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INFLUENCE OF EARLY SPRING FEEDING ON FATTY ACID LEVELS OF COWS' MILK*

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The research was carried out on 17 cows and the level of fatty acids in milk fat during the early spring feeding period was analysed. It was observed that the increasing quantity of green forage in the ration was accompanied by the increased content of fatty acids (MUFA and PUFA, including CLA).

The increase in CLA content by 40% upon introduction of green forage to the ration (compared to the winter feeding) is worth noticing.

INTRODUCTION

In recent years, health-improving components of human diet have been the subject of a growing interest. One of the possibilities rising health-promoting properties of milk is to increase the level of its bioactive components, *e.g.* conjugated linoleic acid (CLA) which possesses anti-tumours and anti-bacterial proprieties, counteracts arteriosclerosis, and helps in obesity treatment [Dhiman *et al.*, 1996; Jahreis *et al.*, 1999; Lock & Garnsworthy, 2003]. Moreover, it was proved that butyric acid (C4:0) and linolenic acid (C18:3) brake the development of tumours. Many researches concerning the improvement of fatty acid profile of milk have been carried out so far. Pasture feeding has been found particulary profitable for unsaturated fatty acids content (especially CLA) [Kelly *et al.*, 1998, Chilliard *et al.*, 2001]. There are also known works [Chouinard *et al.*, 1998], demonstrating that CLA concentration of milk was high in spring and summer periods. Collomb *et al.* [2001] proved that the level of polyunsaturated acids was higher in milk of cows grazing in mountains than in these grazing in lowlands. An increasing CLA content of milk of cows fed in winter with feeding stuffs enriched with carrot indicates a beneficial influence of unpreserved (fresh) feedstuff additive on fatty acid profile of cow's milk [Nałęcz-Tarwacka *et al.*, 2003]. According to Voigt and Hagemeister [2001], there is a need to continue investigations into the increase of unsaturated fatty acids content of cow's milk. It is not a simple task due to a high positive correlation between the content of CLA and the sum of *trans*-configurated acids (r=0.88), which are not beneficial for men as they influence LDL cholesterol increase.

Investigations described in literature have mainly concentrated on the analysis of fatty acid profile in summer or winter feeding seasons. There are few researches concerning the influence of early spring or autumn feeding on milk fat composition. Therefore the aim of this study was to determine the influence of early spring feeding on fatty acid levels of cow's milk.

MATERIAL AND METHODS

The investigation was carried out in the Experimental Station of Warsaw Agricultural University on 17 cows with the share of HF cattle genes in the genotype, which were in the similar lactation stage – about 100 days after calving. The experiment was conducted during the 5-week feeding transition (from winter to summer) period. In the subsequent weeks maize silage quantity in the ration was decreased, and pasture green forage increased according to the scheme presented in Table 1.

TABLE 1. Feeding ration for cow during the experiment.

Weeks of the experiment (sampling number)	Feeding ration (kg)				
	Maize silage	Pasture	Brewer's grains	Hay	Concentrate
1	35	0	10	4.5	3
2	30	10	10	3	3
3	10	50	6	3	3
4	5	60	6	3	3
5	0	65	6	2	3

Milk samples were collected from cows 5 times in one-week intervals. Fatty acid levels of milk were evaluated with gas chromatography method. A Hewlett-Packard gas chromatograph with FID was used. The results obtained were subjected to the analysis of variance by SAS software.

RESULTS AND DISCUSSION

The levels of fatty acids of milk fat of cows fed with early spring diet were shown in Tables 2–4. Butyric acid (C4:0) level was the highest in the 2nd sample collection and

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amounted to 3.903 g/100 g of fat. Its lowest content – 3.355 g/100 g fat ($p \leq 0.05$) – was observed when pasture green forage was applied as the basic juicy roughage. The results obtained differ from the data presented by Lock and Garnsworthy [2003], who observed the increase of this acid in milk of cows fed green forage. Similar tendencies (*i.e.* the highest level in the 2nd and the lowest in the 5th sample collection) were noticed for the following acids: C6:0, C8:0, C10:0, C12:0 and C14:0. Differences between samplings were statistically highly significant ($p \leq 0.01$) and significant ($p \leq 0.05$). These tendencies are in accordance with the results of a study by Lock and Garnsworthy [2003], who examined fatty acid levels in subsequent months of a year. They reported a decrease in the discussed acids in May. Similar tendencies, as in the case of the above-mentioned acids, were noticed for C14:1, but the differences between groups were not statistically confirmed. The level of C15:0 – – C17:0 fatty acids (Table 3) was lower in milk of cows fed pasture compared to milk of those, which were fed mainly with silages. Therefore, in the early spring cow feeding period, a decrease in saturated fatty acids (SFA) content was observed. Highly significant and significant influence of pasture green forage feeding in the increase of C18:0–C20:1 acids level in cow's milk was noticed (Table 3 and Table 4).

TABLE 2. The content of saturated fatty acids (C 4 – C 14) and C14:1 of cow's milk fat.

Fatty acid	Sampling number	N	LSM	SE
C 4:0	Total average	85	3.710	0.050
	1	17	$3.855^{A,d}$	0.112
	2	17	3.903^{B}	0.112
	3	17	3.808^{C}	0.112
	4	17	3.628^{d}	0.112
	5	17	$3.355^{A,B,C}$	0.112
C 6:0	Total average	85	2.359	0.025
	1	17	2.438^{A}	0.056
	2	17	$2.492^{b, C}$	0.056
	3	17	2.431^{D}	0.056
	4	17	$2.311^{b, c}$	0.056
	5	17	$2.124^{A, C, D, e}$	0.056
C 8:0	Total average	85	1.347	0.020
	1	17	1.424^{A}	0.045
	2	17	$1.445^{b, C}$	0.045
	3	17	1.396^{D}	0.045
	4	17	$1.314^{b, e}$	0.045
	5	17	$1.155^{A, C, D, e}$	0.045
C 10:0	Total average	85	3.283	0.054
	1	17	3.404^{A}	0.120
	2	17	3.448^{B}	0.120
	3	17	3.399^{C}	0.120
	4	17	3.214	0.120
	5	17	$2.949^{A, B, C}$	0.120
C 12:0	Total average	85	3.704	0.054
	1	17	$3.915^{a, B}$	0.120
	2	17	$3.931^{c, D}$	0.120
	3	17	3.791^{E}	0.120
	4	17	$3.576^{a, c}$	0.120
	5	17	$3.306^{B, D, E}$	0.120
C 14:0	Total average	85	10.888	0.102
	1	17	$11.653^{A, B}$	0.228
	2	17	$11.688^{C, D}$	0.228
	3	17	$11.082^{e, F}$	0.228
	4	17	$10.429^{A, C, e, g}$	0.228
	5	17	$9.588^{B, D, F, g}$	0.228
C 14:1	Total average	85	1.165	0.035
	1	17	1.230	0.079
	2	17	1.238	0.079
	3	17	1.196	0.079
	4	17	1.118	0.079
	5	17	1.042	0.079

N – sample number; LSM – least square mean; SE – standard error; values marked with the same letter differ significantly (small letters) or high-significantly (capital letters): a, b – $p \leq 0.05$; A, B – $p \leq 0.01$

TABLE 3. The content of saturated fatty acids (C 15–C 18) and monounsaturated fatty acids of cow's milk fat.

Fatty acid	Sampling number	N	LSM	SE
C 15:0	Total average	85	0.904	0.021
	1	17	0.959^{a}	0.048
	2	17	0.941^{b}	0.048
	3	17	0.952^{c}	0.048
	4	17	0.860	0.048
	5	17	$0.805^{a, b, c}$	0.048
C 16:0	Total average	85	25.849	0.154
	1	17	$26.571^{a, B}$	0.344
	2	17	$26.629^{c, D}$	0.344
	3	17	26.318^{E}	0.344
	4	17	$25.382^{a, c, f}$	0.344
	5	17	$24.347^{B, D, E, f}$	0.344
C 16:1	Total average	85	1.848	0.028
	1	17	$1.961^{a, B}$	0.063
	2	17	1.949^{C}	0.063
	3	17	1.876^{d}	0.063
	4	17	1.778^{a}	0.063
	5	17	$1.678^{B, C, d}$	0.063
C 17:0	Total average	85	0.688	0.009
	1	17	$0.734^{a, B}$	0.021
	2	17	0.698^{c}	0.021
	3	17	0.705^{d}	0.021
	4	17	0.668^{a}	0.021
	5	17	$0.633^{B, c, d}$	0.021
C 18:0	Total average	85	11.778	0.117
	1	17	$11.147^{a, B}$	0.261
	2	17	$11.176^{c, D}$	0.261
	3	17	11.482^{E}	0.261
	4	17	$12.094^{a, c, f}$	0.261
	5	17	$12.988^{B, D, E, f}$	0.261
C 18:1 *cis*	Total average	85	21.239	0.095
	1	17	$20.418^{A, B}$	0.212
	2	17	$20.012^{C, D}$	0.212
	3	17	$20.565^{E, F}$	0.212
	4	17	$21.800^{A, C, E, G}$	0.212
	5	17	$23.400^{B, D, F, G}$	0.212
C 18:1 *trans*	Total average	85	1.992	0.079
	1	17	$1.558^{a, B}$	0.176
	2	17	1.815^{c}	0.176
	3	17	1.991	0.176
	4	17	2.164^{a}	0.176
	5	17	$2.431^{B, c}$	0.176

N – sample number; LSM – least square mean; SE – standard error; values marked with the same letter differ significantly (small letters) or high-significantly (capital letters): a, b – $p \leq 0.05$; A, B – $p \leq 0.01$

A higher content of linoleic acid C18:2 (2.843 g/100 g of fat) was observed upon introduction of pasture green forage (an increase by 29%) in comparison to its content in milk of cows fed silage (2.204 g/100 g of fat). The level of CLA was dependent on pasture green forage amount in the diet. The higher it was, the higher was CLA level in milk of the cows examined. CLA content was the highest in milk collected after 35 days of the research (5th sampling) – 0.706 g/100 g of fat – when pasture was the base of the ration. The increase in CLA content by 40% upon pasture introduction obtained in this experiment is lower than that reported by Lock and Garnsworthy [2003], who reported the following values: 0.9 and 1.4 g/100 g of fatty acids – in April and May, respectively. Similar results regarding CLA content in cow's milk (0.84 g/100 g of fat) were obtained by Dhiman *et al.* [1996], when pasture constitued 1/3 of the ration. In a research by Kelly *et al.* [1998] as much as 1.09 g of CLA/100 g of fat (grazing cows) *versus* 0.45 g/100 g of fat (control group) were noticed. The results obtained of CLA content of milk in the initial and final feeding periods (samplings # 1 and 5) are similar to those reported by Jahreis *et al.* [1999], who observed a lower CLA content of milk during winter, and higher – in summer months. The level of C18:3 acid increased from 0.695 in sampling #1 up to 0.791 g/100 g of fat ($p \leq 0.01$) in sampling #5, whereas that of C20:1 from 0.183 up to 0.211 ($p \leq 0.05$) in the 1st and 5th sampling, respectively. The increase in the levels of individual unsaturated fatty acids of milk of cows fed a ration containing an increased share of pasture green forage, was reflected in the sum of monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids. Similar tendencies, *i.e.* lower SFA content of milk fat of cows during summer feeding, and higher content of MUFA and PUFA (both for udder and bulk milk) in comparison to milk fat of the same cows fed winter ration, were reported by Kuczyńska [1999]. The introduction of pasture green forage to the ration effected in an increase in C18:1 *trans* acid content from 1.558 up to 2.431 g/100g of fat ($p \leq 0.01$). The observed 56% increase is not beneficial from milk consumers point of view. Similar results, *i.e.* the increase in this acid's content by 45% in May compared to April, were presented by Lock and Garnsworthy [2003].

TABLE 4. The content of polyunsaturated and C 20:1 fatty acids in cow's milk fat.

Fatty acid	Sampling number	N	LSM	SE
C 18:2	Total average	85	2.415	0.032
	1	17	2.204 $^{A, B}$	0.072
	2	17	2.205 $^{C, D}$	0.072
	3	17	2.294 $^{e, F}$	0.072
	4	17	2.530 $^{A, C, e, G}$	0.072
	5	17	2.843 $^{B, D, F, G}$	0.072
C 18:2 CLA	Total average	85	0.564	0.012
	1	17	0.504 $^{a, B}$	0.026
	2	17	0.499 $^{C, f}$	0.026
	3	17	0.524 ^{D}	0.026
	4	17	0.585 $^{a, f, E}$	0.026
	5	17	0.706 $^{B, C, D, E}$	0.026
C 18:3	Total average	85	0.721	0.009
	1	17	0.695 ^{A}	0.021
	2	17	0.686 ^{B}	0.021
	3	17	0.695 ^{C}	0.021
	4	17	0.739	0.021
	5	17	0.791 $^{A, B, C}$	0.021
C 20:1	Total average	85	0.183	0.004
	1	17	0.182 ^{a}	0.009
	2	17	0.165 ^{B}	0.009
	3	17	0.169 ^{C}	0.009
	4	17	0.187	0.009
	5	17	0.211 $^{a, B, C}$	0.009
SFA	Total average	85	64.500	0.146
	1	17	66.257 $^{A, B, C}$	0.326
	2	17	66.191 $^{d, E, F}$	0.326
	3	17	65.044 $^{A, d, G, H}$	0.326
	4	17	63.655 $^{B, E, G, I}$	0.326
	5	17	61.355 $^{C, F, H, I}$	0.326
MUFA	Total average	85	26.415	0.106
	1	17	25.347 $^{A, B}$	0.237
	2	17	25.281 $^{C, D}$	0.237
	3	17	25.614 $^{E, F}$	0.237
	4	17	27.067 $^{A,C, E, G}$	0.237
	5	17	28.766 $^{B, D, F, G}$	0.237
PUFA	Total average	85	3.886	0.049
	1	17	3.616 $^{A, B}$	0.110
	2	17	3.608 $^{C, D}$	0.110
	3	17	3.709 $^{e, F}$	0.110
	4	17	4.029 $^{A, C, e, G}$	0.110
	5	17	4.471 $^{B, D, F, G}$	0.110

N – sample number; LSM – least square mean; SE – standard error; values marked with the same letter differ significantly (small letters) or high-significantly (capital letters): a, b – $p \leq 0.05$; A, B – $p \leq 0.01$

Concluding, it ought to be said that the introduction of pasture green forage to the feeding ration for cows resulted in decreasing SFA as well as increasing MUFA and PUFA contents of milk fat. The differences in these fatty acid contents between samplings were statistically significant.

SUMMARY

The research was carried out on 17 cows during the early spring feeding period. In the subsequent weeks, maize silage quantity in the ration was decreased, and pasture green forage increased. Fatty acid levels of cow's milk fat were evaluated. Milk derived from cows fed early spring ration was found to contain more beneficial, from the consumers' sanitary point of view, unsaturated fatty acids: MUFA and PUFA, including CLA, in comparison to milk collected from cows during their winter feeding period. The increase in C18:1 *trans* acid content was unbeneficial, but unfortunately unavoidable due to the high correlation between CLA and *trans*-configurated acids.

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W okresie wczesnowiosennego żywienia oznaczano zawartość kwasów tłuszczowych zawartych w mleku pochodzącym od 17 krów. Stwierdzono, że zwiększającej się ilości zielonki w dawce pokarmowej towarzyszyło zwiększenie zawartości kwasów tłuszczowych MUFA i PUFA, w tym CLA. Na uwagę zasługuje zwiększenie o 40% zawartości CLA po wprowadzeniu zielonki do dawki pokarmowej, w stosunku do zimowego żywienia krów.