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THE EFFECT OF PATERNAL BULL ON MILK FAT COMPOSITION OF DAIRY COWS DIFFERENT BREEDS

Katarína Kirchnerová, Martina Vršková, Ján Huba

ABSTRACT

Intake of milk fat in human nutrition is important because of unsaturated and especially essential fatty acids (FAs), linoleic and α-linolenic acid, and conjugated linoleic acid (CLA), which is found only in meat and milk of ruminants. The objective of our study was to investigate the effect of paternal bulls on fatty acids composition in milk fat of dairy cows of different breeds. The milk samples were taken in total from 299 dairy cows from 11 dairy farms. In experiment Holstein (H, n = 105), Red Holstein (R, n = 120) and Pinzgau (P, n = 74) breeds originated from different bulls were used. Individual milk samples were analyzed for fatty acids in milk fat using gas chromatography (apparatus GC Varian 3800, Techtron, USA), using FID detector in capillary column Omegawax 530; 30 m. In the chromatography records there were identified 54 fatty acids inclusive of particular isomers. Their relative proportions were expressed in percent's (%). Among the studied breeds, the highest content of conjugated linoleic acid (CLA) – 0.67%, essential FAs (EFA) – 2.98%, monounsaturated FAs (MUFA) – 25.84% and the lowest atherogenic index (AI) – 3.10 was at breed P. Within this breed there was high variability and daughters of bull COS1 achieved significant above-average values of CLA content 1.07%, EFA 3.71%, MUFA 29.93% and under breed average AI = 2.40. The group of daughters of NOB3 was significant lower in CLA, 0.50% as compared with an average of P breed. . From the breed H bull MTY2 showed significantly higher value of 0.62% CLA, EFA 3.42%, 34.29% MUFA and lower value of AI, 1.9 as compared to H breed average. Statistically significantly lower levels of CLA 0.29% and 21.46% MUFA and higher AI 3.72 in milk fat of his daughters, bull STY3 may be considered as potential worser of these properties. At the breed R bull MOR506 showed in compar to the breed average significantly higher value of the EFA 3.80% and also the higher content of CLA 0.50% and MUFA 25.09%, resulting in statistically significant lower AI = 2.91. Bull MOR506 could be considered as potential improver of milk fat composition. The above described variability in the composition of milk fat of dairy cows and the subsequent relationships between these values suggest that the selection of the bull according to the fatty acid composition of milk fat may be considered.

Keywords: cow; milk; fatty acid; paternal effect; bull

INTRODUCTION

In recent decades, the intake of milk fat in human nutrition considered a negative factor in relation to cardiovascular disease. The content of saturated acids C12:0, C14:0 and C16:0 is usually expressed in the so-calculated atherogenic index (AI). But the intake of milk fat in human nutrition is important because of unsaturated and especially essential fatty acids (EFA), linoleic and α-linolenic acid, and especially conjugated linoleic acid (CLA), which is found only in meat and milk of ruminants. Detailed examination brought knowledge of bioactive components in milk fat, which has a beneficial effect on the human body. In particular, the polyunsaturated fatty acids (PUFA) regulate the function of cell membranes and serve as precursors of bioactive mediators. Health effects of EFA are gaining prominence within the latest medical research, thus recognizing the importance of milk fat in the human diet. The latest research confirms, besides of nutrition of dairy cows, the importance of genetic effects on the composition of fatty acids in milk fat, and therefore consider it necessary to evaluate this regard at breeds reared in Slovakia. **Capps et al. (1999)** described the Jersey breed cows that produce lower levels of conjugated linoleic acid (CLA) than Holstein when they were fed complete feed mixture with the addition of hay. By **Palmquist et al. (1993)** Holstein dairy cows produce 8 – 42% more short to medium chain fatty acid (C6:0 - C14:0), compared to the Jersey. Jersey dairy cows produced 13% more stearic acid (C18:0) and less oleic acid (C18:1). **Hanuš et al. (2008)** found insignificant differences (p >0.05) between breeds Czech Pied and Holstein, where SAFA 63.97 < 65.80% and unsaturated fatty acids (USFA) 34.62 > 32.87%. In CLA content there was a clear difference 0.80 > 0.55% (p <0.05). **Samková et al. (2012)** in comparison of two breeding groups of individual milk samples (Czech spotted, n = 78; Holstein, n = 86) found a difference in the representation of lauric acid (C12:0, 4.69 > 4.42%) and palmitic acid (C16:0, 32.75 < 34.1%, p <0.05), and no significant differences in the C18 acids. An interesting difference (close to statistical significance) was found for the representation of health desirable CLA (0.42 > 0.38%).

The mentioned dependence shows that the use of selection for the desired change in the composition of fatty acid profile of milk fat could be possible. Higher organisms are able to incorporate double bonds in molecule by means of dehydrogenating enzyme system and reactions of chain growth **(Jenkins** and **McGuire, 2006)**. **Soyeurt (2010)** deals with assessing the breeding value of 1993 bulls based on data corresponding to the number of their daughters (measured by a fast method FTMIR) and states that the heritability of saturated fatty acids (SAFA) and monounsaturated fatty acids (MUFA) were 44% and 22%, which means that there exists the variability needed for the development of selection in order to improve the nutritional quality of milk fat.

The objective of this paper is the study of the composition of milk fat of dairy cows of different breeds in Slovakia and to analyse the potential genetic impact of bull's sire on the content of medically important milk fatty acids in the milk of their daugthers.

MATERIAL AND METHODOLOGY

The milk samples were taken from 299 dairy cows from 11 dairy farms. In the experiment primiparous Holstein (H, n = 105), Red Holstein (R, n = 120) and Pinzgau (P, n = 74) breeds originated form differend bulls were used. The dairy cows were at first lactation on different number of days in milk evenly distributed in the interval of 10 – 111 days. The milk was sampled from the whole amount of milked milk at regular milk recording performed by The Breeding Services of the Slovak Republic.

Milk fat of individual milk samples was analyzed for fatty acid composition. Milk fat was isolated from lyophilised milk samples by extraction in petroleum ether according to Röse-Gottlieb, then it was re-esterified by methanol potassium hydroxide solution, and methyl esters of fatty acids were extracted by hexane. Methyl esters of fatty acids were analysed by gas chromatography (apparatus GC Varian 3800, Techtron, USA), using FID detector in capillary column Omegawax 530; 30m. Irregular temperature gradient from 40 to 240 ºC, injection and detection at 250 ºC were used. Nitrogen flow rate was 6 ml.min^{-1} **(Samková et al. 2009)**. In the chromatography records were identified 54 fatty acids inclusive of particular isomers. Their representation was expressed relatively in percentage of peak areas (%). Groups of fatty

Table 1 The average values (%) of daughters groups of bulls Pinzgau breed

n	bulls	$\bar{x}$	$S_{\bar{x}}$	*p*-value
		CLA		
8	COS1	1.07	0.42	0.0298
74	$\bar{x}$	**0.67**	**0.23**	
8	LOZ2	0.66	0.20	0.9048
10	SBA1	0.62	0.16	0.4757
10	NOB3	0.50	0.15	0.0086
		EFA		
8	COS1	3.71	1.11	0.1064
10	SBA1	2.99	0.77	0.9527
74	$\bar{x}$	**2.98**	**0.84**	
8	LOZ2	2.90	0.71	0.7661
10	NOB3	2.88	0.53	0.6231
		MUFA		
8	COS1	29.93	4.60	0.0415
74	$\bar{x}$	**25.84**	**3.44**	
10	SBA1	25.77	2.29	0.9294
8	LOZ2	24.79	3.91	0.4888
10	NOB3	24.33	2.37	0.1022
		AI		
8	LOZ2	3.39	0.79	0.3475
10	NOB3	3.26	0.45	0.3675
74	$\bar{x}$	**3.10**	**0.56**	
10	SBA1	2.96	0.46	0.4120
8	COS1	2.40	0.70	0.0246

acids and their abbreviation as well as calculated atherogenic indexes (AI) were created according to traditional structural chemical and nutrition criteria in line with works given in References. The analytical data were assessed professional statistical software SAS version 9.2 (SAS 2002) module in SAS STAT. For statisitic evaluation of the bull effect only bulls with higher number of daughters were used.

RESULTS AND DISCUSSION

The evaluation of the content of medically significant fatty acids and their groups was made with respect to the bull of the monitored cows. In order to assess the possibility of genetic influence on the composition of fatty acids in milk fat of dairy cows we evaluated groups of cows according to their bull in comparison with the results of the whole group of cows of the some breed. As the healthiest important, we evaluated the content of positive CLA, EFA, MUFA and on the opposite, the AI, which relatively high value is undesirable.

Pinzgau breed (Table 1)

Essential fatty acids (EFA) were the highest in the milk of P breed (2.98%). Of these, the most nutritionally important conjugated linoleic acid (CLA) had among studied breeds significantly highest proportion in milk of P breed (0.67%). It is believed that the establishment of heritability is related to the extension of the ruminal trans-11 C18: 1 and a lower rate of cis-9, trans-11 CLA, and to the amount and activity of the delta9-desaturase in mammary tissue **(Kelsey et al., 2003)**. **Medrano et al., (1999)** revealed a difference between breeds in the enzyme activity of stearyl-CoA desaturase, which oxidizes the palmitic (C16:0) and stearic (C18: 0) acid to palmitoleic (C16:1) and oleic (C18:1) acid and acts in the production of CLA.

The highest average CLA content among the studied breeds showed P breed (0.67%). In the context of this breed as a statistically significant higher value (p <0.05) can be evaluated the average value of the daughters of the bull COS1 1.07%, where there were 8 observations. Since the P breed had the highest content of CLA in milk fat among all studied breeds there were even daughters groups with values that were lower than the breed average of favorable results than in other breeds. The daughters of these bulls had relatively high levels of CLA in milk fat (LOZ2 0.66%, 0.62% SBA1). NOB3 was from an average

Table 2 The average values (%) of daughters groups of bulls Holstein black pied breed.

n	bull	$\bar{x}$	$S_{\bar{x}}$	*p*-value
		CLA		
10	MTY2	0.62	0.17	0.0028
22	LU521	0.47	0.11	0.0939
106	$\bar{x}$	**0.41**	**0.19**	
7	STY3	0.29	0.05	0.0002
9	WEL2	0.21	0.05	0.0000
		EFA		
10	MTY2	3.42	0.64	0.0069
7	STY3	2.77	0.34	0.6790
22	LU521	2.76	0.45	0.6694
106	$\bar{x}$	**2.71**	**0.62**	
9	WEL2	2.37	0.43	0.2376
		MUFA		
10	MTY2	34.29	3.50	0.0000
106	$\bar{x}$	**25.66**	**5.75**	
22	LU521	25.15	3.32	0.5759
9	WEL2	24.25	6.07	0.8302
7	STY3	21.46	1.29	0.0000
		AI		
7	STY3	3.72	0.32	0.0014
9	WEL2	3.39	0.99	0.9199
106	$\bar{x}$	**3.11**	**0.84**	
22	LU521	3.05	0.53	0.6516
10	MTY2	1.93	0.31	0.0000

Table 3 The average values (%) of daughters groups of bulls Red Holstein breed.

n	bull	x̄	$S_{\bar{x}}$	*p*-value
		CLA		
7	MOR506	0.50	0.14	0.5409
10	BS46	0.49	0.11	0.9896
7	BW8	0.47	0.11	0.1145
6	KOB505	0.46	0.12	0.3063
120	**x̄**	**0.43**	**0.10**	
7	MES1	0.40	0.08	0.7094
10	ZAK1	0.34	0.07	0.8351
		EFA		
7	MOR506	3.80	0.54	0.0015
7	BW8	2.97	0.41	0.1770
7	MES1	2.94	0.49	0.3178
10	BS46	2.82	0.29	0.3964
120	**x̄**	**2.73**	**0.53**	
10	ZAK1	2.44	0.37	0.0425
6	KOB505	2.43	0.23	0.0203
		MUFA		
7	MOR506	25.09	2.52	0.5794
10	BS46	24.80	3.55	0.8007
10	ZAK1	24.72	5.57	0.9078
120	**x̄**	**24.50**	**3.57**	
7	BW8	24.22	1.41	0.6632
6	KOB505	22.52	1.74	0.0375
7	MES1	22.00	1.65	0.0055
		AI		
7	MES1	3.72	0.30	0.0097
6	KOB505	3.64	0.38	0.0930
10	ZAK1	3.45	1.10	0.6980
10	BS46	3.36	0.65	0.8390
120	**x̄**	**3.31**	**0.69**	
7	BW8	3.18	0.24	0.2470
7	MOR506	2.91	0.40	0.0393

of P breed statistically significant (p <0.01) lower in CLA, 0.50%. Within this breed NOB3 seems to be worser of this feature, but even this value is higher than the mean values of breeds with low CLA.

The highest content of essential fatty acids (EFA) showed P breed, 2.98%. Bull COS1 showed a group of eight daughters with an average 3.71%. Bull NOB3, which had the lowest value of CLA seems also at EFA (2.88%) to be a worser within a breed, but compared breeds H and R has a higher content of EFA.

In group of dauthers of the same bull COS1, the highest content of MUFA was found out, as it was mentioned above for CLA and EFA. Daughters of bull COS1 showed statistically significant (p <0.05) higher MUFA content of 29.93% than average value of the P breed 25.84%. Conversely, COS1 daughters had statistically significant (p <0.05) lower Al (2.40) as the average of the P breed (3.10). NOB3 bull whose daughter had a lower content of CLA, EMC and MUFA was compared to the breed average higher ranked AI (3.26).

Holstein black pied – H breed (Table 2)

H breed showed low average CLA content of 0.41% as compared with P breed (a similar value as observed by **Hanuš et al. (2008)** and **Samková et al. (2012)**), 2.71% EFA, MUFA 25.66% and average AI = 3.11. Daughter of the bull MTY2 had significantly higher value of 0.62%

CLA, EFA 3.42%, 34.29% MUFA and lower (p <0.0001) value of AI, 1.93 as compared to average value. Statistically significantly lower levels of CLA 0.29% (p <0.005) and 21.46% MUFA (p <0.0001) and higher AI 3.72 (p <0.005) in milk fat of daughters could indicat a bullSTY3 as a potential worser of these properties.

Red Holstein – R breed (Table 3)

R breed showed lower content of CLA 0.43%, EFA 2.73% and MUFA 24.50% and the highest average AI = 3.31 as compared to the average breed P. Each component about the same level with the H breed. Bull MOR506 had higher value of the EFA 3.80% (p <0.005) and also the higher content of CLA 0.50% and MUFA 25.09% as compared to the breed average, resulting in statistically significant (p <0.05) lower AI = 2.91. It puts bull MOR506 in to the role of potential improver. **Soyeurt (2010)** stated that the heritability of SAFA and MUFA were 44% and 22%, which means that there exists the variability needed for the development of selection in order to improve the nutritional quality of milk fat.

Bulls KOB505 and MES1 who had statistically significant higher AI than the breeds average (3.64, p <0.1, respectively 3.72, p <0.01), had statistically significant lower content of MUFA (22.52%, p <0.05, respectively. 22.00%, p <0.01) while the CLA and EFA content was different from the mean relatively little. These results sort bull KOB505 and MES1 to potential worserer of milk fatty acids composition.

CONCLUSION

Analysis of the bulls on the basis of their daughters suggests that the genetic influence on the composition of milk fat is applicable and could not be excluded. It would be appropriate to evaluate the impact of fathers using exact genetic methods. These results indicate that it was possible to find such bulls who have a positive effect on properties of the milk fat. Among the studied breeds, the highest content of conjugated linoleic acid (CLA) – 0.67%, essential FAs (EFA) – 2.98%, monounsaturated FAs (MUFA) – 25.84% and the lowest atherogenic index (AI) – 3.10 was found out at P breed. Within this breed there was high variability and daughters of bull COS1 achieved significant above-average values of CLA content 1.07%, EFA 3.71%, MUFA 29.93% and under breed average AI = 2.40. The group of daughters of NOB3 was from an average of P breed statistically significant lower in CLA, 0.50%. From the H breed bull MTY2 showed compared to H breed average significantly higher value of 0.62% CLA, EFA 3.42%, 34.29% MUFA and lower value of AI, 1.9. Statistically significantly lower levels of CLA 0.29% and 21.46% MUFA and higher AI 3.72 in milk fat of his daughters, bull STY3 may be considered as potential worser of these properties. At the R breed bull MOR506 showed significantly higher value of the EFA 3.80% and also the higher content of CLA 0.50% and MUFA 25.09%, as compared to the breed average resulting in statistically significant lower AI = 2.91. It considers bull MOR506 in to the role of potential improver of milk fat composition. The above described variability in the composition of milk fat of dairy cows and the subsequent relationships between these values suggest that the selection of bulls according to the fatty acid composition of milk fat may be considered.

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Contact address:

Katarína Kirchnerová, National Agricultural and Food Centre, Research Institute for Animal Production, Hlohovecká 2, 951 41 Lužianky, Slovakia, E-mail: kirchnerova@vuzv.sk.

Martina Vršková, National Agricultural and Food Centre, Research Institute for Animal Production, Hlohovecká 2, 951 41 Lužianky, Slovakia, E-mail: vrskova@vuzv.sk.

Ján Huba, National Agricultural and Food Centre, Research Institute for Animal Production, Hlohovecká 2, 951 41 Lužianky, Slovakia, E-mail: huba@vuzv.sk.