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Effects of extruded linseed dietary supplementation on milk yield, milk quality and lipid metabolism of dairy cows

P. Pezzi[1], M. Giammarco[1], G. Vignola[1], N. Brogna[2]

[1] Dipartimento di Scienze degli Alimenti. Università di Teramo, Italy
[2] Dipartimento di Morfofisiologia Veterinaria e Produzioni Animali. Università di Bologna, Italy

Corresponding author: Paolo Pezzi. Dipartimento di Scienze degli Alimenti. Facoltà di Agraria, Università di Teramo. Viale Crispi, 212, 64100 Teramo, Italy - Tel. +39 0861 266991 - Fax: +39 0861 266994 - Email: ppezzi@unite.it

ABSTRACT: Twenty Italian Friesian dairy cows were used in an experimental trial to study the effects of extruded linseed dietary supplementation on milk production, milk quality and fatty acid (FA) percentages of milk fat and total plasma lipids and plasma phospholipids. Control cows were fed a corn silage based total mixed ration (TMR) while treated animals also received 700g/head/d of extruded linseed supplementation. Feed intake was similar between groups. Milk yields was tendentially greater for cows fed extruded linseed. Milk urea content ($P<0.05$) were reduced by treatment. Results showed a significant increase n-3 FA concentration (particularly alpha linolenic acid) and a significant reduction of n-6/n-3 FA ratio in milk fat, total plasma lipids and plasma phospholipids ($P<0.001$); moreover a reduction trend ($P<0.1$) of arachidonic acid concentrations was observed in milk fat, total plasma lipids and plasma phospholipids. At last, treatment enhanced milk fat conjugated linoleic acid (CLA) percentage ($P<0.05$).

Key words: Dairy cow, Linseed, N-3 fatty acids, CLA.

INTRODUCTION – Since dietary polyunsaturated fatty acids (PUFA) are perceived to be healthier than saturated fatty acids, there has been a great deal of interest in increasing milk PUFA concentration to respond to consumers' demands. Among PUFA, particularly appreciate are n-3 and conjugated linoleic acid (CLA). Feeding oilseeds to lactating dairy cows is one method to change the proportion of unsaturated FA in milk fat, with increases as high as 40% (Kim *et al.,* 1993), although extensive biohydrogenation occurs normally in the rumen (Palmquist and Jenkins, 1980). In the present study, the effects of extruded linseed dietary supplementation on milk yield, milk quality and blood lipid metabolites are evaluated.

MATERIAL AND METHODS – The trial was carried out in a Farm of Teramo Province (Italy). Twenty Holstein Friesian dairy cows housed free stall were used. Animals were milked two times per day and fed total mixed ration (TMR). At the beginning of the trial they were divided into two homogeneous groups (age, parity, BCS, calving time, milk yield capacity and milk quality). TMR was composed (D.M. basis) by 29.03% corn silage, 18.56% alfalfa hay, 9.39% mixed hay, 13.56% corn ground, 13.56% barley ground, 10.67% soybean meal (44% C.P.), 2.7% minerals and vitamins premix, 2.16% flaked soybean and 0.37% palm oil calcium soap salts. Treated group also received 700 g/day extruded linseed supplementation mixed in TMR (2.75% of TMR D.M. basis). TMR was delivered every day at 9:00 h. Trial time was 4 weeks. Feed intake was recorded as group means by difference from daily TMR delivered and residues. One week before the starting, and two and four weeks later feed samples was taken immediately after the delivery to the animals. Samples was analysed for dry matter, crude protein, ether extract, crude ash (Martillotti *et al.*, 1987), NDF (Van Soest, 1967), and fatty acid percentages (Gas Chromatographic system Fisons Mega II). Milk yield was recorded at 0, 2 and 4 weeks after the beginning of the trial by sum of quantity of two consecutive milking. At the same times individual milk and blood (from the jugular vein) samples were collected. Each blood sample, collected at 8:00 using Lithium heparin tube, was immediately centrifuged (3500 g x 10') and plasma obtained was readily frozen at –20°C. Milk samples were taken at the milking of 06:00 h and were analysed for fat, protein, and lactose percentage, somatic cell count and urea content (Milkoskan, Foss Electric, DK).

Somatic cell count data were converted in a logarithmic scale: Somatic Cell Score (SCS; Ali and Shook, 1980). Milk fat (Folch *et al.*, 1957), total plasma lipids (Folch *et al.*, 1957), and plasma phospholipids (Solid phase extraction method) were analysed for fatty acids percentages (Gas Chromatographic system Fisons Mega II). All data were processed by multivariate analysis of variance MANOVA for repeated measures. The statistical package employed was the SPSS Version 3.0.

RESULTS AND CONCLUSIONS – Dry matter intake was not affected by dietary treatment in agreement with results of Gonthier *et al.* (2005), and averaged 22.76 kg/d (Table 1). Feeds compositions are shown in Table 1. As expected only ether extract and fatty acid composition was different between two diets; indeed treated group received 243.5 *vs* 42.1 g/head/d of alpha linolenic acid.

Table 1. Feed intake and composition of TMR and extruded linseed.

		Control	Treated	Extruded linseed
Dry Matter Intake	kg/head/d	22.63	22.88	
Lipid Intake	g/head/d	742	1004	
Dry Matter	% A.F.	57.51 ± 1.94	57.88 ± 1.43	92.88
Net Energy Lact.	Mcal/kg D.M.	1.68	1.71	2.59
Crude Protein	% D.M.	13.59 ± 1.53	13.97 ± 1.31	24.22
Ether extract	% D.M.	3.28 ± 0.42	4.39 ± 0.17	37.95
NDF	% D.M.	35.03 ± 1.50	35.19 ± 0.94	26.68
Fatty acids *				
Saturated	%FA	19.52 ± 1.49	16.39 ± 0.78	6.48
C18:1 n-9	%FA	23.04 ± 0.95	21.68 ± 0.28	19.24
C18:2 n-6	%FA	49.16 ± 2.03	34.84 ± 0.53	16.17
C18:3 n-3 (ALA)	%FA	5.98 ± 0.69	25.51 ± 0.69	53.15

(*) 2.30% and 1.57% respectively in control and treated TMR were undefined peeks.

As shown in Table 2 milk yield was higher (but not significantly) in treated group. This finding is in agreement with data of Petit *et al.* (2004). Probably higher energy content of treated diet was the cause of this finding. Interestingly milk fat percentage was not depressed by n-3 fatty acid supplementation; also this result was in agreement with Petit *et al.* (2004). Interestingly milk urea content was higher in control group ($P<0.05$); this result may be explained by a better utilization of metabolizable protein to synthesize milk protein in treated group.

Table 2. Milk production and milk quality.

		Control	Treated	SEM	Probability	
Heads	n°	10	10		Treatment	Week
Milk	kg/head/d	30.7	32.7	0.69	n.s.	n.s.
FCM 4%	kg/head/d	30.0	31.4	0.84	n.s.	n.s.
Fat	%	3.85	3.79	0.09	n.s.	n.s.
Protein	%	3.20	3.24	0.04	n.s.	n.s.
SCS	P.ts	2.97	2.03	0.34	n.s.	n.s.
Lactose	%	4.99	4.98	0.03	n.s.	n.s.
Urea	mmol/l	3.82	3.22	0.11	P<0.05	n.s.

Dietary extruded linseed supplementation significantly increased n-3 fatty acids concentration and particularly alpha linolenic acid in total plasma lipids ($P<0.001$), in plasma phospholipids ($P<0.001$) and in milk fat ($P<0.001$; Table 3). Treatment showed also a significant decrease of n-6/n-3 fatty acid ratio ($P<0.001$) and a tendentially reduction of arachidonic acid percentage ($P<0.1$) in milk fat, in total plasma lipids and in plasma phospholipids.

These findings are supported by data from other studies (Petit *et al.*, 2002; Petit *et al.*, 2004). Treated animals show a significant increase in milk fat CLA content (P<0.01) in agreement with Gonthier *et al.*, (2005).

Table 3. Fatty acid composition of milk fat.

Fatty acids		Control	Treated	SEM	Probability	
					Treatment	Week
C20:4 n-6	%	0.23	0.18	0.01	P<0.1	P<0.1
C18:3 n-3	%	0.48	0.72	0.02	P<0.001	P<0.01
CLA cis 9, trans 11	%	0.37	0.45	0.01	P<0.05	n.s.
Total n-6	%	3.18	2.80	0.06	P<0.01	n.s.
Total n-3	%	0.58	0.84	0.03	P<0.001	P<0.01
n-6/n-3 ratio		5.53	3.35	0.19	P<0.001	P<0.05

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