Effects of fat-protein supplementation of diets for cows in early lactation on milk yield and composition

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ABSTRACT: An experiment was performed on 37 Holstein-Friesian cows during the first 120 days of lactation. The cows were fed balanced diets composed of haylage and maize silage (together 52% dry mater) and a concentrate containing 19% crude protein (group 1), a concentrate containing 17.5% crude protein and 1 kg of fat-protein supplement Megapro Plus® (group 2) or a concentrate containing 19% crude protein and 1 kg of fat-protein supplement Megapro Plus® (group 3). The mean daily milk yield recorded in groups 2 and 3 amounted to 32.6 kg/d and was by 10.3% higher than in the control group ($P \leq 0.01$). FCM yield increased by 15.5% and 12.1% in groups 2 and 3, respectively, in comparison with group 1. Diet supplementation with Megapro Plus® had no significant effect on the levels of fat, lactose, protein, nitrogen fractions and urea, or some physicochemical properties of milk (density, pH, heat stability). A decrease was noted in solids-non-fat (group 2) and somatic cell count ($P \leq 0.05$). Megapro Plus® supplementation of a diet with a reduced (to 3%) "00" rapeseed meal content in concentrate (group 2) resulted in a significant increase in the concentrations of unsaturated fatty acids (especially C18:1 and C18:2) and hypocholesterolaemic acids (DFA) in milk, recorded on the 120th day of lactation. Megapro Plus® supplementation of a concentrate with a high (10%) "00" rapeseed meal content aimed at increasing the concentrations of both energy and protein (group 3), had no significant effect on improvement in the fatty acid profile, i.e. changes towards increasing unsaturation of milk fat.

Keywords: dairy cows; CaFA salts; milk; composition; yield

Traditional sources of energy and protein are used most frequently in order to improve the nutritive value of diets for high-performance cows. Energy deficiency in the ration as well as excessive supply of rumen degradable protein can reduce milk yield and negatively effect milk composition (Colin–Schoellen et al., 1995; Kowalski, 1997). Therefore the sources of digestible energy such as calcium salts of fatty acids (CaFA), containing rumen undegradable protein, may be a viable alternative to starch since they meet nutrient requirements of high-production cows at the peak of lactation (Kellaway and Porter, 1993; Wu and Huber, 1994; Brzóska et al., 1999a; Bolland et al., 2001; Bargo et al., 2003; Schroeder et al., 2002, 2004). In addition, protein protected with calcium salts of fatty acids effectively increases the supply of intestine-absorbed protein in cows fed high-energy diets (Kowalski, 1997). In addition, fat supplements containing rumen-protected protein modify the composition of milk fatty acids, thus improving the health properties of milk (Brzóska et al., 1999a; Brzóska and Kowalczyk, 2002; Jensen, 2002; Ward et al., 2002). The effectiveness of fat supplements or their derivatives containing rumen undegradable protein is relatively high (Jenkins, 1993; Bolland et al., 2001; Pieszka and Brzóska, 2001) and related, among others, to the type and concentration of fat in the diet (Sklan et al., 1991, 1992; Brzóska et al., 1999a; Drackley et al., 2001). This is the reason why the addition of supplements in which the protein from high-protein components is protected with calcium salts of fatty acids to the diet for high-performance cows is of significant importance. An example of such a feed additive may be the energy-protein supplement Megapro Plus®.

The objective of the present study was to determine the effects of energy-protein supplementation (Megapro Plus®) of winter diets fed to high-performance cows on the yield, composition and some physicochemical properties of milk at the initial stage of lactation.

MATERIAL AND METHODS

Animals and feeding system

An experiment was performed on 37 Holstein-Friesian cows with mean body weights of 640 kg (±42 kg), assigned to three groups by the analogue method, taking into account date of calving, lactation (third or fourth), and milk yield in the previous lactation. The cows were fed balanced diets according to INRA standards (1997). The ration was composed of haylage (15 kg) and 20 kg of maize silage (together 52% dry mater), and a feed mixture with a varying crude protein content. Group 1 (control – 12 head) received roughage and concentrate (I) containing 19% crude protein (128 g PDIN, 106 g PDIE, 0.97 UFL). Group 2 (experimental – 13 head) was fed roughage and concentrate (II) containing 17.5% crude protein (116 g PDIN, 102 g PDIE, 0.97 UFL), and 1 kg of fat-protein supplement (Megapro Plus®, Agro-Best, Czech Republic). Group 3 (experimental –12 head) received roughage and concentrate (I) containing 19% crude protein (as in group 1), and 1 kg of fat-protein supplement (Megapro Plus®). The components of concentrate fed to groups 1 and 3 were as follows: protein-based concentrate (30%), "00" rapeseed meal (10%), ground grain, wheat bran (58%) and mineral supplements (2%). In order to decrease the crude protein concentration in a concentrate for group 2, rapeseed meal content was reduced to 3%.

The supplement Megapro Plus® contains calcium salt of palm oil fatty acids, "00" rapeseed meal and

Table 1. Fatty acid composition of Megapro Plus® fat

Fatty acids	g/100 g	Fatty acids	g/100 g
C_{12}	0.63	others[1]	0.93
C_{14}	1.32	SFA	51.61
C_{16}	45.24	UFA	48.39
C_{18}	4.12	MUFA	36.92
$C_{18:1}$	36.06	PUFA	11.47
$C_{18:2}$	10.24	DFA[2]	48.39
$C_{18:3}$	1.23	OFA[3]	47.49
C_{20}	0.23		

[1]C_{15} – 0.07; $C_{16:1}$ – 0.68; $C_{20:1}$ – 0.18
[2]DFA – $C_{16:1}$; $C_{18:1}$; $C_{18:2}$; $C_{18:3}$; $C_{20:1}$
[3]OFA – C_{12}; C_{14}; C_{15}; C_{16}; C_{20}; C_{22}
C_{18} – neutral FA

Table 2. Chemical composition and feeding value of feeds (% DM)

Item	Haylage	Maize silage	Concentrate I	Concentrate II	Megapro Plus®
Dry matter	39.02	27.37	87.43	86.71	91.66
Crude ash	5.87	4.24	8.19	7.67	10.72
Organic matter	94.13	95.76	91.81	92.33	89.27
Crude protein	14.17	8.73	21.94	20.12	24.95
Ether extract	2.79	2.45	2.86	2.77	28.00
Crude fibre	30.09	21.30	6.50	5.15	7.90
NDF	61.28	42.53	21.59	21.25	23.07
ADF	35.06	26.27	9.81	7.56	14.43
Ca (g)	11.04	4.24	15.65	15.31	33.41
P (g)	5.12	4.89	10.46	8.66	8.20
Mg (g)	3.89	2.19	1.73	1.78	3.32
Na (g)	0.61	0.51	1.26	1.28	1.02
Concentration per kg of DM:					
UFL	0.74	0.88	1.11	1.12	2.00
PDIN (g)	82.55	53.63	146.00	134.00	186.00
PDIE (g)	70.86	73.04	121.30	117.70	169.00

molasses. The nutritive value per kg of supplement is 2.00 UFL, 250 g crude protein, 186 g PDIN and 169 g PDIE. The fatty acid composition of Megapro Plus is given in Table 1. The supplement was applied twice a day (0.5 kg/head) with the concentrate, for the first 120 days of lactation.

The chemical composition and nutritive value of diets and Megapro Plus are given in Table 2.

Chemical analyses

Feed samples were taken once a month to determine the composition of basic nutrients (AOAC, 1990), fractions of acid detergent fibre (ADF) and neutral detergent fibre (NDF) by the Goering and Van Soest method (1970) in a Tecator Fibertec M system. Mineral components were determined using a Flapho-4 flame photometer (Ca and Na) or by atomic absorption spectrophotometry (ASA) (Mg and P).

Milk yield was recorded every 15 days. The levels of major components, urea and somatic cell count (SCC) were assessed in milk samples using a Combi Foss apparatus. The levels of total nitrogen, non-protein nitrogen – NPN (following 15% trichloroacetic acid precipitation) and non-casein nitrogen (following 10% acetic acid and 1 M sodium acetate precipitation) were determined by the Kjedahl procedure. Casein nitrogen was calculated as the difference between total nitrogen and non-casein nitrogen whereas true protein nitrogen was determined as the difference between total protein nitrogen and non-protein nitrogen (NPN). Milk density was determined with lactodensimeter, acidity with pH-meter (model CP-315), and heat stability (ml of 80% C_2H_5COOH) by the methods described by Budsławski (1973).

In milk samples collected on the 45th and 120th day of lactation, milk fatty acids were separated by gas chromatography (PU-4 600 chromatograph, flame-ionization detector FID, capillary column, 30 m × 0.32 mm i.o. × 0.25 µm film, detector temperature 250°C, column temperature 170°C, sample dosing – split/50:1, carrier gas – helium).

Statistical analysis

The results were analyzed statistically by an analys of variance (Anova/Manova) in a two-factor non-orthogonal design (groups of animals, sampling periods). The significance of differences between the experimental factors was determined by Duncan's test, using Statistica 6.0 PL software.

Table 3. Nutritive value of the rations for dairy cows

Item	Group of cows		
	1	2	3
Dry matter (kg)	21.81	22.64	22.73
Concentration per kg of DM			
Crude protein (%)	16.50	16.00	16.90
PDIN (g)	105.80	103.40	109.10
PDIE (g)	95.70	96.90	98.60
UFL	0.95	1.00	1.00
Ether extract (%)	2.73	3.72	3.76
Crude fibre (%)	16.50	15.60	16.20
NDF (%)	37.50	36.90	36.90
ADF (%)	20.70	19.50	20.40
Ca (%)	1.14	1.21	1.22
P (%)	0.76	0.68	0.76
Mg (%)	0.24	0.25	0.24
Na (%)	0.09	0.09	0.09

1 – control

2 – ration with increased energy concentration

3 – ration with increased concentrations of energy and protein

RESULTS AND DISCUSSION

Diet enrichment with the fat-protein supplement Megapro Plus® resulted in a 5.3% increase in dry matter energy concentration (1.00 vs. 0.95 UFL). Group 3 cows, compared with those of group 2 and 1, received a diet with an increased concentration of crude protein, by 5.6% and 2.4% respectively (Table 3). It should be emphasized that the supplement Megapro Plus® had no negative effect on the amount of DM of roughage (silage) taken in by cows over the experimental period.

During the first 120 days of lactation, the mean daily milk yield recorded in cows fed a diet supplemented with Megapro Plus® was by 3.03 kg (group 2) and 3.05 kg (group 3) higher than in the control group (increase by 10.3%, $P \leq 0.01$). FCM yield (Table 4) increased by 15.5% and 12.1%, respectively, in comparison with group 1 ($P \leq 0.01$). A higher dry matter energy concentration in the diet for group 2 allowed to increase milk fat content by 7.8% (4.23 vs. 4.56%), but it was accompanied by a slight decrease in the levels of milk protein (3.07 vs. 3.01%) and solids-non-fat ($P \leq 0.05$), as compared with group 1 (control). The feeding of high levels of supplemental energy and protein in dairy cow diet (group 3) was characterized by slightly higher concentrations of fat (by 2.6%) and dry matter, and a lower protein level (by approx. 2%), in comparison with group 1 (statistically non-significant differences). Due to higher milk production in group 1 and 2, mean daily yields of major milk components were highly significantly or significantly higher than their yields recorded in the control group (Table 4). The slight decrease in the protein content of milk from cows fed a diet supplemented with Megapro Plus®concerned primarily the nitrogen fraction of true protein (groups 2 and 3) and whey protein

Table 4. Milk yield, composition and physicochemical properties of milk*

Item	Group of cows[1]					
	1		2		3	
	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd
Milk yield (kg/day)	29.56[B]	2.78	32.59[A]	2.95	32.61[A]	3.94
FCM (kg/day)	30.58[B]		35.33[A]		34.27[A]	
Milk composition (%)						
Fat	4.23	0.93	4.56	1.09	4.34	0.93
Protein	3.07	0.25	3.01	0.24	3.00	0.22
Lactose	4.83	0.25	4.78	0.21	4.87	0.27
Dry matter	12.61	1.23	12.74	1.34	12.74	1.25
Non-fat solids	8.64[a]	0.38	8.49[b]	0.27	8.60	0.37
Yield						
Fat (g/day)	1 252[Bb]	99	1 484[A]	123	1 415[a]	96
Protein (g/day)	905[B]	27	982[A]	40	979[A]	45
Lactose (g/day)	1 427[B]	86	1 558[A]	77	1 591[A]	66
Dry matter (kg/day)	3.73[B]	0.20	4.18[A]	0.15	4.15[A]	0.10
Non-fat solids (kg/day)	2.59[Bb]	0.16	2.77[a]	0.11	2.81[A]	0.11
Somatic cell count × 10^3	351[a]		204[b]		220[b]	
Physicochemical properties of milk						
Density (g/cm^3)	1.0292	0.0018	1.0287	0.0016	1.0288	0.0016
Acidity (pH)	6.12	0.28	6.14	0.30	6.14	0.29
Heat stability (ml 80% C_2H_5OH)	2.81	0.47	2.87	0.51	2.71	0.58

[1]see Table 3

mean daily values on days 1–120 of lactation; sd = standard deviation

FCM – milk corrected for 4% of fat

[A,B]values in the rows with different letters differ significantly ($P \leq 0.01$)

[a,b]values in the rows with different letters differ significantly ($P \leq 0.05$)

Table 5. Nitrogen fraction and urea content in milk (%)

Item	Group of cows[1]					
	1		2		3	
	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd
Total N	0.480	0.018	0.473	0.025	0.468	0.020
True protein N	0.454	0.017	0.445	0.023	0.441	0.019
NPN	0.026	0.001	0.028	0.002	0.027	0.002
Casein N	0.366	0.011	0.360	0.011	0.364	0.010
Whey N	0.088	0.007	0.084	0.016	0.077	0.014
True protein N (% of total N)	94.49[a]	0.195	94.05[b]	0.333	94.22[ab]	0.505
Casein N (% of total N)	76.30	1.009	76.28	2.487	77.93	2.265
Urea (mg/dl)	15.81	3.08	16.54	4.20	17.20	3.34

[1]see Table 3
sd = standard deviation
[a,b]values in the rows with different letters differ significantly ($P \leq 0.05$)

(group 3). No considerable changes were observed in casein nitrogen and non-protein nitrogen (NPN). The proportion of the nitrogen fraction of true protein in total nitrogen decreased as well, from 94.49% to 94.05% and 94.22% in group 2 ($P \leq 0.05$) and 3, respectively (Table 5). Results of other studies indicated a positive effect of diet supplementation with calcium salts of fatty acids (CaFA) on milk yield and composition, especially at the peak of lactation (Doreau et al., 1993; Cervantes et al., 1996; Kowalski, 1997; Schroeder et al., 2004). According to Kraszewski et al. (2003), diet enrichment with the fat-protein supplement Megapro (during the first 100 days of lactation) enabled to increase daily milk yield by 3.02 kg (34.77 vs. 31.75 kg), and levels of fat (by 0.41 percentage unit) and protein (by 0.05 percentage unit). They also reported a decrease in somatic cell count, with no changes in milk acidity and density. Pieszka and Brzóska (2001) found that rapeseed meal and soybean meal protection by calcium salts of fatty acids during winter feeding of cows at the first stage of lactation resulted in a significant increase in FCM yield, by 2.1 kg and 2.3 kg/day respectively, and milk fat yield, by 118 and 114 g/day. They also observed a slight decrease in milk protein content, especially true protein and casein nitrogen protein fractions (non-significant differences). Other authors (Doreau et al., 1993; Cervantes et al., 1996; Kowalski, 1997; Brzóska et al., 1999b; Brzóska and Kowalczyk, 2002; Schroeder et al., 2004) also confirmed the fact that diets supplemented with fat (including CaFA), regardless of its source, usually reduced milk protein content, but di not decrease protein yield. According to Wu and Huber (1994), an increase in dietary fat content from 2.5 to 8% dry matter was accompanied by a decrease in milk protein content, on average by 3.8%. The slight decrease in milk protein content observed in our study could be a consequence of the deficiency of amino acids indispensable for protein synthesis in the mammary gland, with increased biosynthesis of milk components due to the higher dietary energy supply, as reported also by other authors (Cant et al., 1993; Wu and Huber, 1994; Antoniewicz et al., 1996; Schingoethe, 1996; Kowalski et al., 1999). The lower protein milk level may also be related to a decrease in the levels of available glucose and blood plasma insulin, and reduced insulin efficiency in cows fed fat-supplemented diets (Antoniewicz et al., 1996). The increased milk fat concentration could result from the direct use of long-chain fatty acids from feed for milk lipid synthesis in the mammary gland, thus reducing energy expenditures for milk lipid fraction formation (Palmquist et al., 1993). Many authors (Simas et al., 1995; Cervantes et al., 1996; Kowalski, 1997; Pieszka and Brzóska, 2001) pointed to the fact that the fat content of milk from cows given fat-supplemented diets was differentiated. A decrease in milk fat concentration following diet supplementation with plant oils or fish oils, and an increase in fat content or its unchanged level following the protected fat supply were observed quite frequently (Sklan et al., 1992; Cervantes et al., 1996; Doreau and Chilliard, 1996; Elliott et al., 1996; Brzóska et al., 1999b; Brzóska and Kowalczyk, 2002).

Table 6. Fatty acid composition of milk fat (g/100 g total fatty acids)

Item		Group of cows[1]					
		1		2		3	
		days of milk sampling					
		45	120	45	120	45	120
C_4	$\bar{x}$	5.61	4.89	5.80	5.07	5.23	4.82
	sd	0.74	0.91	0.52	0.66	0.95	0.57
C_6	$\bar{x}$	3.97^{A}	3.16^{B}	3.97^{A}	3.09^{B}	3.69^{A}	3.30^{B}
	sd	0.44	0.58	0.10	0.48	0.56	0.29
C_8	$\bar{x}$	2.38^{A}	1.79^{B}	2.35^{A}	1.65^{B}	2.17^{A}	1.89^{B}
	sd	0.32	0.33	0.10	0.19	0.26	0.15
C_{10}	$\bar{x}$	4.78^{A}	3.29^{B}	4.66^{A}	3.04^{B}	4.43^{A}	3.55^{B}
	sd	0.73	0.61	0.58	0.36	0.57	0.30
C_{12}	$\bar{x}$	4.66^{A}	3.30^{B}	4.44^{A}	2.99^{B}	4.28^{A}	3.51^{B}
	sd	0.79	0.48	0.67	0.26	0.27	0.27
C_{14}	$\bar{x}$	12.72^{A}	10.93^{B}	12.87^{A}	10.10^{B}	12.09^{A}	11.00^{B}
	sd	1.06	0.49	1.50	0.75	0.54	0.55
C_{16}	$\bar{x}$	29.87^{b}	31.13^{b}	30.21^{b}	31.06^{b}	32.19^{a}	33.29^{a}
	sd	2.10	2.14	0.75	0.70	2.09	2.35
$C_{16:1}$	$\bar{x}$	1.33	1.48	1.18	1.47	1.41	1.51
	sd	0.28	0.21	0.08	0.17	0.27	0.20
C_{18}	$\bar{x}$	9.28^{B}	12.00^{A}	8.66^{B}	11.02^{A}	9.89^{B}	11.09^{A}
	sd	2.12	0.73	1.09	0.54	1.06	1.23
$C_{18:1}$	$\bar{x}$	18.47^{Bb}	21.66^{a}	19.50^{B}	24.43^{Ab}	18.40^{Bb}	20.15^{B}
	sd	2.16	2.14	1.61	0.99	1.53	1.08
$C_{18:2}$	$\bar{x}$	1.77^{b}	1.89^{b}	1.89^{b}	2.25^{Aa}	1.61^{B}	1.83^{b}
	sd	0.25	0.25	0.16	0.14	0.28	0.22
CLA	$\bar{x}$	0.34^{A}	0.35^{A}	0.38^{A}	0.38^{A}	0.28^{B}	0.34^{A}
	s	0.03	0.06	0.09	0.07	0.03	0.02
$C_{18:3}$	$\bar{x}$	0.33^{B}	0.49^{A}	0.29^{B}	0.38^{A}	0.28^{B}	0.36^{A}
	s	0.06	0.15	0.01	0.01	0.06	0.08
Other[2]	$\bar{x}$	4.49^{b}	3.64^{a}	3.80^{b}	2.37^{a}	4.05^{b}	3.36^{a}
	sd	0.08	0.07	0.05	0.05	0.08	0.06
SFA	$\bar{x}$	75.57^{A}	72.63^{Aa}	75.09^{A}	69.83^{Bb}	76.27^{Ab}	74.26^{A}
	sd	1.61	2.84	1.63	1.45	1.88	1.09
UFA	$\bar{x}$	24.43	27.73	24.91	30.17	23.73	25.74
	sd	1.67	2.83	2.03	1.14	1.72	2.06
MUFA	$\bar{x}$	21.99^{B}	24.64^{b}	22.35^{B}	27.16^{Aa}	21.56^{Ba}	23.21^{B}
	sd	1.82	2.48	1.56	0.81	1.56	1.20
PUFA	$\bar{x}$	2.44^{ab}	2.73^{ac}	2.56^{ad}	3.01^{Acd}	2.17^{Bbd}	2.53^{ad}
	sd	0.32	0.41	0.16	0.21	0.36	0.29
UFA SFA	$\bar{x}$	0.32	0.38	0.33	0.43	0.31	0.35
DFA[3]	$\bar{x}$	24.43	27.37	24.91	30.17	23.73	25.74
	sd	2.14	3.26	2.02	1.40	1.89	2.12
OFA[4]	$\bar{x}$	66.29	60.63	66.43	58.81	66.38	63.17
	sd	2.97	3.38	2.06	1.43	3.07	2.10

[1]see Table 3

[2]$C_{10:1;}$ $C_{12:1}$; C_{13}; C_{14izo}; $C_{14:1}$; C_{15}; $C_{16\ izo}$; C_{17}; $C_{17:1}$

[3]DFA – $C_{10:1}$; $C_{12:1}$; $C_{14:1}$; $C_{16:1}$; $C_{17:1}$; $C_{18:1}$; $C_{18:2}$; CLA; $C_{18:3}$

[4]OFA – C_4; C_6; C_8; C_{10}; C_{12}; C_{13}; C_{14}; C_{14izo}; C_{15}; C_{16}; C_{16izo}; C_{17}

C_{18} – neutral FA

[A,B]values in the rows with different letters differ significantly ($P \leq 0.01$)

[a,b,c,d]values in the rows with different letters differ significantly ($P \leq 0.05$)

Diet supplementation with Megapro Plus® caused a slight increase in milk urea (from 15.81 mg/dl to 16.54 and 17.20 mg/dl in group 2 and 3, respectively) (Table 5), but had no effect on the physicochemical properties of milk examined in the study. Milk density, pH and heat stability were very similar in all groups (Table 4). It should be stressed that somatic cell count was significantly lower in milk from cows of group 2 and 3 (351×10^3 in group 1 vs. 204 and 220×10^3 in group 2 and 3, respectively) (Table 4). Somatic cell count is one of the milk classification criteria, among others from the aspect of milk suitability for processing. It is also an indicator of the healthy condition of the mammary gland (Jóźwik et al., 2004).

An analysis of milk fatty acid composition on the 45th and 120th day of lactation showed that the concentration of saturated fatty acids decreased in all cows over this period. This tendency was particularly visible in group 2 ($P \leq 0.01$). On the contrary, the concentration of unsaturated fatty acids, both MUFA and PUFA, increased (Table 6). The increased energy concentration in the diet (group 2) also caused a decrease in medium-chain cholesterologenic acids (C_{10}–C_{16}), especially on the 120th day of lactation, which is a beneficial effect. A significant increase in desirable acids, $C_{18:1}$ and $C_{18:2,}$ and a slighter increase in conjugated linoleic acid (CLA) were also observed. It was also found that milk from group 2 cows was characterized by a higher UFA:SFA ratio (on the 120th day of lactation), and the highest proportion of hypocholesterolaemic acids (DFA – 30.17 g/100 g FA). It would be difficult to explain changes in fatty acid concentrations in milk from group 3 cows, i.e. higher levels of saturated fatty acids accompanied by lower levels of unsaturated fatty acids (MUFA and PUFA), particularly on the 120th day of lactation, as compared with their concentrations determined in group 1 and 2. This could result from the fact that group 3 cows received the supplement Megapro Plus® and a concentrate containing 19% crude protein and 10% rapeseed meal (like in group 1 – control), in contrast to group 2, where the concentrate contained 3% rapeseed meal only. As reported by Beaulieu and Palmquist (1995) and Jensen (2002), modification of the fatty acid profile of milk fat may be related to a limited de novo synthesis of short- and medium-chain fatty acids in the mammary gland due to an increased supply of long-chain fatty acids (particularly unsaturated) in the ration. Changes in the fatty acid composition of milk fat towards increasing unsaturation have a beneficial effect on the dietetic value of milk and physical properties of butter (Noakes et al., 1996; Potkański et al., 1997; Brzóska et al., 1999a). The possibility to modify the fatty acid composition of milk fat by dietary fat supplementation , including salts of plant oil fatty acids, was also demonstrated by other authors (Grummer, 1991; Brzóska et al., 1999b; Drackley et al., 2001; Brzóska and Kowalczyk, 2002; Schroeder et al., 2002, 2004).

CONCLUSION

The results of the present study show that the energy-protein supplement Megapro Plus® enables energy enrichment of diets for cows at the initial stage of lactation, which in turn allows to obtain higher yields of milk and major milk components. The process is accompanied by increased unsaturation of milk fat, and positive changes in the fatty acid composition, reflected by improved health properties of milk.

Increased dietary levels of both energy and protein (group 3), i.e. diet supplementation with Megapro Plus® combined with a high (10%) "00" rapeseed meal content in a concentrate, had no significant effect on improvement in the fatty acid profile, i.e. changes towards increasing unsaturation of milk fat. This suggests that in the case of Megapro Plus® supplementation particular attention should be paid to the rapeseed meal content of the dairy cow ration.

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