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EFFECT OF FEEDING EXTRUDED FLAXSEED ON MILK QUALITY OF DAIRY COWS

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Invited paper

Abstract: Aim of the present study was to evaluate the effect of feeding dairy cows with extruded flaxseed (EF) on milk quality. After a 7-d adaptation period, 40 Holstein dairy cows in midlactation were divided in two experimental groups, based on parity, milk yield and composition, and days in milk. Animals were fed for 28 d a standard total mixed ration containing or not (control) 1.8 kg/cow/d of a supplement based on extruded flaxseed (EF). Milk yield was recorded daily and individual milk samples were collected weekly for analysis. Milk yield was not affected by treatment and averaged 26.2 kg/d throughout the study. Feeding EF reduced milk fat (3.95 *vs.* 4.24%; P=0.053) and tended to reduce milk protein (3.32 *vs.* 3.50%; P=0.104). The milk from cows fed EF contained more (P<0.01) stearic (12.0 *vs.* 7.8 mg/100 mg of fat), oleic (21.2 *vs.* 18.0 mg/100 mg of fat), α-linolenic (0.85 *vs.* 0.41 mg/100 mg of fat) and vaccenic (1.43 *vs.* 0.62 mg/100 mg of fat) acids than control and also more c9,t11 CLA (0.91 *vs.* 0.59 mg/100 mg of fat). Conversely, compared with control, feeding EF reduced milk concentrations of palmitic acid (26.5 *vs.* 33.4 mg/100 mg of fat; P<0.01). The present results show that feeding EF to dairy cows is an efficient strategy to enrich milk in beneficial fatty acids such as vaccenic acid, CLA and omega-3 fatty acids. Nevertheless, the milk fat reducing effect of flaxseed as well as other sources of polyunsaturated fatty acids should be taken into account.

Key words: conjugated linoleic acids, dairy cows, flaxseed, milk quality, omega-3 fatty acids.

Introduction

During the last decades, consumer demand for improved food quality has considerably increased. Moreover, there has been an increased tendency for consumers to use food that might help preventing disease. A food can be said to be functional if it contains a component (which may or may not be a nutrient) that

affects one or a limited number of functions in the body in a targeted way so as to have positive effects on health *(Bellisle et al., 1998)*. Among nutrients that might exert a positive effect on consumer health, specific fatty acids such as omega-3 fatty acids and conjugated linoleic acids (CLA) have gained attention. Regular consumption of omega-3 fatty acids has been shown to protect against cardiovascular morbidity and mortality *(Calder, 2004)*, and might be beneficial in inflammatory diseases *(Calder, 2006)* and neurodegenerative illnesses *(Calon and Cole, 2007)*. Moreover, there is some evidence that CLA might alleviate major diseases such as cancer, atherosclerosis, diabetes and obesity *(Benjamin and Spener, 2009)*.

Flaxseed is very rich in α-linolenic acid which is the precursor of the omega-3 fatty acid family; moreover, it is known that α-linolenic acid can be converted in the rumen into vaccenic acid, and the latter acts as a precursor of CLA in the mammary gland *(Bauman et al., 1999)*.

Aim of the present study was the evaluation of the effect of feeding dairy cows with extruded flaxseed on milk quality with particular regard to fatty acid composition.

Materials and Methods

Forty Holstein dairy cows in midlactation were divided into two homogenous groups based on parity, days in milk and milk yield and composition. After a 7-d adaptation phase to the experimental base diet (containing CP 14.2%, EE 1.1%, NDF 39.9%), cows received for 28 d or not (control) 1.8 kg/cow/d of a supplement containing extruded flaxseed (EF) providing approximately 300 g/cow/d of α-linolenic acid. Diets were fed as total mixed rations. Composition of experimental diets and chemical composition of the supplement are reported in Table 1 and 2, respectively. Individual milk yield was recorded daily; individual milk samples were collected weekly from each cow starting on Day 0. All collected milk samples were analyzed for protein, fat and lactose by Milk-O-Scan whereas milk fatty acid profile was determined by gas chromatography in samples collected on Day 0 and 28. Data were analyzed by one-way ANOVA for repeated measures; differences were considered significant for $P<0.05$.

Table 1. Composition of the experimental diets

Ingredient (kg/cow/d)	Control	Flaxseed
Wheat straw	2.0	2.0
Mixed hay	12.0	12.0
Corn meal	6.2	5.9
Soybean meal	3.0	1.5
Soybean hulls	1.5	1.0
Mineral supplement	0.4	0.4
Bypass soybean	0.6	1.1
Flaxseed supplement	-	1.8
Molasses	1.5	1.5

Table 2. Chemical composition of the experimental supplement

Item	
Moisture (% as fed)	8.31
Crude protein (% as fed)	17.8
Ether extract (% as fed)	24.5
Crude ashes (% as fed)	5.14
C18:1ω9 (mg/100 mg fat)	18.9
C18:1ω6 (mg/100 mg fat)	18.3
C18:3ω3 (mg/100 mg fat)	45.8

Results and Discussion

Results regarding milk yield and composition are reported in Table 3. Milk fatty acid composition is shown in Table 4.

Table 3. Milk yield and composition in cows receiving a supplement based on extruded flaxseed

	Control	Flaxseed	SEM	ANOVA P
Milk (kg/cow/d)	26.3	26.0	0.680	0.908
Fat (%)	4.24	3.95	0.148	0.053
Protein (%)	3.50	3.32	0.089	0.104
Lactose (%)	4.69	4.70	0.053	0.690

Table 4. Milk fatty acid composition in cows receiving a supplement based on extruded flaxseed

	Control	Flaxseed	SEM	ANOVA P
C16:0	33.4	26.5	0.613	<0.001
C18:0	7.75	12.0	0.369	<0.001
C18:1t11	0.62	1.43	0.083	<0.001
C18:1ω9	18.0	21.2	0.697	0.004
C18:2ω6	1.82	1.86	0.086	0.784
C18:3ω3	0.41	0.85	0.031	<0.001
C18:2 c9,t11 CLA	0.59	0.91	0.037	<0.001
C18:2 t10,c12 CLA	0.04	0.06	0.007	0.063
C20:5ω3 EPA	0.06	0.06	0.007	0.879
C22:6ω3 DHA	0.08	0.08	0.010	0.766

Feeding dairy cows with extruded flaxseed reduced milk fat by 7%. This finding confirms the fact that dietary polyunsaturated fatty acids can induce milk fat depression in dairy cows *(Shingfield et al., 2006)*. Moreover, it has been shown that both vaccenic acid and C18:2 t10,c12 CLA are able to reduce milk fat synthesis in the mammary gland *(Bauman and Griinari, 2003)*. A tendency was observed towards a reduction in milk protein in cows receiving EF. As expected, feeding extruded flaxseed influenced milk fatty acid composition. In particular, concentrations of α-linolenic acid (+107%), oleic acid (+18%), vaccenic acid (+131%) and C18:2 c9,t11 CLA (+54%) were increased by treatment. Furthermore, EF tended to increase milk concentrations of C18:2 t10,c12 CLA. Conversely, despite the higher levels of α-linolenic acid, milk EPA and DHA concentrations were not influenced by EF. This result is in accordance with other authors *(Lacasse et al., 2002; Allred et al., 2006)* who observed an increase of EPA and DHA only in milk of cows receiving a direct source of EPA and DHA such as fish oil. Our study has produced evidence that increasing dietary levels of α-linolenic acid leads to higher milk concentrations of both vaccenic acid and CLA. This is in accordance with the results obtained by *Kelley et al. (1998)* who fed cows with a mixture of sunflower, peanut and flaxseed oil, and *Dhiman et al. (2000)* who included soybean oil in the cows diet.

Conclusion

Feeding dairy cows with extruded flaxseed has proven to be a valuable dietary strategy to improve milk fat nutritional value, increasing milk concentration of omega-3 fatty acids, vaccenic acid and CLA. Nevertheless, the milk fat reducing

effect of flaxseed as well as other sources of polyunsaturated fatty acids should be taken into account.

Uticaj ishrane ekstrudiranim lanenim semenom na kvalitet kravljeg mleka

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Rezime

Potrošnja pojedinih masnih kiselina kao što su omega-3 masne kiseline i konjugovana linolna kiselina (CLA) može da ima koristan uticaj na zdravlje potrošača. Cilj ovog rada je bio da se proceni uticaj ishrane mlečnih krava ekstrudiranim lanenim semenom (izvor α-linoleinske kiseline) na kvalitet mleka sa posebnim osvrtom na sastav masnih kiselina. Posle sedmodnevnog perioda adaptacije, 40 krava holštajn rase, na sredini laktacije, podeljeno je u dve eksperimentalne grupe, zasnovane na paritetu, dnevnom prinosu i sastavu mleka. Životinje su hranjene 28 dana standradnom potpunom smešom od 1,8 kg/kravi/dan koja sadrže ili ne (kontrolna grupa) dodatak na bazi ekstrudiranog lanenog semena (EF) koji obezbeđuje oko 300 g/kravi/dan α-linoleinske kiseline. Dodatak sadrži 24,5% masti sa 46% α-linoleinske kiseline. Prinos mleka je dnevno beležen a pojedinačni uzorci mleka za analizu su sakupljani nedeljno. Prinos mleka nije zavisio od tretmana i prosek tokom istraživanja je bio 26,2 kg/dan. Ishrana ekstrudiranim lanenim semenom dovodi do smanjenja sadržaja mlečne masti u mleku (na 3,95 sa 4,24%; P=0,053) i smanjenja sadržaja proteina (na 3,32 sa 3,50%; P=0,104). Mleko krava hranjenih ekstrudiranim lanenim semenom sadrži više (P<0,01) stearinske (12,0 umesto 7,8 mg/100 mg masti), oleinske (21,2 umesto 18,0 mg/100 mg masti), α-linoleinske (0,85 umesto 0,41 mg/100 mg masti) i vakcenske kiseline (1,43 umesto 0,62 mg/100 mg masti) nego mleko iz kontrolne grupe a takođe sadrži više i konjugovane linolne kiseline (0,91 umesto 0,59 mg/100 mg masti). Obrnuto, u poređenju sa kontrolnom grupom, ishrana ekstrudiranim lanenim semenom smanjuje koncentraciju palmitinske kiseline u mleku (26,5 umesto 33,4 mg/100 mg masti; P<0,01). Uprkos višem nivou α-linoleinske kiseline, koncentracije EPA i DHA u mleku nisu bile pod uticajem lanenog semena. Dobijeni rezultati pokazuju da ishrana mlečnih krava ekstrudiranim lanenim semenom obogaćuje mleko korisnim masnim kiselinama kao što su vakcenska kiselina, konjugovana linolna kiselina i omega-3 masne kiseline. Ipak, mlečna mast smanjuje uticaj lanenog semena tako da i druge izvore polinezasićenih masnih kiselina treba uzeti u obzir.

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