POLISH JOURNAL OF FOOD AND NUTRITION SCIENCES
Pol. J. Food Nutr. Sci. 2003, Vol. 12/53, No 2, pp. 53–56

THE INFLUNCE OF CARROT ADDITION TO COW'S RATION ON THE LEVEL OF VITAMINS AND FATTY ACIDS IN COW MILK*

Teresa Nałęcz-Tarwacka, Alicja Karaszewska, Krzysztof Zdziarski

Cattle Breeding Department, Faculty of Animal Sciences, Warsaw Agricultural University, Warsaw

Key words: milk, cows, carotene, vitamins, fatty acids

The aim of the studies was to determine whether the addition of carrot to feeding ration for cows affected an increase of vitamins and β-carotene content in milk as well as whether it improved the composition of fatty acids in milk fat. The obtained results indicate that the applied addition increased not only the content of vitamin A but also the quantity of milk fatty acids: MUFA and PUFA. We should also stress the increase in the level of conjugated linoleic acid (CLA) from 0.47 g/100 g of fat in the control group to 0.65 g in the experimental group.

INTRODUCTION

The opinions on the consumption of milk and its products have been changing since the moment of stating the presence of biologically active, health promoting substances in the milk. For example, the conjugated linoleic acid (CLA) is considered as fatness-preventing, anti-atherosclerotic, anti-cancerogenic and immunity-stimulating factor. The dietetic and health promoting values of milk fat are determined not only by fatty acids, but also by the content of the present vitamins and carotene. According to Jensen *et al.* [1999], the content of vitamins A and E and β-carotene in milk is dependent on their level in the consumed feeds. The contents of these components are higher during the summer feeding period, based on green forage. Vitamin E and carotene are decisive factors for resistance of cow to mastitis. However, the information on relations between their content in feed, in blood and in milk is rather scarce.

As it is given by Chouinard *et al.* [1999], the milk and milk products are the main source of CLA in human diet. Changes in the CLA level in the milk fat may occur due to the following reasons: addition of oily plants to a ration, manipulation of rumen fermentation, and direct addition of CLA to the feed.

Numerous studies, including Brzóska [1998], Focant *et al.* [1998], Kelly *et al.* [1998], Dhiman *et al.* [1999], Pisulewski *et al.* [1999], Timothy *et al.* [2000], and Solomon *et al.* [2000], concerned modification of fatty acid composition *via* feeding system.

The CLA values, as obtained in the studies of Dhiman *et al.* [1999], amounted to: 0.34 g/100 g of fat in the control group, 0.69 g for the groups fed the rations containing the addition of soy seeds, and 0.6 g for the groups fed the diet with cotton seed addition.

In the studies of Chouinard *et al.* [1999], the following values of CLA were obtained: 0.43 g/100g of fat for the control group and from 0.95 to 1.52 g for the cows receiving CLA in the ration.

The extremely favourable effect of pasture feeding on the level of unsaturated fatty acids, especially of CLA, was found. Kelly *et al.* [1998] obtained the mean content of CLA in the milk of cows fed the total mixed ration (TMR) diet on the level of 0.45 g/100 g of fat (fluctuations from 0.24 to 0.7). For the cows grazed only on the pasture, the mean value was equal to 1.09 g/100 g of fat (variations from 0.63 to 1.81). These authors confirm that the differences in the CLA level in the milk were dependent on its presence in the ration of fresh feed, not in the preserved one.

Feeding dairy cows during the winter period is based on the preserved feeds. The non-preserved feeds such as beets or carrot may be administered in small quantities and usually during a part of the total winter period. As it results from the earlier studies of Brzezińska [1988], the best effects in respect of calf, cow and the produced milk were obtained when the addition of carotene had place during the period of cow's drying off.

The aim of the conducted studies was, therefore, to determine whether the carrot addition to the ration for cows affected the increase in vitamins and β-carotene content in the milk and whether it improved the fatty acid composition of milk fat.

MATERIAL AND METHODS

The studies were conducted on 18 Black & White cows with 50–70% share of HF blood at the Experimental Plant of Warsaw Agricultural University. The cows were divided into 2 groups, 9 animals in each group. The experiment was carried on during the period running from drying off till the 20th day after calving. In both groups, feeding was similar, except for carrot addition, which was administred in the quantity of 5 kg per head a day to the cows from the

Author's address for correspondence: Teresa Nałęcz-Tarwacka, Katedra Szczegółowej Hodowli Zwierząt, Zakład Hodowli Bydła, SGGW, ul. Ciszewskiego 8, 02-786 Warszawa; tel/fax: (48 22) 853 09 55

experimental group. From the cows covered with the experiment, the milk samples were collected on the 10th and 20th day after calving and apart from the chemical composition, the level of fat-soluble vitamins, β-carotene and fatty acids, was determined. Vitamins and β-carotene were determined, using UV-VIS Spectrophotometer and fatty acids were determined in gas chromatograph of Hewlett-Packard, with flame-ionisation detector (FID).

The obtained results were subjected to two-factor variance analysis, using statistical program SAS.

RESULTS AND DISCUSSION

In Table 1, the content of vitamins and carotene in the milk of the studied cows, is given. In the milk of the cows from the experimental group, higher levels of vitamins A, D and E as well as of carotene were obtained: 431.94; 0.097; 745.88, and 175.25 in μg/L, respectively, as compared to the content of these components for the control group: 291.17; 0.072; 666.44, and 115.5. The statistically significant differences between the groups were confirmed only for vitamin A. The obtained quantities of vitamin A for the control group were lower than the results, observed in the studies of Jensen *et al.* [1999]. In the milk of cows receiving the carrot addition they were similar to those described by the above-mentioned authors (from 330 to 490 μg/L). The level of β-carotene obtained in the milk of cows from the experimental group was higher than that stated in the studies of Jensen *et al.* [1999] – from 77 to 117 μg/L.

The comparison of the content of vitamins and β-carotene in the milk of cows on the 10th and 20th day of lactation did not show any statistically significant differences in respect to the studied traits; the milk from the 10th day of lactation contained, however, a higher level of the examined components in comparison to their content on the 20th day of lactation.

The data concerning fatty acids, present in milk fat and the total content of the main groups of fatty acids, are illustrated in Table 2. The statistically significant differences between the experimental and control groups for the following unsaturated fatty acids were noticed; C4, C8, C10, C12, and C16 and for saturated fatty acids: C18:1*cis*; C18:2, CLA, and C20:1. The statistically significant differences between the groups were found in respect to the following fatty acids: saturated (SFA), monounsaturated (MUFA), and polyunsaturated (PUFA) acids.

The presented results are similar to those obtained by Kuczyńska *et al.* [1999]. The quantity of MUFA and PUFA obtained in the present studies for the experimental group were higher than the values observed by the above-mentioned authors.

We should pay attention to the increase in the CLA content from 0.47 g/100 g of fat in the milk of cows from the control group to 0.65 g/100 g of fat in the milk derived from the cows of the experimental group. The obtained CLA quantities are similar to those found in the studies of Dhiman *et al.* [1999] and lower as compared to the results of the studies of Chouinard *et al.* [1999]. As reported by Kelly *et al.* [1998], the highest CLA content may be obtained in summer during the pasture feeding and in winter in the case of using the non-preserved roughages. The non-preserved roughages affect the improvement of fermentation in rumen, thus increase the level of CLA in the milk.

The analysis of the level of fatty acids on the 10th and 20th day of lactation (Table 3) shows similar values in the

TABLE 2. The level of fatty acids in the milk of the examined cows (in g/100 g of fat).

Name of acid	Experimental group (n=16)		Control group (n=18)		Significance of differences
	LSM	SE	LSM	SE	
C 4:0	3.07	0.111	3.76	0.105	XX
C 6:0	2.07	0.048	2.08	0.044	
C 8:0	1.01	0.053	1.19	0.050	X
C 10:0	2.51	0.107	2.89	0.101	X
C 12:0	2.98	0.125	3.55	0.118	XX
C 14:0	10.19	0.242	10.19	0.229	
C 14:1	1.34	0.083	1.30	0.079	
C 15:0	0.67	0.041	0.704	0.039	
C 16:0	24.23	0.396	25.74	0.373	XX
C 16:1	2.32	0.099	2.23	0.094	
C 17:0	0.56	0.032	0.54	0.030	
C 18:0	11.61	0.561	10.91	0.529	
C 18:1*cis*	25.14	0.314	24.06	0.296	X
C 18:1*tans*	1.07	0.094	1.21	0.089	
C 18:2	2.91	1.09	2.36	0.103	XX
C 18:2 CLA	0.65	0.031	0.47	0.029	XX
C 18:3	0.82	0.029	0.77	0.028	
C 20:1	0.24	0.012	0.20	0.011	X
SFA	58.94	0.442	61.49	0.417	XX
MUFA	30.13	0.255	29.09	0.240	XX
PUFA	4.63	0.154	3.83	0.146	XX

XX – highly significant differences between the groups at p≤0.01; X – significant differences between the groups at p≤0.05

TABLE 1. The level of vitamins in the cow milk [μg/L].

Specification	N	Vitamin A		Vitamin D		Vitamin E		Carotene	
		LSM	SE	LSM	SE	LSM	SE	LSM	SE
Total mean	68	361.55	33.954	0.084	0.007	706.16	26.854	145.38	15.902
Experimental group	16	431.94	49.411	0.097	0.011	745.88	39.079	175.25	23.141
Control group	18	291.17	46.59	0.072	0.010	666.44	36.844	115.50	21.818
Significance of differences		X		NS		NS		NS	
Milk on the 10th day of lactation	17	393.78	48.018	0.086	0.011	713.55	37.98	154.81	22.489
Milk on the 20th day of lactation	17	329.33	48.018	0.082	0.011	698.77	37.98	135.94	22.489
Significance of differences		NS		NS		NS		NS	

X – significant differences between the groups at p≤0.05; NS – the differences between the groups are insignificant

TABLE 3. The level of fatty acids in the milk on the 10th and 20th day of lactation (g/100 g of fat).

Name of acid	Milk on the 10th day of lactation (n=17)		Milk on the 20th day of lactation (n=17)		Significance of differences
	LSM	SE	LSM	SE	
C 4:0	3.35	0.108	3.48	0.108	
C 6:0	1.98	0.045	2.17	0.045	XX
C 8:0	1.05	0.052	1.15	0.052	
C 10:0	2.62	0.104	2.78	0.104	
C 12:0	3.18	0.121	3.35	0.121	
C 14:0	10.03	0.236	10.35	0.236	
C 14:1	1.33	0.081	1.30	0.081	
C 15:0	0.64	0.040	0.75	0.040	X
C 16:0	24.84	0.385	25.13	0.385	
C 16:1	2.33	0.097	2.23	0.097	
C 17:0	0.54	0.031	0.56	0.031	
C 18:0	11.19	0.545	11.33	0.545	
C 18:1*cis*	25.02	0.305	24.19	0.305	
C 18:1*trans*	1.01	0.091	1.27	0.091	
C 18:2	2.77	0.106	2.51	0.106	
C 18:2 CLA	0.56	0.030	0.56	0.030	
C 18:3	0.82	0.028	0.77	0.028	
C 20:1	0.22	0.011	0.21	0.011	
SFA	59.48	0.430	60.96	0.430	X
MUFA	30.04	0.248	29.18	0.248	X
PUFA	4.4	0.150	4.06	0.150	

XX – highly significant differences between the groups at $p \leq 0.01$; X – significant differences between the groups at $p \leq 0.05$.

range of the studied acids. Statistically significant differences were found for C6:0, C15:0 acids and for the sum of saturated (SFA) and monounsaturated (MUFA) fatty acids. The interaction between the day of lactation and a given group for the studied fatty acids was statistically insignificant.

Summing up, we should state that the addition of 5 kg of carrot, as a fresh, non-preserved feed, had an influence on the increase of the vitamin A content in the milk and also, on the level of some fatty acids, including CLA, which is very important from the health state viewpoint of the milk consumers. It should be emphasised that the introduction of the carrot to the ration for the dairy cows is cheap and simple to be used in practice, in contrary to other feeding methods applied for modification of the milk composition.

SUMMING UP

The experiment was conducted with the aim to determine whether the addition of carrot in the quantity of 5 kg (per one cow/a day) to the ration during the winter feeding period affected the increase in the content of certain vitamins and β-carotene in the milk, and whether it improved the fatty acid composition of the milk fat. The experiment was carried out in the period from the cow's drying off till the 20th day of lactation. The obtained results show the increased contents of vitamin A in milk of the cows from the experimental group ($p \leq 0.05$). The statistically significant differences between the groups were observed in respect to the following acids: saturated (SFA), monounsaturated (MUFA), and polyunsaturated (PUFA).

The attention should be paid to the fact that the content of CLA increased from 0.47 g/100 g of fat in the milk derived from the cows of the control group to 0.65 g/100 g of fat in the milk of cows from the experimental group.

The increase in the level of the studied milk components, as a result of the use of carrot addition to the ration, is very important from the health state viewpoint of milk consumers.

CONCLUSIONS

1. The application of 5 kg of fresh carrot in the feeding ration for cows during the winter feeding period increased the content of vitamin A in milk.
2. The introduction of non-preserved feed during the winter feeding period had an influence on the improvement of fatty acid composition of milk fat.
3. The improvement of the quality of the studied milk parameters is very important from the health state viewpoint of the milk consumers.

*Paper presented on the IX Scientific Conference "Lepsza Żywność", 27 June 2002, Olsztyn, Poland, organized by University of Warmia and Mazury in Olsztyn, Olsztyn, Poland.

REFERENCES

1. Brzezińska M., Wpływ zróżnicowanego żywienia krów i różnych źródeł karotenu oraz witaminy "A" na poziom wybranych składników biochemicznych krwi i siary krów, a także krwi cieląt, jako wskaźników efektywności ich odchowu. Rozprawy i Studia. UW Szczecin, 1988, 1–113 (in Polish).
2. Brzóska F., Modyfikowanie składu i walorów dietetycznych tłuszczu mlecznego, 1998, *In*: Materiały z VI Szkoły Zimowej z Zakresu Hodowli Bydła. Kraków, Poland pp. 76–87.
3. Chouinard P.Y., Corneau L., Saebo A., Bauman D.E., Milk yield and composition during abomasal infusion of conjugated linoleic acids in dairy cows. J. Dairy Sci., 1999, 82, 2737–2745.
4. Dhiman T.R., Helmink E.D., McMahon D.J., Fife R.L., Pariza M.W., Conjugated linoleic acid content of milk and cheese from cows fed extruded oilseeds. J. Dairy Sci., 1999, 82, 412–419.
5. Focant M., Mignolet E., Marique M., Clabots F., Breyne T., Dalemans D., Laronddelle Y., The effect of vitamin E supplementation of cows diets containg rapeseed and linseed on the prevention of milk fat oxydation. J. Dairy Sci., 1998, 81, 4, 1095–1101.
6. Jensen S.K., Johannsen A.K.B., Hermansen J.E., Quantitative secretion and maximal secretion capacity of retinol, β-carotene and A-tocopherol into cows' milk. J. Dairy Res., 1999, 66, 511–522.
7. Kelly M.L., Kolver E.S., Bauman D.E., Amburgh M.E., Muller L.D., Effect of intake of pasture on concentrations of conjugated linoleic acid in milk of lactating cows. J. Dairy Sci., 1998, 81, 6, 1630–1636.
8. Kuczyńska B., Reklewska B., Karaszewska A., Profil kwasów tłuszczowych w mleku wymieniowym i zbior-

czym krów czarno-białych z kilku rejonów Polski. Zeszyty Naukowe Przeglądu Hodowlanego, 1999, 44, 143–150 (in Polish).
9. Pisulewski P.M., Szymczyk B., Hanczakowski P., Szczurek W., Wzbogacanie żywności pochodzenia zwierzęcego w sprzężony kwas linolowy (SKL), 1999, *In*: Materiały z VII Szkoły Zimowej z Zakresu Hodowli Bydła. Kraków, Poland, 204-213 (in Polish).
10. Solomon R., Chase L.E., Ben-Ghedalia, Bauman D.E., The effect of nonstructural carbohydrate and addition of full fat extruded soybeans on the concentration of conjugated linleic acid in the milk fat of dairy cows. J. Dairy Sci., 2000, 83, 6, 1322–1329.
11. Thimothy W.J., Keady C., Sinclair M., Deirdre A., Effects of supplementation of dairy cattle with fish oil on silage intake, milk yield and milk composition. J. Dairy Res., 2000, 67, 137–153.

Received April 2002. Revision received October 2002 and accepted January 2003.

WPŁYW DODATKU MARCHWI DO DAWKI POKARMOWEJ DLA KRÓW NA POZIOM WITAMIN I KWASÓW TŁUSZCZOWYCH W MLEKU

Teresa Nałęcz-Tarwacka, Alicja Karaszewska, Krzysztof Zdziarski

Zakład Hodowli Bydła, Wydział Nauk o Zwierzętach, Szkoła Główna Gospodarstwa Wiejskiego, Warszawa

Celem badań było określenie czy dodatek marchwi do dawki pokarmowej dla krów wpłynie na zwiększenie zawartości witamin i beta karotenów w mleku i czy poprawi skład kwasów tłuszczowych tłuszczu mleka. Uzyskane wyniki wskazują, że stosowany dodatek podwyższył nie tylko zawartość witaminy A, ale również ilość kwasów tłuszczowych w tłuszczu mleka: MUFA i PUFA. Na szczególną uwagę zasługuje zwiększenie zawartości skoniugowanego kwasu linolowego (CLA) z 0,47 g/100g tłuszczu w grupie kontrolnej do 0,65 w grupie doświadczalnej (tab. 2).