Journal of Animal Science and Products (JASP)
International peer-reviewed journal
7 (2): 145-152, 2024

Comparison of Chemical, Nutritional and Fatty Acid Composition of Organic and Conventional Milk Manufactured in Türkiye

Selma BÜYÜKKILIÇ BEYZİ*

Erciyes University, Faculty of Agriculture, Department of Animal Science, 38039 Kayseri, Türkiye

Selma BÜYÜKKILIÇ BEYZİ, ORCID No: 0000-0002-4622-0645

ARTICLE INFO

Research Article

Some data in the study presented at the congress of "5th International Eurasian Congress on Natural Nutrition, Healthy Life & Sport, 02-06 October 2019, Ankara-Turkey".

Received : 24.10.2024
Accepted : 23.12.2024

Keywords

Organic and conventional milk
Cholesterol
PUFA
CLA
SFA

*** Sorumlu Yazar**

sbuyukkilic@erciyes.edu.tr

ABSTRACT

Due to its polyunsaturated fatty acids (PUFA) and conjugated linoleic acid (CLA), milk plays a significant role in human nutrition. The purpose of this study was to ascertain the fatty acid composition of milk samples that were both conventional and organic. The commercial milk products were bought from several shops in the Türkiye city of Kayseri. From various retail establishments in the city, three different brands and three different lots within a brand were acquired. The t-test was used to assess the data. C14:0, C16:0, C18:0, and C18:1 fatty acids were the main ones found in milk. Organic milk showed a higher PUFA, but also lower levels of monounsaturated fatty acids (MUFA) and higher levels of saturated fatty acids (SFA). There was no difference between conventional and organic milk CLA concentration. Excess cholesterol in the diet has been increasingly acknowledged to cause atherosclerosis in recent years. As a result, dairy products with low cholesterol are more popular and advised. This study measured the fat and cholesterol content of conventional and organic milks. The percentage of milk fat in the conventional and organic samples was 3.34% and 2.73%, respectively. Organic and conventional milk had cholesterol ratios of 207.1 and 452.0 mg/100 g, respectively. The conventional and organic milk samples had 4% fat-corrected cholesterol concentrations of 303.5 and 541.28 mg/100g, respectively. Consequently, organic milk had a decreased cholesterol level ($P < 0.01$).

Türkiye'de Üretilen Organik ve Konvansiyonel Sütün Kimyasal, Besinsel ve Yağ Asidi kompozisyonunun Karşılaştırılması

MAKALE BİLGİSİ

Araştırma Makalesi

Bu çalışmadaki bazı veriler "5th International Eurasian Congress on Natural Nutrition, Healthy Life & Sport, 02-06 October 2019, Ankara-Turkey"kongresinde sunulmuştur.

Geliş: 24.10.2024
Kabul: 23.12.2024

ÖZ

Süt, içeriğindeki konjuge linoleik asit (CLA) ve çoklu doymamış yağ asitleri (PUFA) nedeniyle insan beslenmesinde önemli bir rol oynar. Bu çalışmanın amacı hem geleneksel hem de organik olarak üretilen süt örneklerinin yağ asidi kompozisyonunu belirlemektir. Süt ürünleri, Türkiye'nin Kayseri şehrindeki çeşitli dükkanlardan satın alındı. Şehirdeki çeşitli perakende işletmelerinden, üç farklı marka ve bir marka içinde üç farklı partiden elde edildi. Verileri değerlendirmek için t-testi kullanıldı. Sütte bulunan başlıca yağ asitleri C16:0, C18:0, C14:0, ve C18:1'di. Geleneksel sütle karşılaştırıldığında, organik süt daha yüksek oranda çoklu doymamış yağ asidi (PUFA) gösterdi, ancak aynı

Lütfen aşağıdaki şekilde atıf yapınız / Please cite this paper as following;
Büyükkılıç Beyzi, S., 2024. Comparison of chemical, nutritional and fatty acid composition of organic and conventional milk manufactured in Türkiye, Journal of Animal Science and Products (JASP) 7 (2):145-152. DOI: 10.51970/jasp.1567907

Anahtar Kelimeler

Organik ve konvansiyonel süt
Kolesterol
PUFA
CLA
SFA

*** Corresponding Author**

sbuyukkilic@erciyes.edu.tr

zamanda daha yüksek seviyelerde doymuş yağ asidi (SFA) ve daha düşük seviyelerde tekli doymamış yağ asidi (MUFA) gösterdi. CLA ile geleneksel ve organik süt arasında bir fark görülmedi. Diyetteki aşırı kolesterolün son yıllarda giderek daha fazla ateroskleroza neden olduğu kabul edilmektedir. Sonuç olarak, düşük kolesterollü süt ürünleri daha popüler ve tavsiye edilmektedir. Bu çalışmada, geleneksel ve organik sütlerin yağ ve kolesterol içeriği ölçülmüştür. Geleneksel ve organik örneklerdeki süt yağı yüzdesi sırasıyla %3,34 ve %2,73'tür. Organik ve geleneksel sütün kolesterol oranları sırasıyla 207,1 ve 452,0 mg/100 g'dır. Organik ve geleneksel süt örneklerinin %4 yağ düzeltilmiş kolesterol seviyeleri sırasıyla 303,5 ve 541,28 mg/100 g'dır. Organik sütün kolesterol seviyesi daha düşük tespit edilmiştir (P <0,01).

Introduction

Cow's milk comprises several fatty acids, including those potentially advantageous to human health, such as polyunsaturated fatty acids (PUFA) omega-3, and conjugated linoleic acid (CLA) (Jensen, 2002). Augmenting dietary intake of PUFA is believed to be advantageous in mitigating cardiovascular disease (Hu and Willett, 2002). Moreover, in vitro research indicates that dietary CLA offers protection against cancer (Ip et al. 1991) and is linked to antiatherogenic and antiobesity properties (Whigham et al. 2000). The milk fatty acid profile can be affected by numerous circumstances. The primary factors are species, season, ration composition, grazing, roughage proportion, and fat sources utilized in the ration (Ellis et al., 2006). Research indicates that including alfalfa as roughage in the diet enhances the milk fatty acid profile (Dewhurst et al., 2003). It is shown that farms producing organic milk predominantly utilize roughage for feeding. Cholesterol is a lipid synthesized by the liver and ingested via animal-derived food, including meat, eggs, fish, and dairy. Cholesterol in the body facilitates nerve insulation and the formation of cell membranes. However, it is generated in sufficient amounts by the body, thus extra supplementation is unnecessary. Nonetheless, cholesterol is crucial for cardiovascular health. Cholesterol is classified as both beneficial and detrimental. While low-density lipoprotein (LDL) is regarded as detrimental cholesterol, high-density lipoprotein (HDL) is seen as good cholesterol. Human cardiovascular illnesses, such as coronary heart disease and stroke, are significantly increased by elevated serum cholesterol levels (Tabas, 2002). Excess cholesterol in the bloodstream can lead to the formation of plaque, a dense and rigid deposit, on artery walls. A buildup of cholesterol or atherosclerosis causes the arteries to thicken, harden, and lose their flexibility, which hinders and occasionally blocks the heart's blood flow. Chest pain may be the result of blocked blood flow. When the heart's blood supply is severely restricted, a clot totally stops circulation, a heart attack happens (Ma, 2004). Consequently, it is imperative to diminish dietary cholesterol intake. The quantity of research determining the chemical and fatty acid composition, and cholesterol levels in milk samples from organic and conventional sources in our nation is significantly restricted. This study aims to ascertain the chemical composition, fatty acid profile, and cholesterol levels in milk samples sourced from both organic and conventional packaged products available for purchase.

Materials and Methods

Preparation of milk samples

The research included 18 milk samples from various commercial milk products acquired from diverse retailers in Kayseri, Türkiye. Three separate brands and three unique lots from each brand were obtained from various retail outlets within the city.

Chemical analysis

The dry matter content was determined using oven drying in a laboratory oven at 105 °C for 24 hours (AOAC, 1984). The total protein was calculated using a total nitrogen factor of 6.38. The extraction of milk fat was conducted utilizing the Gerber method (James, 1995). The crude ash was determined by subjecting the samples to dry ashing in a muffle furnace at 550 °C for 24 hours (AOAC, 1984). All samples completed triple testing, and the procedure was repeated as required.

Cholesterol analysis

The cholesterol levels were determined by Fletouris et al. (1998) procedure. In a flask, 20 mg of the reference standard was dissolved in hexane to prepare the stock solution (2 mg/ml) and working solutions ranging from 10 to 100 mg/ml were prepared by appropriately diluting aliquots of the stock solution with hexane. A fused silica capillary column (60 m, 0.25 mm) were used. The oven temperature was set to 285 °C, the flame ionization detector to 300 °C and the injection port to 300 °C. The airflow rate was 300 ml/min, hydrogen was 30 ml/min, and helium was 2 ml/min. One milliliter was administered, and the split ratio was 20:1.

Five milliliters of methanolic KOH solution were introduced to a 0.2-g milk sample, which had been weighed and positioned in a sample preparation tube. Upon properly sealing the tube, the contents were vortexed for fifteen seconds. The tube was immersed in a water bath (80 °C) for 15 minutes, with every 5 minutes removed to vortex for 10 seconds. Arranging several tubes within a wire basket would facilitate their handling. Subsequent to heating, the tube was permitted to cool using tap water, after which 1 ml of water and 5 ml of hexane were introduced. The contents were subsequently agitated vigorously for 1 minute, centrifuged at 2000 × g for 1 minute, and then extracted. In preparation for GC analysis, the upper phase was transferred into vial and then the GC's autosampler (Fletouris et al., 1998).

One milliliter of each standard solution was injected, and the measured peak area was graphed against the mass of the injected analyte to construct a calibration curve. The slope, intercept, and least squares fit of the standard curve were computed. The analyte mass in the injected 1 ml of unknown sample extracts was determined using the slope and intercept from the calibration curve data. The milk samples cholesterol concentration (milligrams per 100 g)in the analyzed samples was calculated as equation $C = M \times V \times 2.5$. M represents the analyte in the injected extract (1 ml) computed mass (nanograms), whereas V; the relevant dilution factor (Fletouris et al., 1998).

Fatty acid analysis

Folch et al. (1957) were employed to extract lipids from 5 g of milk samples using 100 ml of a chloroform-methanol solvent (2:1, v/v). One milliliter aliquots of the extracts were dried in triplicate in a water bath at 50–60 degrees.

Fatty acid methyl esters were created from the materials using a one-step extraction-transesterification process (Sukhija and Palmquist, 1988). The analyses were performed in gas chromatography (GC) (Schimadzu, GC 2010 plus, Kyoto, Japan) fitted with a fluorescence ionization detector, a capillary column (60 m x 0.25 mm ID x 0.250 µm; cat. # 13199), and hydrogen as carrier gas. The FAMEs were isolated using a temperature gradient methodology (injection: 2.0 µL split (split ratio 200:1), injection temperature: 225 °C, 4 mm inlet liners (cat # 20814), carrier gas: hydrogen, oven temperature: 100 °C (4 min) to 240 °C (10 min) at 3 °C/min), flow rate: 1.2 mL/min. Authentic standards (Supelco #37, Supelco Inc., Bellefonte, PA, USA; L8404 and O5632, Sigma) were compared to the retention times. The retention times compared with the CLA standard (cat # 16413 Sigma-Aldrich) retention times and the amount of milk fat CLA was determined (Folch et al., 1957)

Color measurement

The milk's colors were assessed in a cold, dark environment using a chroma meter (Konica Minolta, Tokyo, Japan). The brightness (L*) and yellowness (b*) characteristics were assessed utilizing the methodology of Kim et al. (2013). The calibration properties of the white reference plate were established by measuring its brightness (97.46), redness (0.08), and yellowness (1.81).

Statistical analysis

The SPSS software (IBM Statistics SPSS) was used to statistically evaluate all of the data. The results of the t-test analysis were displayed as the mean and standard error of means.

Results and Discussion

Table 1 displays the chemical content of organic and conventional milk. Conventional milk samples exhibited elevated levels of dry matter, fat, and lactose ($P<0.05$), whereas organic milk samples demonstrated superior protein content and density ($P<0.05$). During the investigation, milk sourced from organic production methods was chosen for both production techniques; nevertheless, the chemical content of the collected milk samples exhibited substantial variations. The chemical composition of milk is known to vary based on animal breed, lactation stage, nutrition, and care settings (Walker et al., 2004).

Tablo 1. Türkiye'de organik ve ticari olarak üretilen süt örneklerinin kimyasal bileşimi (g/100g)
Table 1. Chemical composition (g/100g) of milk samples in organic and commercially produced in Türkiye

Items	Organic		Conventional		*P*
	Mean	SEM	Mean	SEM[1]	
Dry matter	7.61	0.082	7.07	0.029	0.004
Fat	2.74	0.027	3.34	0.015	0.000
Protein	2.87	0.029	2.68	0.033	0.006
Lactose	4.18	0.033	3.87	0.029	0.000
Density	25.58	0.217	22.85	0.330	0.001

[1]Standart error of means

The fatty acid analysis of milk samples identified a total of 16 fatty acids. No significant difference was seen in the concentrations of C14:0, C12:0, C17:1, C16:1, C18:1n9t, C18:2n6c, and CLA fatty acids in milk from organic versus conventional production (P>0.05). The concentrations of short-chain fatty acids (C4) and medium-chain fatty acids (C6, C8, and C10) were significantly elevated in organically produced milk (P<0.05). The concentration of SFA (C16:0 and C18:0) was significantly elevated in organically produced milk (P<0.05). The oleic acid concentration was significantly greater in conventional milk (P<0.05). the PUFA (C18:2n6t, C18:2n6c) were found to be elevated in organic milk (P<0.05). Significant distinctions exist between conventional and organically produced milk, particularly regarding seasonal and nutritional factors, which may influence the fatty acid profile of the milk. Nonetheless, 50% of the fat in cow's milk fat is derived from plasma lipids, with 88% of this sourced from the diet (Grummer, 1991). Consequently, altering the diet may significantly impact the fatty acid composition. While dietary components are unspecified in this study, it is established that organic agricultural firms rely on pasture or grazing or utilize feed with a high roughage content. Research indicates that pasture-based feeding or the incorporation of alfalfa enhances the levels of CLA and PUFA in milk (Dewhurst et al., 2003). A study indicated no disparity in the levels of CLA between conventional and organic milk (Ellis et al., 2006).

Tablo 2. Türkiye'de organik ve ticari olarak üretilen süt örneklerinin yağ asidi bileşimi (g/100g)
Table 2. Fatty acid composition (g/100g) of milk samples in organic and commercially produced in Türkiye

Fatty acids[1]	Organic		Commercial		*P*
	Mean	SEM	Mean	SEM	
(C4:0) Butyric Acid	2.17	0.06	1.03	0.01	0.002
(C6:0) Caproic Acid	3.73	0.29	1.10	0.03	0.011
(C8:0) Caprylic Acid	2.94	0.19	0.96	0.03	0.008
(C10:0) Capric Acid	3.13	0.18	0.99	0.02	0.007
(C12:0) Lauric Acid	1.71	0.17	0.94	0.22	0.053
(C14:0) Myristic Acid	6.92	0.08	6.70	0.01	0.096
(C14:1) Myristoleic Acid	0.80	0.03	0.94	0.01	0.019
(C16:0) Palmitic Acid	25.35	0.30	35.79	0.01	0.001
(C16:1) Palmitoleic Acid	1.22	0.20	1.25	0.03	0.908
(C17:1) Heptadecenoic Acid	0.53	0.08	0.45	0.18	0.720
(C18:0) Stearic Acid	20.34	0.33	16.72	0.04	0.007
(C18:1n9c) Oleic Acid	25.02	0.19	28.21	0.20	0.000
(C18:1n9t) Elaidic Acid	3.92	0.05	3.24	0.26	0.118
(C18:2n6t) Linoleaidic Acid	0.62	0.01	0.16	0.03	0.003
(C18:2n6c) Linoleic Acid	0.55	0.01	0.50	0.02	0.084
(cis-9, trans-11) CLA	1.05	0.06	1.04	0.05	0.877
SFA	66.29	1.60	64.22	0.39	0.002
MUFA	32.54	0.61	35.12	0.73	0.011
PUFA	1.17	0.02	0.66	0.05	0.001

[1]CLA conjugated linoleic acid; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids; SFA: saturated fatty acids; SEM: standard error of means

This study assessed the cholesterol levels in conventional and organically produced cow's milk. The cholesterol level is dependent upon the fat content of the milk; thus, the fat content was assessed, and adjustments were made based on the fat % to ascertain cholesterol levels in both conventional and organic milk at equivalent fat content. The fat percentage in organic milk was measured at 2.74%, whereas conventional milk exhibited a fat content of 3.34%. The cholesterol levels in organic and conventional milk, based on fat content, were measured at 207.1 mg/100g and 452.0 mg/100g, respectively, with organic milk exhibiting a considerably lower cholesterol level ($P<0.01$). To eliminate the influence of fat content on this difference, both milk samples were adjusted to a fat content of 4%. The analysis revealed cholesterol levels of 303.5 mg/100g in organic milk and 541.3 mg/100g in conventional milk, indicating that the cholesterol level in organically produced milk samples was significantly lower ($P<0.05$). Recent studies have been undertaken to lower cholesterol levels (Jiang et al., 1996; Regester et al., 1997). The primary factor is the origin and quantity of fat incorporated into the diet. In ruminants, elevated fat levels are not advisable due to their detrimental impact on rumen microbial activity, which results in reduced milk production (Song et al., 1998). This study evaluated cholesterol levels in organic and conventionally produced milk, revealing that organic milk contained lower cholesterol levels. This scenario is believed to result from the feed utilized in organic agriculture.

Tablo 3. Türkiye'de organik ve ticari olarak üretilen süt örneklerinin renk ve kolesterol konsantrasyonu

Table 3. Color and cholesterol concentration of milk samples in organic and commercially produced in Türkiye

Color[1]	Organic		Commercial		*P*
	Mean	SEM	Mean	SEM	
L	88.21	0.504	88.06	0.254	0.009
a	-2.79	0.009	-2.91	0.097	0.112
b	5.72	0.140	6.19	0.496	0.140
Fat, %	2.74		3.34		
Cholesterol, mg/100g	207.1	2.60	452.0	5.50	0.001
C Cholesterol, mg/100g	303.5	2.84	541.3	3.41	0.003

[1]C cholesterol: correction for 4% milk fat

Conclusions

The quantity of studies analyzing fatty acid content and cholesterol levels in milk samples from organic and conventional production in our country is notably restricted. Thus, the findings will benefit individuals engaged in this domain. Consequently, it was established that organic milk possesses reduced fat and cholesterol levels compared to conventional milk, a finding that remains consistent when adjusted for equivalent fat content. Organic milk possesses elevated levels of PUFA compared to regular milk, along with increased SFA and reduced MUFA. There was not a significant variation in the CLA content of conventional and organic milk.

Ethical Statement

In this study, milk samples were obtained from the market; no live animals were used. Therefore, the use of experimental animals does not require an ethics committee approval document.

References

AOAC, Association of Analytical Chemists (1984). Standard Official Methods of Analysis of the Association of Analytical Chemists. 14th edition, S.W Williams (Ed), Washington, DC., p. 121.

Dewhurst, R. J., Fisher, W. J., Tweed, J. K. S., Wilkins, R. J. 2003. Comparison of grass and legume silages for milk production. 1.Production responses with different levels of concentrate. Journal of Dairy Science. 86: 2598–2611.

Ellis, K. A., Innocent, G., Grove-White, D., Cripps, P., McLean, W. G., Howard, C. V., Mihm, M. 2006. Comparing the fatty acid composition of organic and conventional milk. Journal of Dairy Science. 89(6): 1938-1950.

Fletouris, D. J., Botsoglou, N. A., Psomas, I. E., Mantis, A. I. 1998. Rapid determination of cholesterol in milk and milk products by direct saponification and capillary gas chromatography. Journal of Dairy Science. 81(11): 2833-2840.

Folch, J., Lees, M., Sloane-Stanley, G. 1957. A Simple Method for the Isolation and Purification of Total Lipids from Animal Tissues. Journal of Biological Chemistry. 226: 497-509.

Grummer, R. R., & Carroll, D. J. (1991). Effects of dietary fat on metabolic disorders and reproductive performance of dairy cattle. Journal of Animal Science, 69(9), 3838-3852.

Hu, F. B., Willett, W. C. 2002. Optimal diets for prevention of coronary heart disease. J. Am. Med. Assoc. 288: 2569–2578.

Ip, C., Chin, S. F., Scimeca, J. A., Pariza, M. W. 1991. Mammary cancer prevention by conjugated dienoic derivative of linoleic acid. Cancer Research. 51: 6118–6124.

James, C. S., 1995. Determination of the fat content of dairy products by the Gerber Method. Analytical Chemistry of Food. Blackie Academic and Professionals, an imprint of Chapman and Hall, Glasgow, UK, pp: 93–95.

Jensen, R. G. 2002. The composition of bovine milk lipids. Journal of Dairy Science. 85: 295–350.

Jiang, J., Bjoerck, L., Fondén, R., Emanuelson, M. 1996. Occurrence of conjugated cis-9, trans-11-octadecadienoic acid in bovine milk: effects of feed and dietary regimen. Journal of Dairy Science. 79(3): 438-445.

Kim, Y., Son, H. H., Yi, K., Kim, H. Y., Ahn, J., & Chang, J. (2013). The color change in artificial white spot lesions measured using a spectroradiometer. Clinical oral investigations, 17, 139-146.

Ma, T. 2004. Cholesterol and Human Health. Nature and Science. 2(4).

Regester, G.O., Smithers, G.W., Mitchell, I.R., McIntosh, G.H., Dionysius, D.A., 1997. Bioactive factors in milk: natural and induced. In: Welch, R.A.S. (Ed.), Milk

Composition, Production and Biotechnology. C.A.B. International, USA, pp.119–132.

Song, M. K., Huang, Z. Z., Choi, S. H. 1998. Effect of source and level of oil on the hydrogenation of C18 unsaturated fatty acids and incorporation of oleic acid by rumen bacteria. Proc. 8th WCAP, 1, 556-557.

Sukhija, P. S., Palmquist, D. L. 1988. Rapid method for determination of total fatty acid content and composition of feedstuffs and feces. Journal of Agricultural and Food Chemistry. 36(6): 1202-1206.

Tabas, I. 2002. Cholesterol in health and disease. Journal of Clinical Investment. 110: 583-90.

Whigham, L. D., Cook, M. E., Atkinson, R. L. 2000. Conjugated linoleic acid: Implications for human health. Pharmaceutical Research. 42: 503–510.

Walker, G. P., Dunshea, F. R., Doyle, P. T. 2004. Effects of nutrition and management on the production and composition of milk fat and protein: a review. Australian Journal of Agricultural Research. 55(10): 1009-1028.