk and fruity milk. Generally, C 16:0, palmitic acid, was major fatty acid in all samples. Other predominant fatty acids were C 18:1, oleic acid, and C 18:0, stearic acid. The average of total CLA was ranged between 0.961% and 1.020%.

Keywords: *Commercial milk, Conjugated linoleic acid, Fatty acid composition, Turkey*

Türkiye'deki Bazı Ticari Sütlerin Yağ Asidi Bileşimi ve Konjuge Linoleik Asit (CLA) İçeriği

Özet

Bu çalışmada, Türkiye'deki bazı ticari sütlerin konjuge linoleik asit (CLA) ile *trans* yağ asidi içeriği ve yağ asidi bileşimi belirlenmiştir. 23 farklı ulusal markaya ait 41 süt numunesi analizlenmiştir. Bu süt numuneleri, yağlı süt, yarım yağlı süt ve meyveli süt olarak gruplandırılmıştır. Genel olarak C 16:0, palmitik asit, majör yağ asididir. Diğer en yüksek yüzdeye sahip yağ asitleri de C 18:1, oleik asit ve C 18:0, stearik asit, olarak belirlenmiştir. Toplam CLA ortalama 0.961% ile 1.020% arasında bulunmuştur.

Anahtar sözcükler: *Ticari süt, Konjuge linoleik asit, Yağ asidi bileşimi, Türkiye*

INTRODUCTION

Milk fatty acid composition is important for milk processing and human health [1]. Fatty acid composition of milk fat is highly saturated [2] which have been implicated as a factor for increased risk of heart disease [3]. n-3 fatty acids which may help prevent coronary heart disease [4] account for less than 1% of total fatty acids in milk fat [5].

CLA is a term to describe a mixture of positional and geometrical isomers of linoleic acid (*cis*-9, *cis*-12 octadecadienoic acid) with conjugated double bonds. A portion of CLA in milk fat derives from the uncompleted biohydrogenation of linoleic acid in the rumen and another portion comes from the action of Δ^9 desaturase enzyme on vaccenic acid (C18:1 *trans*-11) to form rumenic acid within the tissues of the mammary gland [6,7]. Two CLA isomers, *cis*-9, *trans*-11 (rumenic acid) and *trans*-10, *cis*-12, have been reported as the most biologically

İletişim (Correspondence)
☎ +90 332 2231866
✉ aktumsek@selcuk.edu.tr

active [8]. The main isomer present in both milk and meat fat is the *c*-9, *t*-11 CLA that accounts for 80 to 90% of the total CLA present [9].

A number of health benefits are associated with dietary conjugated linoleic acid (CLA) including anti-carcinogenic and antiatherogenic activities [10,11].

CLA occurs naturally in many foods however; main dietary sources are dairy products and foods derived from ruminants [12]. Diet is the most important factor influencing milk CLA concentrations [13].

There is some research about the fatty acid composition and CLA content of dairy products various countries [14,15]. However, there are only a few reports about fatty acid composition and CLA content in dairy products in Turkey [16-18]. Therefore, the objective of this study was to determine fatty acid composition and conjugated linoleic acid content of commercial milk belonging to some brands in Turkey.

MATERIAL and METHODS

In this study, 41 commercial milk samples belonging to 23 different national milk brands were analyzed in 2007. Commercial milk was sampled in local dairy markets and stores in Konya, Turkey. These samples categorized as whole milk (n=21), light milk (n=10) and fruity milk (n=10). All of these samples were UHT milk.

Milk samples were frozen and stored at -27°C for fatty acid composition analysis. Milk fat was extracted by the method of Erickson and Dunkley [19] with hexane as the extraction solvent. The fatty acids in the total lipid were esterified into methyl esters by saponification with 0.5 N methanolic NaOH and transesterified with 14% BF_3 (w/v) in methanol [20].

The fatty acid methyl esters were analyzed on a HP (Hewlett Packard) Agilent 6890N model gas chromatograph (GC), equipped with a flame ionization detector (FID) and fitted with a HP-88 capillary column (100 m, 0.25 mm ID and 0.2 µm). Chromatographic conditions were performed according to Ledoux et al.[21] method modified as follows: Injector and detector temperatures were 250°C and 280°C, respectively. The oven was programmed at 60°C initial temperature and 1 min initial time. Thereafter the temperature increased 20°C/min to 190°C held for 60 min then increased at 1°C/min to 220°C and held for 10 min at 220°C. Total run time was 107.5 min. Carrier gas was helium (1 ml/min).

Identification of fatty acids and *trans* isomers were carried out by comparing sample FAME peak relative retention times with those obtained for Alltech standards. Linoleic acid conjugated methyl ester (mixture of *cis*- and *trans*-9,11- and -10,12-octadecadienoic acid methyl esters, catalog number O5632) was purchased from Sigma-Aldrich (St Louis, MO, USA). Results were expressed as FID response area relative percentages. Each reported result is the average value of three GC analyses. The results are offered as mean±SD.

RESULTS

Results of analysis are presented in *Table 1.* Thirty seven fatty acids in milk samples were identified and evaluated. Palmitic acid (30.849-32.200%), oleic acid (27.399-29.179%), stearic acid (13.791-14.788%) and myristic acid (8.131-9.419%) were of high percentages in milk samples. Generally, palmitic acid was the major fatty acid in all samples *(Table 1).*

Saturated fatty acids (SFAs) were higher than mono-unsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) and varied from 59.387 to 61.505%. MUFAs ranged from 31.828% to 33.345 and oleic acid was the major MUFA in all samples. Oleic acid was found to be 29.179%, 28.043% and 27.399% of total fatty acids in whole milk, light milk and fruity milk, respectively. Other predominant MUFA was palmitoleic acid (2.204-2.257%) in milk samples. PUFAs content varied from 3.142% to 3.199% and linoleic acid was major PUFA in all samples. Linoleic and linolenic acid ranged from 2.427 to 2.656% and 0.210 to 0.413%, respectively.

The average total CLA content of milk samples was 1.020%, 0.965% and 0.961% of total fatty acids in whole milk, light milk and fruity milk, respectively. *c*9, *t*11 CLA is major CLA isomers in all samples.

Trans vaccenic acid was found to be the highest *trans* fatty acid (1.585-2.013%) in all samples and C 14:1*t*9, C 16:1*t*9, C 18:2 *t*9*t*12 and C 18:2 *t*9c12 were other *trans* fatty acids in all samples.

DISCUSSION

In our study, palmitic acid was the most abundant fatty acid in milk samples. These results agree with Prandini et al.[14] who reported that palmitic acid (31.01 g/100 g) was major fatty acid in fermented milk. In the present study, the other predominant fatty acids were oleic, stearic and myristic acid in milk samples. Prandini et al.[14] found that SFA was higher than MUFA and PUFA in fermented milk. Similarly, in the present study, SFAs were found to be higher than MUFAs and PUFAs in all samples and ranged from 59.387% to 61.505%.

Table 1: *Fatty acid composition (as methyl esters) of milk samples (%)*

Tablo 1: *Süt numunelerinin yağ asidi bileşimi (metil esteri olarak) (%)*

Fatty Acids	Whole Milk (n=21)	Light Milk (n=10)	Fruity Milk (n=10)
C 4:0	0.134±0.18	0.194±0.26	0.307±0.25
C 6:0	0.160±0.41	0.036±0.03	0.575±0.59
C 8:0	0.152±0.16	0.183±0.17	0.539±0.45
C 10:0	0.825±0.44	1.050±0.67	1.516±0.93
C 11:0	0.106±0.12	0.070±0.06	0.149±0.11
C 12:0	1.641±0.44	1.958±0.66	2.198±0.77
C 13:0	0.156±0.07	0.174±0.07	0.120±0.03
C 14:0	8.131±1.13	8.834±0.66	9.419±1.17
C 15:0	1.057±0.11	1.102±0.12	1.138±0.09
C 16:0	31.205±2.04	32.200±1.44	30.849±2.17
C 17:0	0.744±0.10	0.707±0.10	0.682±0.12
C 18:0	14.788±1.56	14.329±1.11	13.791±1.59
C 19:0	0.040±0.06	0.026±0.03	0.015±0.01
C 20:0	0.089±0.06	0.067±0.04	0.035±0.02
C 21:0	0.043±0.03	0.043±0.02	0.058±0.04
C 22:0	0.109±0.03	0.104±0.03	0.107±0.02
C 24:0	0.007±0.01	0.016±0.02	0.007±0.01
Σ SFA [a]	**59.387±2.32**	**61.093±2.15**	**61.505±2.38**
C 14:1 n5	1.099±0.22	1.220±0.11	1.350±0.19
C 15:1 n5	0.384±0.06	0.394±0.08	0.361±0.05
C 16:1 n7	2.226±0.22	2.204±0.31	2.257±0.19
C 17:1 n8	0.438±0.05	0.436±0.05	0.439±0.05
C 18:1 n9	29.179±1.91	28.043±1.57	27.399±2.49
C 20:1 n9	0.019±0.01	0.022±0.02	0.022±0.01
Σ MUFA [a]	**33.345±1.83**	**32.319±1.79**	**31.828±2.41**
C 18:2 n6	2.656±0.38	2.578±0.30	2.427±0.20
C 18:3 n6	0.031±0.03	0.033±0.01	0.065±0.03
C 18:3 n3	0.280±0.06	0.210±0.06	0.413±0.10
C 20:2 n6	0.014±0.01	0.026±0.02	0.029±0.02
C 20:4 n6	0.173±0.04	0.207±0.06	0.175±0.03
C 20:5 n3	0.018±0.03	0.044±0.05	0.068±0.06
C 22:6 n3	0.015±0.02	0.044±0.06	0.022±0.03
Σ PUFA [a]	**3.187±0.41**	**3.142±0.38**	**3.199±0.26**
C 14:1 *t*9	0.252±0.05	0.255±0.06	0.269±0.04
C 16:1 *t*9	0.550±0.12	0.455±0.10	0.464±0.12
C 18:1 *t*11	2.013±0.52	1.585±0.56	1.699±0.53
C 18:2 *t*9, *t*12	0.147±0.20	0.124±0.14	0.063±0.02
C 18:2 *t*9, *c*12	0.100±0.10	0.070±0.04	0.025±0.01
Σ TFA [a]	**3.062±0.68**	**2.489±0.71**	**2.520±0.60**
CLA *c*9*t*11	0.937±0.21	0.859±0.18	0.891±0.12
CLA *t*10*c*12	0.083±0.03	0.106±0.06	0.070±0.02
Σ CLA [a]	**1.020±0.22**	**0.965±0.18**	**0.961±0.13**

[a] ***SFA:*** *Saturated fatty acid,* ***MUFA:*** *Monounsaturated fatty acid,* ***PUFA:*** *Polyunsaturated fatty acid,* ***TFA:*** *Trans fatty acid,* ***CLA:*** *Conjugated linoleic acid*

Seckin et al.[17] determined that oleic acid was predominant MUFA and ranged from 23.12 to 32.78 g/ 100 g total fatty acid in some dairy products in Turkey. We have also found that oleic acid was the highest MUFA in all samples. Prandini et al.[14] found that MUFA content were 21.61% and 20.63% in fermented milk and fermented milk mountain pasture. Similarly, they determined that oleic acid was predominant MUFA in the fermented milk and fermented milk mountain pasture.

PUFA was reported to range from 0.34 to 2.58 g/ 100 g total fatty acid in some Turkish dairy products [17]. Prandini et al.[14] found that PUFA was 2.23 g/ 100 g of total fatty acids in fermented milk. The value of PUFA (3.142-3.199%) in our experiment is considerably higher than those reported by Prandini et al.[14] and Seckin et al.[17].

Trans vaccenic acid which is the predominant *trans* isomer in milk fat [22] is formed as an intermediate during the biohydrogenation of dietary linoleic acid to stearic acid [23,24]. Other TFA isomers such as 14:1 *t*9, 16:1 *t*9, 18:1 positional isomers, 18:2 *t* and 18:3 *t* have lower amounts in dairy products [25]. Similarly, in our study, the *trans* vaccenic acid was found to be the most abundant *trans* fatty acid in all samples. Mendis et al.[26] analyzed the fatty acid profile of popular brands of Canadian dairy products including milk (n=8). In their study, the average total trans fatty acids of milk was 5.8% of total fatty acids and vaccenic acid was the major trans-octadecenoic acid isomer accounting for 31.0% of total trans-18:1. In our study, total *trans* fatty acid contents of milk (2.489-3.062% in total fatty acid) was relatively lower than Canadian milk. Total *trans* fatty acids in whole milk (3.062%) were found to be higher than light milk and fruity milk because of high percentages of *trans* vaccenic acid. Σ CLA and trans vaccenic acid were higher in whole milk than other samples. CLA content of processed compounded products will reflect the type and amount of the component fats [27].

Fritsche and Steinhart [28] found that CLA (C 18:2 *c*9*t*11) in German foods was 1.16, 0.98, 0.80 and 0.63% in raw milk, pasteurized milk, UHT milk and condensed milk, respectively. Chin et al.[12] reported total CLA to be 0.55 g/100 g fat in homogenized milk and 0.7 g/100 g fat in condensed milk. In our study, the milk samples which were categorized into various groups have varying contents of CLA. The differences in CLA content may also be explained by differences in origin and initial CLA content of raw milks, and production technologies [17]. Prandini et al.[14] stated that animal diet, specific characteristics of milk used in manufacturing, with special reference to the species and CLA content of the milk, processing and production methods play and important role in setting the CLA levels in dairy products.

Rodriguez-Alcala and Fontecha [15] analyzed the total fatty acid content and CLA isomer composition of 6 commercially available CLA-fortified dairy products during processing and refrigerated storage in Spain. They stated that the CLA isomers C18:2 *cis*-9, *trans*-11 and C18:2 *trans*-10, *cis*-12 were the predominant fatty acids at a ratio ranging from 0.97 to 1.05. Rumenic acid was the major CLA isomer of dairy products in Canada [26]. Park et al.[29] stated that based on the distribution ratios

of CLA isomers, the c-9, t-11 isomer appeared to be the major CLA isomer in low-fat milk (89.87%). In our study, the *cis*-9, *trans*-11 isomer was the predominant CLA isomer present in milk samples (0.859-0.937%), with lesser amounts (0.07-0.106%) of *trans*-10, *cis*-12 CLA.

In conclusion, conjugated linoleic acid, *trans* fatty acid and fatty acid composition of some commercial milk in Turkey were determined. Whole milk had highest CLA and *trans* vaccenic acid which is the most common *trans* fatty acid in milk fat from ruminants. More research is needed about CLA content and *trans* fatty acids in Turkish dairy products with regard to food processing and manufacturing because of its health effect.

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