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Analysis of the fatty acid pattern of milk from current and rare cattle breeds

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Abstract. Six different dairy breeds kept under the same farm and fed under the same conditions were evaluated with respect to the fat content and the fatty acid composition of their milk drawn on the 3-5th months of lactation.

Key words and phrases: fatty acid, milk, dairy cow.

The fat content of the milk of the breeds did not differ significantly ($p = 0.076$) owing to the high variance of samples in the examined time period. The mean value of the sum of saturated fatty acids was the highest in the case of Jersey (77.8%) while this value ranged from 71.8% to 74.8% for the other breeds. An inversely proportional tendency can be seen for the ratio of monounsaturated fatty acids: in this case, the mean value for Jersey was the lowest (18.9%) and the values of the other breeds ranged from 21.9 to 24.9%. The saturated fatty acid/unsaturated fatty acid ratio was significantly ($p < 0.05$) higher in the milk fat of Jersey than that of Swedish red, Holstein-Friesian, Norwegian red, and Brown Swiss. The $n6/n3$ ratio of fatty acids in the milk fat of the breeds under investigation did not differ significantly.

1 Introduction

The fatty acid composition of the consumed edible oils and fats is a matter of importance from nutritional point of view. The enhanced intake of some saturated fatty acids has been shown to be associated with the elevated risk of some diseases while other fatty acids proved to have health saving properties (*Chilliard et al.*, 2001). The unfavourable ratio of $n6$ and $n3$ fatty acids in the diet has been shown to enhance the level of health risks. In order to obtain better ratios, the intake of $n3$ fatty acids should be increased at the expense of $n6$ (*Riediger et al.*, 2009). Associated with the studies on the medical effect of the fatty acid pattern of food, efforts have been made to reveal the possibilities in order to change the fatty acid composition of foods. In the case of milk fat forage, feeding has been shown to be one of the most important factors. The effect of season and housing can also be originated in the influence of feeding. A moderate genetic variance regarding the fatty acid profile of milk was also verified (*Soyeurt et al.*, 2006). The aim of the present investigation was to compare the fat content and the fatty acid profile of the milk of different dairy cow breeds kept under the same feeding and housing conditions.

2 Materials and methods

2.1 Milk sampling

There were three farms involved in the investigations. The first part of the milk samples originated from the "Kőrös-Maros Biofarm" Ltd. from Gyulavári, Hungary. There are about 500 Holstein-Friesian cows in this plant. Individuals of further breeds were imported (Swedish red, Jersey, Brown Swiss, Norwegian red, and Ayshire) and an experiment was conducted in order to compare their production. Experimental animals were loose-housed cows kept in small groups. The bedding of the cow-shed was deep litter and the house was provided with concreted open yard. The number of animals was 13-15 per part of the cow-shed. Feed and water were provided in the open yard. The level of the water was fixed in the drinking trough and the feed was prepared with mixer-feeder wagon. Milking was obtained twice a day with herringbone milking parlour.

Feed met the requirements of bioproduction. The daily intake was 9 kg corn silage, 4 kg alfalfa silage, 2 kg alfalfa hay, and 9 kg triticale haylage. The amount of the provided concentrate (6-9 kg) depended on the milk production. The individual dry matter consumption was 19.1 kg, the milk production net energy 125 MJ, and the metabolizable protein content 2017 g.

The milk samples originated from three milking sessions of the trial flock. Milk samples originated from cows with similar days of lactation were sorted out (Table 1) and analysed. Three individuals from each breed were milked and the lactations of the same animals were followed.

Table 1: The average lactation time of the milked cows

Breed	**Days of lactation, average** ($n = 3$)		
	1^{st} **milking**	2^{nd} **milking**	3^{rd} **milking**
Swedish red	99	118	157
Jersey	94	112	151
Holstein-Friesian	91	122	151
Brown Swiss	104	124	160
Norwegian red	89	110	149

The next part of the study was conducted at "Gödrei Mezőgazdasági Zrt." in Gödre, Hungary and the Holstein-Friesian and Brown Swiss dairy herds of the farm were involved. Cows were kept in groups according to their milk yield. The number of animals in one group was 50-60. The bedding of the cow-shed was deep litter. Feed and water were provided in the open yard of the house with mixer-feeder wagon and fixed water level drinking trough. Milking was obtained with herringbone milking parlour. The animals involved in the experiment were selected based on their number of lactation and milk yield. The feeding ration for animals in the first part of lactation was 23 kg corn silage, 7 kg sugar beet pulp, and 4 kg alfalfa hay supplemented with dairy concentrate. The dry matter content of the forage was 22.5 kg, the milk production net energy 142 MJ, and the metabolizable protein content was 2240 g.

The third part of the experiment was carried out at "Lukovics és Társa Ltd." in Magyarszék, Hungary. Individuals of Holstein-Friesian and Jersey milking herds were kept separately loose-housed in small groups. The feeding portion of the animals consisted of 20-23 kg corn silage, 3-5 kg haylage, and 3-4 kg hay that were completed with dairy concentrate depending on the milk production. The dry matter intake was 18 kg for Jersey and 21.5 kg for Holstein-Friesian. The net energy content of TMR was 135 MJ and it contained 2150 g metabolizable protein.

2.2 Chemical analysis

Chemical analysis was carried out at the Department of Chemistry-Biochemistry, Faculty of Animal Science, Kaposvár University. Crude fat content determination was carried out according to the MSZ ISO 8262-3 international standard. Fatty acid profile was determined in the form of fatty acid methyl esters. The homogenized sample was weighed into a flask, 8 cm^3 concentrated hydrochloric acid was added, and it was boiled for 60 minutes. After cooling down, 7 cm^3 ethanol and then 15 cm^3 diethylether was added, following a one-minute shaking. The next extraction was with 15 cm^3 petrolether (b.p.$<$ 60°C). After phase separation, the organic phase that contains about 150-200 mg fat was separated and evaporated under vacuum on a rotadest. Then 4 cm^3 of 0.5 M sodium-hydroxide in methanol was added, and boiled on a water bath for 5 minutes. Then 4 cm^3 of 14% boron-trifluoride in methanol was added and boiled for 3 minutes, following the addition of 4 cm^3 n-hexane. It was boiled for one minute, and then the level of the organic phase was brought to the neck of the flask with saturated sodium-chloride solution. When the phases were separated, samples were taken for the analysis from the organic phase, and it was dry on sodium sulfate.

The fatty acid methyl esters (FAMEs) were separated on a 100 m $\times$ 0.25 mm wall-coated open-tubular (WCOT) column equipped with CP-SIL 88 (FAME) stationary phase. The quantitation of FAMEs was obtained with a flame ionization detector (FID) at 270 °C. The temperature of the splitter injector was 270 °C; the carrier gas was helium with the head pressure of 235 kPa. The oven was temperature-programmed from 140 °C (10 min.) with 10 °C/min increase up to 235 °C (26 min). The injected volume varied between 0.5 and 2 μl. The instrument was a Chrompack CP 9000 gas chromatograph.

The results were calculated as area % (the peak area of the given fatty acid methyl ester was divided by the sum of the peak areas and multiplied by 100) and expressed in fatty acid methyl ester % (w/w).

In the case of the first farm, where six breeds were involved in the experiment, the influence of the breed on the fat content of milk and the fatty acid pattern was evaluated with one-way analysis of variance.

There were only two breeds to compare in the case of the second and third plants; therefore, the comparison of fat content and fatty acid profile of their milk was carried out with two sample T-tests.

3 Results

The milk of the six breeds kept on Biofarm did not differ in fat content at 95% level of significance ($p = 0.071$). Although the fat content (w/w%) of the milk of Jersey seemed to be the highest, the standard deviation was high (5.7 ± 1.3). The mean values of Swedish red, Norwegian red, Brown Swiss, and Ayrshire ranged between 3.8% and 4.1% (Table 2).

The ratio of saturated fatty acids (SFA) and that of monounsaturated fatty acids (MUFA) did not deviate by breeds at 95% level of probability ($p = 0.077$ and $p = 0.059$, respectively). The mean value of the SFA of Jersey was the highest (77.8%). The milk fat of the other breeds contained $71.8\% - 74.8\%$ SFA. An inverse tendency was observed for MUFA: the mean value for Jersey was the lowest (18.9%) while that of the other breeds were found between 21.9% and 24.9%.

The sum of the unsaturated fatty acids (MUFA+PUFA) also did not differ at 95% level of significance by breeds ($p = 0.076$), but the mean value of Jersey was the lowest among breeds (Table 2.)

The only acceptable significant difference appeared in the ratio of the saturated and unsaturated fatty acids SFA/(MUFA+PUFA). The milk fat of Jersey contained significantly ($p = 0.029$) more saturated fatty acids – related to unsaturated fatty acids – than Swedish red, Holstein-Friesian, Norwegian red, and Brown Swiss.

The milk fat of the breeds under investigation did not differ either in the amount or in the ratio of $n6$ and $n3$ fatty acids ($p > 0.154$).

Table 2: The characterization of fat content and fatty acid composition[1] of milk of different breeds (n=9)[2]

	Swedish red		Jersey		Holstein-Friesian		Brown Swiss		Norwegian red		Ayrshire	
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
Crude fat content	3.8	0.4	5.7	1.3	4.9	0.4	3.9	0.8	4.1	0.6	4.0	0.8
SFA	73.0	1.3	77.8	0.6	72.4	4.8	73.5	1.8	71.8	1.9	74.8	0.7
MUFA	23.6	1.1	18.9	0.5	24.4	4.6	22.9	1.5	24.9	1.9	21.9	0.6
PUFA	3.4	0.3	3.2	0.2	3.3	0.2	3.7	0.4	3.3	0.1	3.3	0.1
MUFA+PUFA	27.0	1.3	22.2	0.6	27.6	4.8	26.6	1.8	28.2	1.9	25.2	0.7
SFA/(MUFA+PUFA)	2.7^{a}	0.2	3.5^{b}	0.1	2.7^{a}	0.6	2.8^{a}	0.3	2.6^{a}	0.2	3.0^{ab}	0.1
n3	0.38	0.02	0.35	0.06	0.30	0.10	0.39	0.03	0.36	0.07	0.33	0.05
n6	2.7	0.2	2.6	0.1	2.6	0.1	2.9	0.3	2.5	0.1	2.6	0.1
n6:n3	7.1	0.7	7.6	1.2	9.5	3.9	7.5	0.3	7.2	1.6	7.8	0.9

[1] Expressed in fatty acid methyl ester %

[2] Averages in one row with common superscript do not differ ($p \geq 0.05$).

The absence of superscripts in one row means that there are not any significant differences between the means.

SFA = the sum of the ratio of saturated fatty acids.

MUFA = the sum of the ratio of monounsaturated fatty acids

PUFA= the sum of the ratio of polyunsaturated fatty acids

Table 3: The average fatty acid composition of milk of different breeds expressed in fatty acid methyl ester % (n=9)[1]
Part 1: C4-C17 fatty acids

Fatty acid		**Swedish red**		**Jersey**		**Holstein-Friesian**		**Brown Swiss**		**Norwegian red**		**Ayrshire**	
		mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
Butyric acid	4:0	0.50	0.11	0.52	0.12	0.70	0.06	0.70	0.16	0.61	0.04	0.69	0.13
Caproic acid	6:0	1.12	0.06	1.12	0.05	1.19	0.06	1.20	0.12	1.12	0.14	1.18	0.03
Caprylic acid	8:0	1.11	0.08	1.07	0.06	1.07	0.09	1.13	0.09	1.03	0.18	1.06	0.01
Capric acid	10:0	3.46	0.42	3.60	0.53	3.13	0.65	3.39	0.26	3.09	0.77	3.10	0.09
Undecanoic acid	11:0	0.43	0.07	0.39	0.08	0.43	0.21	0.38	0.08	0.38	0.04	0.36	0.07
Lauric acid	12:0	4.61	0.63	5.09	1.11	4.10	0.96	4.45	0.31	4.27	1.03	4.10	0.16
Tridecanoic acid	13:0	0.31	0.09	0.33	0.08	0.34	0.23	0.27	0.08	0.36	0.14	0.25	0.04
Myristic acid	14:0	14.24	0.51	13.59	0.61	12.39	1.15	14.08	0.83	13.14	1.18	14.12	0.49
Myristoleic acid	14:1	1.07	0.04	0.93	0.10	1.10	0.31	1.07	0.15	0.97	0.05	1.09	0.35
Pentadecanoic acid	15:0	1.73	0.62	1.67	0.49	1.67	0.59	1.56	0.45	1.60	0.22	1.49	0.10
Palmitic acid	16:0	35.29	0.92	38.98	0.36	36.74	4.27	33.58	1.95	35.53	0.46	38.18	2.07
Palmitoleic acid	16:1	1.35	0.09	1.37	0.38	1.75	0.60	1.13	0.14	1.60	0.32	1.38	0.30
Margaric acid	17:0	0.87	0.07	0.85	0.06	0.98	0.15	0.89	0.02	0.87	0.06	0.83	0.05

[1] For superscripts, see Table 2.

Table 3: The average fatty acid composition of milk of different breeds expressed in fatty acid methyl ester % (n=9)[1]
Part 2: C18 fatty acids

Fatty acid		Swedish red		Jersey		Holstein-Friesian		Brown Swiss		Norwegian red		Ayrshire	
		mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
Stearic acid	18:0	8.94	0.20	10.27	1.72	9.28	3.65	11.41	0.26	9.49	0.66	9.06	1.57
Elaidic acid	18:1n9t	1.01	0.03	0.98	0.34	1.13	0.15	1.00	0.41	0.82	0.14	0.87	0.30
Oleic acid	18:1n9c	19.29	1.04	14.89	0.77	19.36	5.33	18.82	1.42	20.55	1.67	17.77	0.94
7-octadecenoic acid	18:1n7	0.83[ab]	0.05	0.69[a]	0.06	0.98[b]	0.13	0.80[ab]	0.06	0.90[ab]	0.16	0.77[ab]	0.07
Linoleic acid	18:2n6	2.20	0.07	2.15	0.16	2.27	0.11	2.54	0.27	2.14	0.07	2.21	0.08
γ-linolenic acid	18:3n6	0.03	0.01	0.04	0.01	0.04	0.01	0.03	0.01	0.04	0.02	0.04	0.01
α-linolenic acid	18:3n3	0.30	0.02	0.27	0.05	0.23	0.10	0.32	0.02	0.29	0.06	0.26	0.04
c9, t11- conjugated linoleic acid	c9,t11-18:2	0.31	0.02	0.27	0.02	0.31	0.04	0.35	0.08	0.38	0.08	0.33	0.03

[1] For superscripts, see Table 2.

Table 3: The average fatty acid composition of milk of different breeds expressed in fatty acid methyl ester % (n=9)[1]
Part 3: C20 – C24 fatty acids

Fatty acid		Swedish red		Jersey		Holstein-Friesian		Brown Swiss		Norwegian red		Ayrshire	
		mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
Arachidic acid	20:0	0.15	0.02	0.17	0.05	0.15	0.06	0.20	0.02	0.15	0.01	0.16	0.03
Eicosenoic acid	20:1	0.05	0.00	0.05	0.02	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01
Heneicosanoic acid	21:0	0.03	0.01	0.04	0.01	0.04	0.03	0.05	0.01	0.05	0.01	0.04	0.02
Eicosadienoic acid	20:2	0.03	0.01	0.05	0.04	0.04	0.02	0.03	0.01	0.03	0.01	0.03	0.01
Behenic acid	22:0	0.11	0.01	0.08	0.02	0.09	0.02	0.11	0.02	0.10	0.01	0.10	0.03
Eicosatrienoic acid	20:3n6	0.16	0.07	0.14	0.02	0.10	0.02	0.12	0.02	0.10	0.01	0.11	0.00
Arachidonic acid	20:4n6	0.27	0.10	0.24	0.03	0.22	0.01	0.21	0.02	0.21	0.02	0.21	0.01
Lignoceric acid	24:0	0.13	0.10	0.07	0.03	0.05	0.02	0.07	0.02	0.06	0.01	0.08	0.03
Docosapentanoic acid	22:5n3	0.07	0.01	0.08	0.01	0.07	0.00	0.07	0.01	0.06	0.01	0.07	0.01

[1] For superscripts, see Table 2.

In the case of the individual fatty acids, there was only one detected significant difference: the milk fat of Holstein-Friesian contained more 7-octadecenoic acid (0.98%) than that of Jersey ($0.69\%; p = 0.049$). The palmitic acid surplus of Jersey related to Norwegian red was not significant at 95% level ($p = 0.081$). The highest average value for linoleic acid was obtained with Brown Swiss, but the difference by breeds was not significant ($p = 0.050$).

The milk originated from the six breeds kept in Biofarm was examined in order to decide whether the time after calving exerts an effect on the crude fat content and the fatty acid composition, because some changes may occur in these parameters from the third to the fifth months of lactation. According to the results of the statistical calculations, there were not any significant differences ($p > 0.161$) either in the ratio of fatty acid groups {SFA, MUFA, PUFA, MUFA+PUFA, SFA/(MUFA+PUFA), $n3$, $n6$, $n6/n3$ ratio} or in the fat content of milk (Table 4).

Table 4: The crude fat content (w/w%) and the fatty acid composition[1] of milk obtained in different months after calving, expressed in the average of six breeds (n=6)

	3rd months		**4th months**		**5th months**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Crude fat	4.0	0.5	4.6	1.2	4.6	0.9
SFA	72.8	3.8	74.6	2.7	74.2	1.9
MUFA	23.7	3.7	22.2	2.6	22.4	1.8
PUFA	3.4	0.3	3.2	0.1	3.4	0.2
MUFA+PUFA	27.2	3.8	25.4	2.7	25.8	1.8
SFA:(MUFA+PUFA)	2.7	0.5	3.0	0.4	2.9	0.3
n3	0.4	0.0	0.4	0.0	0.3	0.1
n6	2.7	0.3	2.5	0.1	2.7	0.2
n6 : n3	7.4	0.8	7.1	0.9	8.8	2.7

[1] Expressed in fatty acid methyl ester %

The ratio of the individual fatty acids was also evaluated in the function of time after calving. The ratio of some long-carbon-chain saturated fatty acids being present in small amount changed between the third and the fifth months of lactation (Table 5). The odd number carbon containing undecanoic acid and pentadecanoic acid reached a maximum in the fourth month.

Table 5: The fatty acid composition[1] in the average of the six breeds (n=6)[2]

Fatty acid		3rd months		4th months		5th months	
		Mean	SD	Mean	SD	Mean	SD
Butyric acid	4:0	0.66	0.16	0.60	0.07	0.60	0.16
Caproic acid	6:0	1.14	0.12	1.14	0.04	1.19	0.06
Caprylic acid	8:0	1.08	0.12	1.05	0.06	1.12	0.07
Capric acid	10:0	3.30	0.65	3.14	0.40	3.44	0.35
Undecanoic acid	11:0	0.36[a]	0.06	0.48[b]	0.10	0.34[a]	0.05
Lauric acid	12:0	4.53	1.11	4.24	0.56	4.54	0.55
Tridecanoic acid	13:0	0.32	0.12	0.38	0.12	0.24	0.03
Myristic acid	14:0	13.37	1.31	13.27	0.61	14.14	0.79
Myristoleic acid	14:1	0.95	0.08	1.18	0.25	1.00	0.12
Pentadecanoic acid	15:0	1.50[a]	0.15	2.06[b]	0.34	1.30[a]	0.06
Palmitic acid	16:0	35.20	2.77	38.09	2.63	35.87	1.70
Palmitoleic acid	16:1	1.37	0.29	1.65	0.49	1.28	0.12
Margaric acid	17:0	0.89	0.05	0.94[b]	0.11	0.82[a]	0.03
Stearic acid	18:0	10.11	1.28	8.91	2.34	10.20	1.41
Elaidic acid	18:1n9t	0.96	0.27	0.87	0.30	1.08	0.11
Oleic acid	18:1n9c	19.50	3.61	17.61	2.82	18.23	1.62
7-octadecenoic acid	18:1n7	0.91	0.13	0.83	0.14	0.75	0.06
Linoleic acid	18:2n6	2.35	0.25	2.14	0.10	2.28	0.13
Arachidic acid	20:0	0.15[a]	0.03	0.14[a]	0.03	0.19[b]	0.02
γ-linolenic acid	18:3n6	0.04	0.01	0.04	0.01	0.04	0.01
Eicosenoic acid	20:1	0.05	0.01	0.04	0.01	0.05	0.01
α-linolenic acid	18:3n3	0.30	0.04	0.29	0.05	0.26	0.07
c9,t11- conjugated linoleic acid	c9,t11-18:2	0.34	0.06	0.32	0.06	0.32	0.04
Heneicosanoic acid	21:0	0.03[a]	0.01	0.05[b]	0.01	0.05[b]	0.01
Eicosadienoic acid	20:2	0.03	0.01	0.02	0.01	0.05	0.03
Behenic acid	22:0	0.10	0.02	0.09	0.01	0.11	0.01
Eicosatrienoic acid	20:3n6	0.12	0.02	0.12	0.02	0.13	0.06
Arachidonic acid	20:4n6	0.21	0.01	0.22	0.02	0.26	0.06
Lignoceric acid	24:0	0.09	0.08	0.05	0.01	0.08	0.01
Docosapentanoic acid	22:5n3	0.07	0.01	0.07	0.00	0.07	0.01

[1] Expressed in fatty acid methyl ester %

[2] For superscripts, see Table 2.

Milk fat samples originated from Holstein-Friesian and Brown Swiss cows in the farm in Gödre did not differ significantly in the ratio of saturated and unsaturated fatty acids (see "SFA/(MUFA+PUFA)" row in Table 6). The ratio of the unsaturated fatty acids (PUFA+MUFA) did not differ in the milk fat, but significant differences were detected in the unsaturated fatty acid pool: the milk fat of Brown Swiss contained significantly ($p < 0.001$) more PUFA than that of Holstein-Friesian. The sum of PUFA and MUFA did not differ between the two breeds because the surplus of PUFA in the milk fat of Brown Swiss (0.5% more than that of Holstein-Friesian) was compensated with the relative deficiency of MUFA (1.7% less than that of Holstein-Friesian).

The milk fat of Brown Swiss contained more $n6$ and also more $n3$ fatty acids than Holstein-Friesian, but this excess existed with the same ratio of $n6$ and $n3$, that is, the $n6/n3$ ratio was the same in the milk fat of these two breeds (Table 6).

Table 6: The crude fat content (w/w%) and the fatty acid composition[1] of milk obtained from the two dairy herds in Gödre (n=20)[2]

	Holstein-Friesian		Brown Swiss	
	Average	SD	Average	SD
Crude fat	3.9	0.8	4.0	0.7
SFA	67.1	7.4	68.4	6.4
MUFA	29.4	4.7	27.7	3.3
PUFA	3.5^{a}	0.4	4.0^{b}	0.5
MUFA+PUFA	32.9	5.1	31.6	3.9
SFA/(MUFA+PUFA)	2.0	1.4	2.2	1.6
n3	0.26^{a}	0.02	0.30^{b}	0.05
n6	2.8^{a}	0.3	3.2^{b}	0.4
n6:n3	10.6	14.1	10.7	8.1

[1] Expressed in fatty acid methyl ester %

[2] For superscripts, see Table 2.

In the case of saturated fatty acids, the milk fat of Brown Swiss contained significantly more undecanoic acid and myristic acid than that of Holstein-Friesian (Table 7). Regarding the components of MUFA occurring in small amounts, Brown Swiss had more myristoleic acid and eicosenoic acid. There was not significant difference in the ratio of oleic acid giving the main part of MUFA (23.0% for Brown swiss and 25.0% for Holstein-Friesian). In the case of the fatty acids of PUFA, the milk fat of Brown Swiss was richer in linoleic acid ($p < 0.001$), α-linolenic acid, and conjugated linoleic acid ($p = 0.002$) than that of Holstein-Friesian. The surplus of these three fatty acids is responsible for the excess of PUFA in the milk fat of Brown Swiss related to Holstein-Friesian.

Table 7: The fatty acid composition of the fat of milk from dairy herds in Gödre, expressed in fatty acid methyl ester % (n=20)[1]

Fatty acid		Holstein-Friesian		Brown Swiss	
		Average	SD	Average	SD
Butyric acid	4:0	0.77	0.13	0.77	0.08
Caproic acid	6:0	1.13	0.12	1.13	0.11
Caprylic acid	8:0	0.97	0.11	0.98	0.13
Capric acid	10:0	2.69	0.49	2.75	0.38
Undecanoic acid	11:0	0.28^{a}	0.06	0.32^{b}	0.06
Lauric acid	12:0	3.46	0.72	3.75	0.47
Tridecanoic acid	13:0	0.20	0.04	0.25	0.11
Myristic acid	14:0	10.97^{a}	1.31	11.79^{b}	0.77
Myristoleic acid	14:1	0.79^{a}	0.13	0.96^{b}	0.23
Pentadecanoic acid	15:0	1.17	0.17	1.19	0.18
Palmitic acid	16:0	33.71	2.94	34.43	2.32
Palmitoleic acid	16:1	1.73	0.36	1.64	0.35
Margaric acid	17:0	0.77	0.08	0.72	0.08
Stearic acid	18:0	10.88	1.18	10.11	1.64
Elaidic acid	18:1n9t	1.80	0.26	1.92	0.24
Oleic acid	18:1n9c	24.95	3.94	23.03	2.48
Linoleic acid	18:2n6	2.46^{a}	0.17	2.83^{b}	0.26
Arachidic acid	20:0	0.15	0.03	0.16	0.06
γ-linolenic acid	18:3n6	0.09^{b}	0.04	0.05^{a}	0.05
Eicosenoic acid	20:1	0.09^{a}	0.04	0.15^{b}	0.05
α-linolenic acid	18:3n3	0.26^{a}	0.02	0.30^{b}	0.05
c9,t11- conjugated linoleic acid	c9,t11-18:2	0.43^{a}	0.07	0.51^{b}	0.08
Eicosatrienoic acid	20:3n6	0.11	0.05	0.12	0.06
Arachidonic acid	20:4n6	0.15	0.03	0.16	0.04

[1] For superscripts, see Table 2.

In the case of milk samples originated from the farm situated in Magyarszék, the fat content of the milk of Jersey proved to be significantly higher ($p < 0.001$) than that of Holstein-Friesian (Table 8). The milk fat of Jersey contained more saturated fatty acid than that of Holstein-Friesian. The milk fat of Holstein-Friesian contained significantly more PUFA and unsaturated fatty acid (PUFA+MUFA) but the MUFA-surplus was not significant at 95% level ($p = 0.052$). The milk fat of Jersey contained 4.2-fold more saturated fatty acid than unsaturated fatty acid SFA/(MUFA+PUFA); the value of this ratio (3.4) was significantly smaller for Holstein-Friesian. The milk fat of Holstein-Friesian contains a significantly higher ratio of $n3$ fatty acids than that of Jersey. Although the $n6$ fatty acids surplus in the milk fat of Holstein-Friesian did not prove to be significant, the p-value is on the limit value ($p = 0.05$). However, the $n6/n3$ ratio did not differ among breeds ($p = 0.340$).

Table 8: The crude fat content (w/w%) and the fatty acid composition[1] of milk obtained from the milking herds situated in Magyarszék (n=5)[2]

	Holstein-Friesian		Jersey	
	Average	**SD**	**Average**	**SD**
Crude fat	3.5^{a}	0.8	7.0^{b}	0.3
SFA	77.1^{a}	2.3	80.6^{b}	1.9
MUFA	19.6	2.2	16.7	1.7
PUFA	3.4^{b}	0.4	2.7^{a}	0.2
MUFA+PUFA	23.0^{b}	2.3	19.4^{a}	1.9
SFA/(MUFA+PUFA)	3.4^{a}	0.4	4.2^{b}	0.5
n3	0.71^{b}	0.09	0.53^{a}	0.06
n6	2.3	0.4	1.9	0.2
n6/n3	3.3	0.6	3.6	0.4

[1] Expressed in fatty acid methyl ester %

[2] For superscripts, see Table 2.

Saturated fatty acids, which are responsible for the saturated character of the milk fat of Jersey, appear from the evaluation of the individual fatty acids. In the group of saturated fatty acids, the excess of caproic acid and lauric acid is significant in Jersey (Table 9). Among unsaturated fatty acids, oleic acid – giving the bulk amount of MUFA – occurs in higher amount in the milk fat of Holstein-Friesian than that of Jersey. The same situation emerged in the case of the α-linolenic acid – being present in high ratio within PUFA – and docosapentaneoic acid.

Table 9: The fatty acid composition[1] of the fat of milk from dairy herds in Magyarszék, (n=5)[2]

		Holstein-Friesian		Jersey	
		Average	SD	Average	SD
Butyric acid	4:0	4.64	0.54	3.52	0,96
0.96 Caproic acid	6:0	1.16^{a}	0.07	1.28^{a}	0.07
Caprylic acid	8:0	1.02	0.09	1.10	0.09
Capric acid	10:0	2.90	0.44	3.38	0.35
Undecanoic acid	11:0	0.33	0.06	0.34	0.02
Lauric acid	12:0	3.78^{a}	0.62	4.68^{b}	0.44
Tridecanoic acid	13:0	0.24	0.09	0.28	0.03
Myristic acid	14:0	12.61	1.08	12.64	0.60
Myristoleic acid	14:1	0.92	0.26	0.89	0.13
Pentadecanoic acid	15:0	1.60	0.38	1.44	0.09
Palmitic acid	16:0	39.21	2.09	41.64	2.66
Palmitoleic acid	16:1	1.61	0.47	1.81	0.29
Margaric acid	17:0	0.88	0.12	0.83	0.04
Stearic acid	18:0	8.29	0.92	9.14	0.85
Elaidic acid	18:1n9t	1.05	0.31	0.85	0.24
Oleic acid	18:1n9c	15.98^{b}	1.91	13.16^{a}	1.47
Linoleic acid	18:2n6	1.96	0.38	1.60	0.14
Arachidic acid	20:0	0.13	0.01	0.14	0.02
γ-linolenic acid	18:3n6	0.02	0.01	0.02	0.00
Eicosenoic acid	20:1	0.04	0.01	0.04	0.01
α-linolenic acid	18:3n3	0.61^{b}	0.08	0.46^{a}	0.04
c9,t11- conjugated linoleic acid	c9,t11-18:2	0.29	0.05	0.24	0.04
Heneicosanoic acid	21:0	0.05	0.01	0.04	0.02
Eicosadienoic acid	20:2	0.04	0.02	0.03	0.01
Behenic acid	22:0	0.09	0.02	0.09	0.02
Eicosatrienoic acid	20:3n6	0.12	0.02	0.09	0.01
Arachidonic acid	20:4n6	0.21	0.03	0.17	0.04
Lignoceric acid	24:0	0.12^{b}	0.04	0.03^{a}	0.01
Docosapentanoic acid	22:5n3	0.10^{b}	0.01	0.07^{a}	0.02

[1] Expressed in fatty acid methyl ester %

[2] For superscripts, see Table 2.

4 Summary

Summarizing the results, it can be stated that the milk fat of Jersey possessed the most saturated character among the six breeds under investigation. The milk fat of Brown Swiss – owing to the abundance of linoleic acid, α-linolenic acid, and c9, t11-conjugated linoleic acid – was richer in polyunsaturated fatty acids than that of Holstein-Friesian (cows at the farm in Gödre). The milk fat of Brown Swiss contained more $n6$ and $n3$ than that of Holstein-Friesian (cows at the farm in Gödre); moreover, the milk fat of Holstein-Friesian was richer in $n3$ fatty acids than that of Jersey (animals at the plant in Magyarszék). Despite the differences in the absolute amount of $n6$ and $n3$ fatty acids, the $n6/n3$ ratio of milk fat did not differ significantly among breeds.

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