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Extruded soybean and flaxseed enhance fat composition of milk for Parmigiano-Reggiano cheese

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ABSTRACT – Twenty Friesian dairy cows were used in an experimental trial to study the effects of extruded full-fat soybean and flaxseed dietary supplementation, at the level authorized by Consorzio of Parmigiano-Reggiano cheese (CPRC) feeding guidelines (1.0 and 0.4 kg/cow/day), on milk production and fatty acid composition. Diet was typically based on alfalfa and mixed hays and cereals. Compared with the concentrations before trial start, CLA and DHA were significantly increased by dietary treatment. These results confirm that the inclusion of extruded full-fat soybean and flaxseed, in the amount authorized by CPRC rules, in the diet of dairy cows is a possible strategy to enhance milk fat composition.

Key words: Dairy cows, Parmigiano-Reggiano, Milk quality, CLA.

Introduction – Conjugated linoleic acids (CLA) are a series of positional and geometric isomers of linoleic acid that naturally occur in foods derived from ruminants. A study by Ip *et al.* (1999) demonstrated that cis-9, trans-11 CLA, which represents more than 82% of total CLA in dairy products (Chin *et al.*, 1992), reduces mammary tumor incidence in rats when added to the diet or consumed as a natural component of butter. Thus, increasing the concentration of cis-9, trans-11 CLA in milk may be beneficial to public health. A number of recent studies have demonstrated that substantial increases in the CLA content of milk fat can be achieved using proper animal dietary and management practices. Feeding full-fat extruded soybeans, full-fat extruded cottonseed, or sunflower oil increased the CLA content in milk (Dhiman *et al.* 1999; Kelly *et al.*, 1998). In a previous study, Formigoni *et al.* (2007) observed that the average CLA content in Parmigiano-Reggiano cheese is 0.32 mg/100 mg of fat but these values are significantly higher in cheese from factories located on mountains. Aim of this study was to evaluate if the use of feed rich in fat (extruded full-fat soybeans and flaxseed), in amounts that are authorized by the Consorzio of Parmigiano-Reggiano cheese (CPRC) feeding guidelines, was effective to enhance the CLA and omega-3 fatty acid contents in milk.

Material and methods – The research was carried out in a dairy farm with 150 Holstein milking cows, with an annexed cheese factory for Parmigiano-Reggiano cheese production. During the pre-experimental period (4 weeks), cows were fed a total mixed ratio (TMR) based on: alfalfa hay (11 kg), mixed hay (4 kg), sugar beet pulp (1.5 kg), wheat bran (1.5 kg), corn meal (5 kg), barley meal (2 kg), soybean meal 44% (1 kg) and minerals and vitamins (0.5 kg); during the following 150 days (experimental period) TMR included: extruded full-fat soybeans (1 kg) and flaxseed (0.4 kg) to fed cows with the same level of crude protein, starch and fiber fraction; diet was offered *ad libitum* and daily consumption of the entire herd was recorded as a difference between feed delivered and refusal. Twenty milking cows, representing the entire herd (age, parity, days of lactation and BCS) were selected and monitored throughout the trial for milk yield and quality. Every two weeks, including the pre-experimental period, individual samples of milk were collected from

Table 1. Fatty acids composition (% of total fatty acids) of milk from dairy cows receiving full-fat soybean and flaxseed.

Week	C4:0	C6:0	C8:0	C14:0	C16:0	C18:0	C18:1 ω-9	C18:2 ω-6	C18:3 ω-3	C18:2 c9,t11 CLA	C18:2 t10,c12 CLA	C20:4 ω-6	C20:5 ω-3, EPA	C22:6 ω-3 DHA	Total ω-6	Total ω-3	ω-6/ ω-3 ratio
0[a]	3.31	2.25	1.44	12.1	33.1	9.76	19.8	2.64	0.67	0.29	0.047	0.029	0.058	0.067	2.67	0.79	3.36
2	2.65*	1.92*	1.30	12.5	33.3	8.63	19.5	3.01	0.75	0.47*	0.056	0.022	0.054	0.082	3.03	0.89	3.40
4	2.46*	1.82*	1.26	12.9	34.4	8.72	19.2	2.49	0.82	0.37	0.049	0.019*	0.068	0.088*	2.51	0.97	2.58*
6	2.39*	1.70*	1.18*	12.4	34.2	9.30	20.1	2.40	0.79	0.46*	0.041	0.019*	0.058	0.087	2.42	0.93	2.59*
8	2.70	1.95	1.34	13.2	34.1	9.23	18.4	2.42	0.79	0.45*	0.046	0.018*	0.066	0.089*	2.44	0.94	2.59*
10	2.48*	1.77*	1.22	12.5	32.2	11.27	20.5	2.42	0.75	0.45*	0.044	0.019*	0.057	0.093*	2.44	0.90	2.70*
13	2.28*	1.85*	1.32	13.8	35.0	8.32	17.5	2.50	0.87	0.45*	0.039	0.018*	0.061	0.085	2.51	1.02	2.46*
15	2.67	1.96	1.31	12.8	33.7	9.98	19.0	2.44	0.82	0.44*	0.047	0.026	0.059	0.099*	2.46	0.97	2.52*
17	2.38*	1.85*	1.25	13.1	33.9	9.78	19.4	2.38	0.79	0.53*	0.045	0.019*	0.052	0.083	2.40	0.92	2.62*
19	2.35*	1.67*	1.11*	12.7	32.2	12.01	20.7	2.38	0.79	0.49*	0.055	0.024	0.062	0.098*	2.41	0.95	2.55*
21	2.39*	1.49*	0.94*	11.1	32.8	10.74	23.3	2.42	0.73	0.31	0.046	0.027	0.067	0.111*	2.45	0.91	2.71*
SEM[1]	0.075	0.020	0.009	0.975	3.259	1.672	4.579	0.050	0.005	0.003	0.001	0.001	0.001	0.001	0.051	0.06	0.012
P[2]	***	***	***	ns	ns	***	ns	*	ns	***	***	***	*	***	*	+	***

[a]=after four weeks of a basal diet with no addition of extruded full-fat soybean and flaxseed;
**=significant difference (P<0.05) from Week 0; [1]=pooled standard error mean;*
*[2]=ANOVA P=***=P<0.001; **=P<0.01; *=P<0.05; +=P<0.1; ns=not significant.*

the selected cows. Moreover, Parmigiano-Reggiano cheese was produced throughout the trial; cheese will be available for analyses after 24 months of seasoning. Milk analyses were performed according to AOAC (1990) and samples of milk fat were analyzed by gas chromatography to determine their fatty acid composition. Lipids extraction was performed according to the Folch method (1957); fatty acid methyl esters were prepared using the technique proposed by Christie (1989). Data were subjected to one-way ANOVA with time as the main effect and Dunnet test was used as the post-test (SAS Inst Inc, Cary NC).

Results and conclusions – The effects of the dietary supplementation with extruded full-fat soybeans and flaxseed on milk production and quality are briefly summarized.

The average of feed intake (24.2 kg DM/cow/d) was not influenced by the inclusion of extruded soybean and flaxseed. Milk yield was not influenced by treatment (average milk yield throughout the trial was 36.2±5.7 kg/d). Milk analyses (fat, protein, lactose, casein, and urea) did not show any significant differences related to treatment and averaged 3.19%, 3.20%, 4.96%, 2.48%, and 23.4 mg/100 ml of milk, respectively. Fatty acid composition of individual samples of milk are represented in Table 1. Compared with fatty acid concentrations before trial start (week 0), short chain fatty acids (butirric, caproic, and caprilic acids) and arachidonic acid were significantly reduced ($P<0.01$), while cis-9, trans-11 CLA and DHA concentrations were significantly increased (respectively +52% and +36%) ($P<0.01$). Furthermore, the omega-6/omega-3 fatty acid ratio ($P<0.01$) was significantly reduced (-20%). The increased concentration of milk CLA seems to confirm that a diet containing extruded full-fat soybean and flaxseed stimulates cis-9, trans-11 CLA production from dietary linoleic and alfa-linolenic acid. The diet that was used in the present study determined an increase of CLA and DHA concentration and reduced the omega-6/omega-3 fatty acid ratio in milk fat, thus leading to the production of milk that may be more beneficial to public health. In conclusion, the present results show that it is possible to increase the CLA content of milk for Parmigiano-Reggiano cheese production through an appropriate and targeted integration of cattle feed.

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