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Investigation of fatty acids of milk from different cow breeds

Untersuchungen von Fettsäuren der Milch verschiedener Rinderrassen

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Summary

The aim of this study was to determine the effects of cow breed on the changing fatty acid composition of cow milk. A total of 105 cow milk samples were collected in November 2008. Gas Chromatography (GC) was used to determine the fatty acid composition of milk for Holstein, Simmental and Brown Swiss cow breeds. The milk fat saturated fatty acids (SFAs) concentration from the milk of Brown Swiss cows (70.19 %) was higher than that from Simmental (66.28 %) and Holstein (67.37 %) cows. The amount of mono unsaturated fatty acids (MUFAs) ranged from 28.53 (Brown Swiss) to 29.61 (Holstein) %. The biggest difference in poly unsaturated fatty acids (PUFAs) was between Simmental (2.74 %) and Brown Swiss (3.21 %). The concentration of conjugated linoleic acid (CLA) in Simmental (0.30 %) was higher in milk fat than the Holstein (0.28 %) and Brown Swiss (0.24 %). These data showed that there are the significant differences ($P<0.05$) in the fatty acid composition of milk from different cow breeds.

Keywords: Fatty acids, cow breed, milk

Zusammenfassung

Das Hauptziel dieser Studie war es, die Auswirkungen von Rinderrassen auf die Veränderung der Fettsäurezusammensetzung von Kuhmilch zu bestimmen. Insgesamt wurden 105 Milchproben im November 2008 gesammelt. Mittels Gaschromatographie (GC) wurde die Fettsäurezusammensetzung der Milch bestimmen. Es wurden Proben der Rassen Holstein, Fleckvieh und Brown Swiss untersucht. Die Konzentration der ungesättigten Fettsäuren aus der Milch von Brown Swiss (70.19 %) war höher als die von Fleckvieh (66.28 %) und Holstein (67.37 %). Die Menge an einfach ungesättigten Fettsäuren schwankte von 28.53 % (Brown Swiss) bis 29.61 % (Holstein). Der größte Unterschied von mehrfach ungesättigten Fettsäuren war zwischen Brown Swiss (3.21 %) und Fleckvieh (2.74 %) festzustellen. Die Konzentration der konjugierten Linolsäure im Milchfett war beim Fleckvieh höher (0,30 %), als die bei Holstein (0.28 %) und Brown Swiss (0.241 %). Diese Daten zeigten, dass es wesentliche Unterschiede ($P<0.05$) in der Fettsäurezusammensetzung von Milch aus verschiedenen Rinderrassen gibt.

Schlüsselwörter: Fettsäuren, Rinderrassen, Milch

Introduction

The components of milk differ greatly between mammal species in terms of fat, protein and mineral content (Franzke, 1998). Animal breed, lactation, age, health, climatic conditions, milking time/milking method, feed composition, care and psychology of the animals have varying effect on milk composition. Blood composition and substances ingested via feed have pronounced effects on milk composition (Demirci, 2008; Butler et al., 2008).

Milk fat has an important role in human health, as it includes fatty acids such as CLA and omega-3 that have significant positive effects on health. Various studies showed that CLA and other mono or poly long-chain unsaturated fatty acids have many positive effects on the immune, musculoskeletal and neural systems (Ehrlich, 2006). CLA is anticarcinogenic, reduces the risk of type-2 diabetics and strengthens the immune system; it is also known that the n 3 fatty acid content can counteract the negative physiological effects of SFAs (Wahle et al., 2004). It is known that to get nourished with SFAs-rich and PUFAs-poor foods is one of the important reasons of arteriosclerosis and cardiovascular diseases (Ravnskov, 1998) and is a risk factor for obesity and breaking insulin resistance (Givens, 2005).

A number of studies have previously reported variations in fatty acid composition in cow milk from different parts of the world, including: Comparison of fatty acid contents (White et al., 2001); the composition of bovine milk lipids (Jensen 2002); effect of diet on fatty acids (Oldemiro et al., 2004); comparison of fatty acid and cholesterol content (Talpur et al., 2006); milk composition of different breeds in response to increasing levels of dietary fat (Carroll et al., 2006); seasonal variations in fatty acid composition (Collomb et al., 2008); and the effects of feeding factors and breed (Ferlay et al., 2011). Although milk and milk dairy products are the major sources of fat in the human diet in Turkey, there are a limited number of studies on fatty acid composition. No previous studies have compared the three breeds used in the present study: Simmental, Holstein and Brown Swiss.

In Turkey which is one of the leading milk producers in the world, Afyonkarahisar Province is the 6th biggest milk producer of Turkey. The province is ideally suited to raising livestock, due to its natural and climatic conditions, and it has an important economic role in dairy farming, with intensive feeding rather than meadow breeding. Brown Swiss, Holstein and Simmental are the preferred cow breeds in the region (DPT, 1996). This study investigates the differences in functional fatty acids between cow breeds by determining the fatty acid contents of milk samples from three different cow breeds raised on farms implementing the same milking program and the same rations in Afyonkarahisar Province.

Materials and methods

Animals and sampling

Milk samples from Simmental (45 samples), Holstein (45 samples) and Brown Swiss (15 samples) hybrid cow breeds were collected from five different farms (1. farm samples: 22 Holstein; 2. farm samples: 6 Simmental, 10 Brown Swiss; 3. farm: 7 Holstein; 4. farm: 39 Simmental; 5. farm: 16 Holstein, 5 Brown Swiss) in Afyonkarahisar Province, Turkey, in November 2008. The farms used the same rations (dried weed, corn silage, milk feed) and the same milking period (November), and were selected as representing conventional production and feeding systems that are commonly used in Turkey.

Fatty acid composition

Raw milk samples were divided into three subsamples in 50-ml vials to facilitate triplicate analysis. The samples were stored immediately at –20 °C until analysis. To determine fatty acids, methylated with a 2 % solution of sodium methylate (NaOMe), according to Christopherson and Glass (1969).

Distribution of fatty acids in milk samples was determined by gas chromatography. Fatty acid methyl esters (FAMEs) were analyzed using an Agilent 7890A model GC, equipped with a flame ionization detector (FID) and fitted with an HP 88 Agilent capillary column (100 m 0.25 µm film thickness and 0.25 mm i. d.). Injector and detector temperatures were 250 °C and 260 °C respectively. The column temperature program was 80 °C for 3 min, then increasing at 20 °C/min up to 230 °C, where it was maintained for 5 min. Carrier gas was helium (2 ml/min) and split ratio was 30:1. Fatty acids were determined by comparing sample peaks according to the retention times of the peaks obtained from Supelco (37 mix) standards. GC analyses of each sample were carried out in triplicate.

Statistical Analysis

The results were statistically analyzed using SPSS Statistics 17.0 software. The results were given as the average of two repeated measurements ± standard deviation. One-way analysis of variance (ANOVA) was performed to determine if the differences among corresponding parameters of the samples were significant. Significant differences between the means were determined by Duncan's multiple comparison test. Differences were considered as significant at ($P<0.05$) level.

Results and discussion

The results of statistical data of MUFAs, PUFAs, SFAs groups and fatty acid compositions of milk fat samples taken from three different breeds are presented in Tables 1–3. SFAs contents (range: 66.28 Simmental – 70.19 % for Brown Swiss) were higher than both MUFAs and PUFAs in each of three breeds. For SFAs, MUFAs and PUFAs fatty acid groups, SFAs showed the greatest variation between breeds (Tab. 1), whereas the PUFAs fatty acid group showed the smallest variation. PUFAs was 3.21 % for Brown Swiss and 2.74 % for Simmental. Similarly, Pešek et al. (2005) reported similar differences between Holsteins and Czech cow breeds. In SFAs, palmitic acid (C16:0) varies between 32.61 % and 35.88 %, and is the most important SFAs in each of three breeds. Palmitic acid (C16:0) in the SFAs group (Brown Swiss: 33.82 %; Holstein: 32.61 %; Simmental: 35.88 %) and myristic acid (C14:0) (Brown Swiss: 12.07 %; Holstein: 11.78 %; Simmental: 10.94 %) have the highest value of fatty acids in each of three breeds. Similar results were reported by Pešek et al. (2005) and Jensen (2002). In a study conducted in Pakistan, Talpur et al. (2006) found that palmitic acid (C16:0) and stearic acid (C18:0) have the highest value. Stull and Brown (1964) reported higher content of palmitic acid in Holsteins

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TABLE 1: *SFAs content of milk fat samples and total SFAs (%).*

	Brown Swiss (n = 15)	Holstein (n = 45)	Simmental (n = 45)
C4:0 Butyric acid	3.82±0.32^a	3.27±0.21^c	3.36±0.35^b
C6:0 Caproic acid	1.60±0.15^b	1.67±0.10^a	1.35±0.22^c
C8:0 Caprylic acid	1,24±0.12^a	1.19±0.10^b	0,93±0.13^c
C10:0 Capric acid	2.81±0.29^a	2.61±0.28^b	2.19±0.31^c
C11:0 Undecanoic acid	0.39±0.05^a	0.33±0.05^b	0.35±0.08^c
C12:0 Lauric acid	3.45±0.26^a	3.09±0.34^b	3.08±0.49^b
C13:0 Tridecanoic acid	0.23±0.03^a	0.18±0.03^b	0.23±0.05^a
C14:0 Myristic acid	12.07±0.62^a	11.18±0.64^b	10.94±1.00^c
C15:0 Pentadecaoic acid	1.42±0.09^b	1.23±0.13^c	1.64±0.16^a
C16:0 Palmitic acid	33.82±2.32^b	32.61±1.93^c	35.88±2.22^a
C17:0 Heptadecanoic acid	0.72±0.06^b	0.69±0.15^a	0.47±0.03^c
C18:0 Stearic acid	8.12±0.47^b	8.87±0.83^a	5.33±0.79^c
C20:0 Arachidic acid	0.20±0.02^b	0.15±0.04^c	0.23±0.08^a
C21:0 Heneicosanoic acid	0.10±0.02^a	0.11±0.02^a	0.12±0.03^a
C22:0 Behenic acid	0.14±0.03^a	0.12±0.03^a	0.12±0.03^a
C23:0 Tricosanoic acid	0.06±0.003^a	0.07±0.001^a	0.06±0.009^a
∑ SFAs	70.19^a	67.37^b	66.28^c

* Different letters in the same row indicate statistically significant differences (P<0.05).

compared to Jersey and Guernsey breeds. Carroll et al. (2006) found the highest value of palmitic acid in milk from Holstein and Jersey cattle, and the lowest value in Brown Swiss, and confirmed that there can be differences in fatty acid composition between breeds.

In all milk samples taken from Holstein, Simmental and Brown Swiss breeds in the present study, MUFAs were 29.61 %, 29.35 % and 28.53 % respectively. Oleic acid (C18:1) was the most commonly found MUFAs in all breeds. The highest value of MUFAs (23.04 %) was oleic acid present in Holsteins. In milk samples, the second-most common MUFAs was palmitoleic acid (C16:1) (Tab. 2). Values of oleic acid in Thari and Sindhi breeds were reported as 24.06 % and 26.56 % respectively (Talpur et al., 2006). These results are higher than those for Brown Swiss (21.95 %), Holstein (23.04 %) and Simmental (21.91 %) breeds and the differences between oleic acid amounts of Brown Swiss, Holstein and Simmental breeds are statistically significant (P<0.05). The oleic acid content is low in

TABLE 2: *MUFAs content of milk fat samples and total MUFAs (%).*

	Brown Swiss (n = 15)	Holstein (n = 45)	Simmental (n = 45)
C14:1 Myristoleic acid	1.43±0.21^a	1.21±0.20^c	1.39±0.29^b
C15:1 *cis*-10-Pentadecenoic acid	0.50±0.11^b	0.46±0.04^c	0.67±0.21^a
C16:1 Palmitoleic acid	2.60±0.19^b	2.55±0.22^c	3.84±0.53^a
C17:1 *cis*-10-Heptadecenoic acid	0.36±0.05^b	0.31±0.05^c	0.58±0.20^a
C18:1 Elaidic acid	1.26±0.22^a	1.68±0.40^b	0.70±0.15^c
C18:1 Oleic acid	21.95±1.70^b	23.04±2.05^a	21.91±2.28^c
C20:1 *cis*-11-Eicosenoic acid	0.44±0.08^a	0.37±0.06^b	0.26±0.05^c
∑ MUFAs	28.53^c	29.61^a	29.35^b

*Different letters in the same row indicate statistically significant differences (P<0.05)

the two other breeds compared to Holsteins, which is due to low production of stearic acid (C18:0) (AbuGhazaleh et al., 2002). The effect of different breeds on oleic acid value was also reported by White et al. (2001) and Malacarne et al. (2001).

Examining PUFAs fatty acids determined in three different breeds, the highest value of Linoleic acid (1.64 %) is determined in milk from Holsteins, the highest value of γ-Linolenic acid (0.21 %) and Linolenic acid (0.49 %) is determined in Brown Swiss. The highest value of Arachidonic acid (C20:4) (0.18 %) is determined in Simmental and Holstein milk samples but the differences between Arachidonic acid amounts of cow breeds are not statistically significant (P<0.05). The highest CLA (0.30 %) is determined in Simmental milk samples. There are significant differences between three different cow breeds in terms of CLA values. The concentration of CLA is significantly higher in Simmental (0.303 %) than the two other breeds (Tab. 3). In other studies, (White et al., 2001) reported that Holsteins (0.41 %) produced a higher value of CLA than Jersey cattle (0.32 %), and Carroll et al. (2006) reported that milk from Brown Swiss contained higher value of CLA (0.34 %) compared to Holstein (0.33 %) and Simmental (0.29 %).

TABLE 3: *PUFAs content of milk fat samples and total PUFAs (%).*

	Brown Swiss (n = 15)	Holstein (n = 45)	Simmental (n = 45)
C18:2 Linolelaidic acid	0.11±0.01^a	0.13±0.02^a	0.12±0.03^a
C18:2 Linoleic acid	1,53±0.19^b	1,64±0.21^a	1,39±0.26^c
C18:2 c9, t11-Conjugated linoleic acid	0.24±0.004^c	0.28±0.048^b	0.30±0.062^a
C18:3 γ-Linolenic acid	0.21±0.02^a	0.18±0.02^b	0.17±0.03^b
C18:3 Linolenic acid	0.49±0.08^a	0.31±0.086^b	0.22±0.048^c
C20:2 *cis*-11,14-Eicosadienoic acid	0.06±0.001^c	0.12±0.004^a	0.10±0.02^b
C20:3 *cis*-11,14,17-Eicosatrienoic acid	0.16±0.05^a	0.08±0.02^b	0.08±0.02^b
C20:4 Arachidonic acid	0.16±0.05^a	0.18±0.03^a	0.18±0.03^a
C20:5 *cis*-5,8,11,14,17-Eicosapentaenoic acid	0.08±0.018^a	0.07±0.016^a	0.07±0.019^a
C22:2 *cis*-13,16-Docosadienoic acid	0.17±0.02^a	0.06±0.016^c	0.11±0.04^b
∑ PUFAs	3.21^a	3.04^b	2.74^c

*Different letters in the same row indicate statistically significant differences (P<0.05)

Conclusion

The study results confirm that there are differences in milk composition between different breeds of cattle given the same feed rations in terms of SFAs, MUFAs, PUFAs and CLA concentrations. It is thought that these differences in milk fatty acid concentrations between breeds are important for human health. Therefore, the breed of cattle should be taken into consideration while writing an individual diet prescription for a person with health problems, and when choosing the raw materials of milk powder for baby formula.

Conflict of interest

We certify that there is no actual or potential conflict of interest in relation to this article.

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