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Effect of linseed oil fatty acid calcium salts and vitamin E on milk yield and composition*

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ABSTRACT

Eight Holstein Red-and-White cows were used in two squares of a 4 x 4 Latin square design experiment and fed for 84 days (weeks 4-16 of lactation) with Ca salts of fatty acids (CaSFA) of linseed oil and animal fat. Experimental diets contained 0, 3, 6 and 9% CaSFA (on DM basis) and vitamin E at doses of 40 and 168 mg kg^{-1} DM of concentrate (DM). Cows were fed grass silage and 0.280 kg of concentrate per kg of milk. Average FCM yield was 24.0±0.5 kg/d^{-1} with 40.0±0.7 and 31.2±0.3 g/kg^{-1} fat and protein, respectively. No significant effects of CaSFA or vitamin E on feed intake, milk yield, milk fat, protein or lactose contents were received. A tendency towards decreasing protein and increasing milk fat content was observed at a 9% CaSFA in the diet. The addition of CaSFA significantly (P>0.01) elevated UFA (78.07 to 67.06 g/100 g), MUFA (19.44 to 29.18 g/100 g), and PUFA (2.49 to 3.76 g/100 g). DFA (a hypocholesterolemic acid) in milk was increased from 29.35 to 42.59 g/100 g (P<0.01) but total cholesterol decreased from 10.43 to 10.02 mg/100 ml of milk (P>0.05). CaSFA from linseed oil and animal fat significantly decreased the concentration of C_{10}, C_{12} and C_{14} acids, but slightly increased the concentration of $C_{18:1}$, $C_{18:2}$, $C_{18:3\ n3}$, $C_{18:3n6}$ in the milk (P>0.01). The concentrations of EPA and DHA were not affected by treatments (P>0.05). There were no significant effects of vitamin E on the fatty acid content in milk (P>0.05).

INTRODUCTION

Coronary heart disease is one of the major concerns of modern human medicine. On average, milk fat, which has been identified as hypercholesterolemic, contains about 70% saturated FA, 25% monounsaturated FA and 5% polyunsatu-

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rated FA (Storry, 1988). Consumption of medium long chain fatty acids (miristic, palmitic) in dairy products can stimulate low density lipoprotein (LDL) synthesis in the human liver. This fact caused a dramatic decrease in butter consumption and lowered the demand for milk fat in many countries. Studies have shown a direct correlation between the levels of dietary ω3 (n-3) FA and reduced incidence of hypertension, atherosclerosis, and/or cardiovascular diseases (Crawford et al., 1989; Zöllner and Tató, 1992). Polyunsaturated FA (PUFAs) such as γ-linolenic acid (GLA) and α-linolenic (ALNA) are very effective in prevention of heart disease. They are precursors of prostaglandins and leucotrienes that play important roles in the protection of blood vessels from atherosclerosis (Bjerve et al., 1989; Kulasek and Bartnikowska, 1994). Inclusion of full fat canola, sunflower or heated rapeseed seeds in the diets of lactating cows decreased the concentrations of short- and medium-chain FA in milk fat (Ashes et al., 1992; Strzetelski et al., 1993; Mansbridge and Blake, 1997). Infusion of oil directly to the intestine or feeding as calcium FA soaps, resulted in significant changes in the fatty acid profile of milk (Christensen et al., 1994; Kennelly, 1996). Linseed oil is a rich source of PUFAs and has a strong effect on milk fat composition when infunded into the duodenum (Hagemaister et al., 1988). The effect of CaSFA made from linseed and animal fat (Erafet, ERA Sp. z o.o.) on milk composition has not been evaluated yet. Increasing the unsaturated fatty acid content of milk can stimulate auto-oxidative reactions in milk fat. An oxidative taste of milk can develop spontaneously. The vitamin E content of stored feed may decrease auto-oxidation (Atwal et al., 1990; McDowell et al., 1996).

The objective of this study was to determine the effect of both CaSFA, from linseed oil and animal fat, as well as vitamin E on FA, particularly α-linolenic acid (ALNA) and γ-linolenic (GLA) contents in milk.

MATERIAL AND METHODS

Animals and feeding

The possibility of increasing CaSFA from linseed oil and animal fat as well as vitamin E transfer to milk by feeding CaSFA and vitamin E to cows was examined in this experiment. The experiment involved eight Red-and-White Lowland cows, allocated to four groups in a 4 x 4 x 2 Latin square design (4 treatments, 4 periods, 2 squares) that were fed for 84 days with four feeding treatments of CaSFA and two treatments of vitamin E. Eight cows were randomly assigned to two squares. Experimental treatment 1 consisted of four concentrates, with or without CaSFA. CaSFA was 3, 6 and 9 % of DM intake. Additionally, the cows in two separate squares received vitamin E (dl-α-tocopheryl acetate) as treatment 2, at doses of 40 and 168 mg/kg DM of concentrate. All cows received the same amount of grass

silage. The concentrates were fed individually in equal amounts during the two milkings at a fixed rate of 0.28 kg $^{-1}$ of milk yield. All cows were fed according to Polish Standards (Ryś, 1993). The cows were in weeks 4 to 16 of their second to fourth lactation and were chosen from a herd of 100 cows according to age, lactation, date of calving, body weight and current productivity. The concentrate contained ground barley, rapeseed meal, blood and feather meal, inert fat Erafet, made partly from linseed oil and animal fat, and mineral-vitamin premix with vitamin E. The cows were housed in individual stalls without litter. Each of the four feeding periods lasted 21 days, including an 18-day adaptive period plus the last 3 days of sample collection. Silage and concentrate consumption were determined daily. Milk yield was recorded and samples were collected on two consecutive a.m. and p.m. milkings every last three days of each period for fat, fatty acids, protein, lactose, acidity, density and renneting time. Body weights were recorded for 5 consecutive days at the start and end of each feeding period. Silages and concentrate were sampled once a week, bulked, and used for analysis. Blood samples were drawn from jugular veins after each period. Samples were drawn in heparinized vacutainers and stored on ice; plasma was prepared and stored at –18° C.

Measurements and chemical analysis

Chemical composition of feeds was determined by conventional methods (AOAC, 1990). Dry matter was determined at 105° C and its content in silages was corrected for volatile substances (Dulphy and Demarquilly, 1981). Total N and N fraction in milk were determined by a Kjeldahl technique using the procedure of Gordon and Kalan (1983). Ammonia N in silage was released by magnesium oxide, removed by steam distillation and determined titrimetrically on a Büchi Analyzer (Skulmowski, 1974). Water-soluble carbohydrate was determined colorimetrically (Dubois et al., 1956), neutral detergent fibre (NDF) and acid detergent fibre (ADF) were estimated according to Goering and Van Soest (1970). The fatty acid and alcohol levels in silages and milk were determined as methyl esters using GLC Varian 3400 equipment with a DB-FFAP Gas column and procedure based on the method of Atwal et al. (1990). α- and γ-tocopherol in milk were recorded using HPLC and the procedure described by Hidiroglou (1989). Fat, protein and lactose contents of milk, milk acidity, density and renneting time were determined according to Polish Standards (PN 68/A-86122). Glucose, protein, urea, triglycerols, and cholesterol were assayed using kits produced by Cormay Diagnostyka S.A. (Warsaw, Poland) in heparinized blood plasma samples. Thyroxine (T_3), triiodthyronine (T_3) and prostaglandin E2 were estimated using an isotope procedure with commercial kits (T_3-RIA-PROP, T_4-RIA-PROP produced by OBRJ POLATOM (Otwock-Świerk, Poland), and prostaglandin E 2 using a ^{125}I RIA KIT produced by the Institute of Isotopes C.O. LTD, (Budapest, Hungary).

The results were subjected to analysis of variance using the statistics software package Statgraphics Plus 6.0 (1992). Treatment means were compared using Tucke'y multiple range test for CaSFA concentration and Student's t test for vitamin E content in the diet (Elandt, 1964).

RESULTS AND DISCUSSION

The composition of rations is given in Table 1, feed fat Erafet in Table 2 and chemical composition of feeds in Table 3. Average dry matter intake was 8.94±0.24 kg d^{-1} of silage and 5.62±0.13 kg d^{-1} of concentrate and was not affected by treatments. The diets that contained CaSFA decreased milk production and protein concentration in the milk, but the fat concentration in milk was not significantly increased (P>0.05; Table 4). These results are in agreement with some studies (Drackley and Schingoethe, 1986; Cervantes et al., 1996), but in disagreement with others (Erickson et al., 1992; Kim et al., 1993). The similar nutrients intake was observed when cows were fed diets with and without linseed (Kennelly and Khorasani, 1992; Khorasani and Kennelly, 1994). Production of milk and FCM were not affected (P>0.05) by vitamin E supplementation. Atwal et al. (1990) found that feeding cows α-tocopherol improved the transfer of vitamin E to milk in early lactation, but McDowell et al. (1996) showed a correlation between vitamin E supplementation for cows and its concentration in colostrum.

TABLE 1

Ingredients in the rations for dairy cows, % DM

Ingredients	CaSFA, % DM of the diet			
	control	3	6	9
Grass silage	62.95	63.30	63.75	62.10
Barley ground	30.00	26.00	22.00	20.00
Rapeseed meal	1.60	2.10	2.50	3.00
Blood and feather meal	4.00	4.25	4.50	4.75
CaSFA (Erafet)	–	3.00	6.00	9.00
Limestone	0.40	0.30	0.20	0.10
Dicalcium phosphate	0.60	0.60	0.60	0.60
Magnesium oxide	0.20	0.20	0.20	0.20
NaCl	0.20	0.20	0.20	0.20
Mineral-vitamin premix*	0.05	0.05	0.05	0.05
Protected methionine** (g/d^{-1})	15	15	15	15

* Polfamix for ruminants, „Polfa" Kutno S.A.: Ca 160, P 60, Na 80, Mg 30, Zn 6, Cu 0.8, Co 0.03, Mn 2, I 0.1, Se 0.02 g/kg, vit. A 1 000 000, vit. D_3 120 000 IU/kg with application of 20 kg/t of concentrate mixture

** Smartamine, Rhône-Poulenc

TABLE 2

Fatty acids composition of Erafet fat

Fatty acid	g/100 g	Fatty acid	g/100 g
C_{6}	0.24	C_{20}	0.26
C_{8}	0.07	$C_{20:4}$	0.04
C_{10}	0.08	$C_{20:5}$	0.02
C_{12}	0.08	C_{22}	0.13
C_{14}	1.29	$C_{22:1}$	0.55
C_{16}	16.02	$C_{22:6}$	0.34
$C_{16:1}$	1.78	SFA	29.23
C_{18}	11.08	UFA	70.77
$C_{18:1}$	31.56	MUFA	33.89
$C_{18:2}$	8.67	PUFA	36.88
$C_{18:3\ n3}$	27.76	DFA	81.85
$C_{18:3\ n6}$	0.03	OFA	18.15

TABLE 3

Chemical composition and nutritive value of feeds

Nutrients, %	Grass silage	Concentrate mixtures			
		CaSFA content in the diet, DM %			
		control	3	6	9
Dry matter	24.03	86.08	86.79	87.09	87.25
Organic matter	89.99	93.71	94.00	93.70	92.18
Crude protein	21.31	25.42	23.93	22.87	24.34
Ether extract	5.07	2.03	5.53	11.27	17.30
Crude fibre	32.41	6.79	6.15	5.31	5.48
N-free extractives	31.20	59.47	58.39	54.25	45.06
Ash	10.01	6.39	6.00	6.30	7.82
NDF	69.85	43.50	41.10	38.35	37.34
ADF	34.21	6.57	7.70	7.80	7.54
Nutrients, kg^{-1} of DM					
crude protein, g	213.1	254.2	239.3	228.7	243.4
ME, MJ	9.80	12.53	13.17	14.15	15.10
NEL, MJ	5.74	7.13	7.32	7.72	7.91
UFL, g	0.91	1.08	1.07	1.30	1.40
PDIN, g	118	147	148	149	145
PDIE, g	89	147	143	139	134

TABLE 4

Milk yield and composition

Item	CaSFA, % DM in daily ration				Vitamin E		SE
	control	3	6	9	40	164	
Milk yield, kg d^{-1}	25.00	23.74	22.91	23.59	23.67	23.95	0.51
FCM, kg d^{-1}	24.59	24.35	23.70	23.81	24.88	23.47	0.51
fat, %	3.89	4.17	4.23	4.06	4.23	3.94	0.09
protein, %	3.28	3.19	3.08	3.12	3.15	3.19	0.04
lactose, %	5.06	5.19	5.17	5.13	5.17	5.11	0.02
total cholesterol, mg/100 ml	9.85	10.84	11.22	10.14	10.41	10.62	0.48
α-tocopherole, Fg/ml	0.824	0.636	0.625	0.528	0.646	0.660	0.042
γ-tocopherole, Fg/ml	0.018	0.026	0.027	0.017	0.020	0.024	0.003
Yield, g d^{-1}							
fat	969	990	953	955	995	939	21
protein	820	754	706	734	746	762	18
lactose	1221	1245	1242	1233	1265	1206	28
Acidity, °SH	6.87	6.45	6.40	6.39	6.64	6.42	0.11
Renneting time, s	144.1	182.8	203.9	185.6	169.0	189.2	8.8
Cows body weight, kg	599	611	609	608	610	604	8.5
Nutrient utilization per 1 kg of milk:							
dry matter, kg	0.58	0.61	0.64	0.62	0.60	0.62	0.07
crude protein, g	131.40	137.24	139.15	140.40	134.56	139.33	10.66
UFL	0.56	0.60	0.67	0.66	0.62	0.64	0.06
PDI, g	74.16	79.61	82.67	80.20	77.69	80.42	5.14

Milk fat was not altered significantly by treatments ($P>0.05$). These data agree with those from other studies indicating that CaLCFA fed to lactating dairy cows did not alter the percentage of fat in milk (Erickson et al., 1992; Schuff et al., 1992). A positive effect on milk fat percentage as result of oil seeds supplementation has been reported by Ashes et al. (1992) and Strzetelski et al. (1993). In contrast, milk fat percentage was not influenced by feeding sunflower seeds, or extruded soyabeans in other studies (Lightfield et al., 1993). In our study, fat percentage decreased when vitamin E was added to the diet at a higher dose, but the differences were not significant ($P>0.05$).

Milk protein decreased in cows fed diets containing supplemental CaSFA salt. This agrees with the results of several studies (Erickson et al., 1992; Kim et al., 1993). In this study the protein percentage in milk from cows fed the diet supplemented with CaSFA tended to decrease, however, the proportion of casein N to total N in the treatments were similar. The effect of vitamin E on milk protein was not significant ($P>0.05$).

The lactose content in milk was higher in cows fed diets containing supplemental CaSFA, but the differences between treatments were not significant (P>0.05). Lactose percentage were not affected by fat (Kim et al., 1993) or vitamin E supplementation. Similarly, there were no significant differences in the yield of fat, protein and lactose, milk acidity and renneting time.

There was a tendency towards a higher total cholesterol and lower tocopherol content in the milk from cows fed the ration with the higher CaSFA content. The level of vitamin E did not affect any of the factors significantly (P>0.05).

The N content in milk was similar (P>0.05) for cows fed all diets (Table 5). Many studies have reported a lower or unchanged level of total N and true protein N content when fat was included in the diet (LaCount et al., 1994). Nitrogen fractions were not affected by supplemented CaSFA, however, there was a tendency towards lower total N, true protein N and casein N levels in the milk of cows fed the higher CaSFA in the ration. The same tendency was observed in the N fraction yield in the milk. These changes are similar to those often observed when supplemental fats are fed to cows (DePeters and Cant, 1992). In other studies, milk crude protein was decreased when fat was included in the diet for cows (Gagliostro and Chilliard, 1991; Christensen et al., 1994). There was no significant effect of vitamin E on total, true and casein nitrogen fractions in the milk, but did significantly affect the N whey concentration (P<0.05). The higher vitamin E level in the ration increased the N whey concentration in the milk.

TABLE 5

Nitrogen fraction in the milk

Item	CaSFA, % DM in daily ration				Vitamin E		SE
	control	3	6	9	40	164	
In milk, %							
N total	0.514	0.499	0.482	0.488	0.493	0.499	0.006
N true protein	0.483	0.465	0.447	0.454	0.459	0.466	0.006
NPN	0.031	0.033	0.035	0.034	0.033	0.033	0.001
N casein	0.384	0.372	0.351	0.363	0.364	0.371	0.007
N whey	0.099	0.095	0.096	0.091	0.088[b]	0.102[a]	0.003
N true, % N total	93.9	93.4	92.6	93.0	93.2	93.3	0.3
N casein, % N total	74.7	74.4	72.7	74.2	75.3	72.7	0.7
Yield, kg/d $^{-1}$							
N total	0.128	0.124	0.111	0.115	0.117	0.122	0.003
N true protein	0.120	0.116	0.103	0.107	0.109	0.114	0.003
NPN	0.008	0.008	0.008	0.008	0.008	0.008	0.003
N casein	0.095	0.092	0.081	0.086	0.088	0.089	0.002
N whey	0.025	0.024	0.022	0.023	0.021	0.025	0.001

[a,b] – P≤0.05

Inclusion of CaSFA in the diet altered the fatty acid composition of milk (Table 6). Dietary CaSFA decreased the concentration of saturated acids ($C_{10:0}$ and $C_{14:0}$) in the milk fat significantly ($P<0.01$), without changing $C_{16:0}$ or $C_{18:0}$. Dietary CaSFA did not affect weight percentages of C_6, C_8, C_{16} and $C_{16:1}$, but increased the percentage of mono- and polyunsaturated acids ($C_{18:1}$, $C_{18:2}$, $C_{18:3,\ n3}$, $C_{18:3,\ n6}$) in the milk fat significantly ($P<0.01$). This decrease indicated lower *de novo* FA synthesis within the mammary gland, which was described by Chouinard et al. (1997). Decreases in weight percentages of short- and medium-chain fatty acids and increases in weight percentages of long-chain fatty acids in milk were similar to those observed when raw whole soyabean seeds, heat-treated whole soyabean seeds or Ca-LCFA were fed (Mohamed et. al., 1988; Canale et al., 1990). They have frequently been observed with the addition of long-chain FA to the diet (Storry, 1988). Cows receiving CaSFA in their diet had significantly higher PUFA-3 and

TABLE 6

Fatty acid composition of the milk fat, g/100 g

Item	CaSFA, % DM in daily ration				Vitamin E		SE
	control	3	6	9	40	164	
C_6	5.18	5.92	4.92	4.45	5.05	5.12	0.22
C_8	5.37	5.25	4.46	3.77	4.58	4.85	0.23
C_{10}	9.01^{a}	8.34^{ab}	6.86^{ab}	5.42^{b}	7.26	7.55	0.43
C_{12}	7.30^{A}	5.96^{B}	4.73^{AB}	4.07^{B}	5.30	5.73	0.36
C_{14}	15.43^{a}	14.32^{ab}	11.72^{ab}	10.60^{b}	12.52	13.51	0.57
C_{16}	27.82	26.94	27.22	27.35	27.13	27.52	0.22
$C_{16:1}$	1.50	1.42	1.51	1.68	1.49	1.57	0.06
C_{18}	7.63	9.16	11.07	10.24	10.05	9.00	0.54
$C_{18:1}$	17.67^{B}	19.50^{AB}	23.33^{AB}	27.70^{A}	22.78	21.32	1.03
$C_{18:2}$	1.60^{B}	1.85^{AB}	2.34^{AB}	2.75^{A}	2.03	2.23	0.11
$C_{18:3\ n3}$	0.66^{C}	0.88^{BC}	1.31^{AB}	1.50^{A}	1.05	1.13	0.08
$C_{18:3\ n6}$	0.05^{B}	0.10^{AB}	0.14^{A}	0.15^{A}	0.11	0.11	0.05
C_{20}	0.04	0.06	0.09	0.04	0.06	0.06	0.007
$C_{20:4}$	0.04	0.04	0.04	0.03	0.03	0.04	0.002
$C_{20:5}$	0.02	0.02	0.02	0.02	0.02	0.02	0.002
C_{22}	0.01	0.02	0.02	0.01	0.02	0.02	0.002
$C_{22:6}$	0.20	0.22	0.23	0.21	0.22	0.22	0.01
SFA	78.23^{A}	75.97^{A}	71.08^{AB}	65.94^{B}	72.25	73.36	1.19
UFA	21.77^{B}	24.03^{AB}	28.92^{AB}	34.06^{A}	27.75	26.64	1.13
MUFA	19.19^{B}	20.93^{AB}	24.84^{AB}	29.39^{A}	24.28	22.90	1.05
PUFA	2.58^{C}	3.10^{BC}	4.08^{AB}	4.67^{A}	3.46	3.75	0.20
DFA	29.15^{B}	33.20^{AB}	39.99^{AB}	44.30^{A}	37.67	35.65	1.61
OFA	70.85^{A}	66.80^{AB}	60.01^{AB}	55.70^{B}	62.33	64.35	1.61

^{a,b} – $P\leq0.05$

^{A,B,C} – $P\leq0.01$

PUFA-6 concentrations than the control cows. The increase in the $C_{18:1}$, $C_{18:2}$ and $C_{18:3}$ content of milk was a direct consequence of the transfer of these fatty acids from CaSFA to the milk. This data agrees with results obtained by Aii et al. (1991), who investigated the effect of calcium soap from linseed oil on cow milk fatty acid composition. This decrease in *de novo* FA synthesis has been attributed to direct inhibition of mammary acetyl-coenzyme A carboxylase activity because of increased mammary uptake on long-chain FA soap from plasma triacylglycerols (Storry, 1988). Another factor that could be responsible for this decrease in mammary synthesis could be the increasing concentration of trans-$C_{18:1}$ and cis-$C_{18:1}$ in milk fat as the dietary CaSFA level increased (Chouinard et al., 1997). This data is in agreement with that of LaCount et al. (1994) indicating that postruminal administration of FA probably inhibits the enzymatic pathway for *de novo* FA synthesis by the mammary gland. The favourable effect of linseed seeds on changing milk FA composition was shown by Kennelly and Khorasami (1992), however, linseed feeding produced relatively small changes in the concentration of $C_{18:3}$ in milk, indicating that extensive biohydrogeneration of α-linolenic acid occurred in the rumen. Lipids, particularly those containing high levels of PUFA, have an adverse effect on rumen microflora and fibre digestion (Kowalczyk et al., 1977), and at high levels can reduce yields of milk and milk constituents. Our study shows that intake of vitamin E by cows had no effect on the proportion of fatty acids in the milk ($P>0.05$). Production and manufacturing properties of milk and milk products containing approximately 20% $C_{18:2}$ required the antioxidants to prevent autoxidation and development of off-flavours (McDonald and Scott, 1977). The level of $C_{18:2}$ in our fat-modified milk was much lower.

The CaFA salt made partly from linseed oil fed in the diet did not elevate the eicosapentaenoic (EPA, $C_{20:5}$) or docosahexaenoic acid (DHA, $C_{22:6}$) contents in milk (Table 6). The concentrations of hypocholesterolemic acids increased from 29.15% (control) to 44.30% (9% in DM) in milk fat.

The plasma metabolite and hormone concentrations (Table 7) were not significantly different, however, feeding CaSFA significantly increased total cholesterol and high-density lipoprotein (HDL) contents in blood plasma samples ($P<0.05$). Plasma glucose, protein and urea were similar in all cows regardless of the diet fed ($P>0.05$). There were no significant differences in thyroxine (T_3) and triiodthyronine (T_3) concentrations in blood samples ($P>0.05$). A tendency to reduce prostaglandin (PGE2) was observed when a higher level of CaSFA was supplemented in the ration ($P>0.05$).

CONCLUSIONS

This study demonstrated that feeding CaSFA from linseed oil and animal fat significantly increased the proportion of $C_{18:1}$ monounsaturated and $C_{18:2}$, $C_{18:3}$

TABLE 7

Metabolite and hormone level in the blood plasma

Item	CaSFA, % DM in daily ration				Vitamin E		SE
	control	3	6	9	40	164	
Glucose, mg/100 g	57.86	56.81	54.40	56.69	53.39	59.49	2.22
Protein, mg/100 g	11.33	11.06	11.29	10.76	10.63^{b}	11.58^{a}	0.18
Urea, mg/100 g	60.02	53.73	51.26	57.17	57.82	53.27	2.49
Thriglycerols, mg/100 g	15.21	17.88	17.53	18.99	17.0	17.73	0.81
Total cholesterol, mg/100 g	157.53^{c}	174.70^{b}	213.17^{ab}	228.99^{a}	202.55	184.51	10.56
HDL, mg/100 g	129.45^{b}	148.99^{ab}	175.64^{ab}	189.29^{a}	166.95	154.74	7.61
LDL, mg/100 g	25.29	22.35	34.27	35.89	32.31	26.59	4.79
T_3, nmol/l	0.582	0.666	0.644	0.681	0.653	0.634	0.18
T_4, nmol/l	85.19	60.61	99.32	93.11	75.44	93.67	7.43
PG E2, ng/ml	0.6756	0.5606	0.5491	0.4771	0.6545	0.4768	0.0528

$^{a, b}$ – $P \leq 0.05$

polyunsaturated fatty acids in the milk without causing metabolic disturbances. The lack of significant interactions of the tested factors and vitamin E in the diet indicated that supplementing CaSFA was unaffected by adding vitamin E to the diet. In terms of human nutrition, this change in FA have been reported to constitute the hypocholesterolemic portion of milk fat.

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STRESZCZENIE

Wpływ mydeł wapniowych kwasów tłuszczowych oleju lnianego oraz witaminy E na wydajność i skład mleka krów

W doświadczeniu przeprowadzonym na 8 krowach rasy czerwono-białej, w układzie podwójnego kwadratu łacińskiego, badano wpływ dodatku 0, 3, 6 lub 9% soli wapniowych kwasów tłuszczowych (CaKT) oleju lnianego lub tłuszczu zwierzęcego (SM dawki pokarmowej) oraz 40 i 168 mg witaminy E/kg paszy treściwej (SM) na wydajność, skład i frakcje azotu mleka oraz podstawowe wskaźniki krwi.

Nie stwierdzono istotnego wpływu rosnących dawek soli CaKT na wydajność mleka oraz zawartość w nim białka, tłuszczu, laktozy i cholesterolu, a także na poziom frakcji azotu w mleku, w tym kazeiny. Stwierdzono ujemny istotny wpływ dodatku soli CaKT na zawartość kwasu kaprynowego, laurynowego i mirystynowego w mleku. Skarmianie soli CaKT wpłynęło na istotne zwiększenie zawartości kwasu oleinowego, linolowego, α- i γ-linolenowego w mleku natomiast zwiększyła się zawartość sumy kwasów o działaniu hypocholesterolemicznym z 29,15 do 44,30 %. Zwiększający się udział soli CaKT wpłynął istotnie na wzrost poziomu cholesterolu całkowitego i frakcji HDL w surowicy krwi. Nie stwierdzono istotnego wpływu poziomu witaminy E w paszy treściwej na wydajność i skład mleka.