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Effect of dietary inclusion of flaxseed on milk yield and composition of dairy cows

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ABSTRACT - The aim of the experiment was to study the effects of flaxseed inclusion on milk yield (MY), milk fat and protein contents and milk fatty acids (FA) composition in dairy cows diets. Eight Italian Friesian primiparous cows were divided into two homogeneous groups and fed a control diet (based on corn silage, fescue hay and a concentrate) or the same diet having 0.9 Kg DM concentrate replaced by coarsely grounded flaxseed for a 21 d experimental period. The groups were inverted in respect to the dietary treatments in a subsequent experimental period according to a change-over design. The flaxseed inclusion (4-5% DM) had a positive effect on dry matter intake (DMI, 22.2 vs. 21.3Kg/d) and significantly (P<0.01) increased the MY (26.9 vs. 26.1Kg/d) and milk fat corrected yield (FCM, 27.7 vs. 26.7Kg/d). Milk fat and protein percentages (4.18 and 3.46%, respectively on average) were not affected by flaxseed treatment. Results also indicated a significant (P<0.01) reduction of saturated fatty acid/unsaturated fatty acid ratio (SFA/UFA) and an increase of n-3/n-6FA, monounsaturated (MUFA) and polyunsaturated fatty acid (PUFA). Moreover a higher proportion of total C18:1 and conjugated linoleic acid isomers (CLA) was also observed for treated group.

*Key words***:** Dairy cow, Flaxseed, Milk yield, Fatty acids composition.

Introduction - Feeding oilseeds to lactating dairy cows allow to change the milk FA profile to obtain a milk rich in UFA, specially in n-3 PUFA and CLA. Among vegetable fat sources, linseed has a very high contents of n-3 linoleic FA (around 30% of total FA) and low amounts of SFA. Different studies show the milk FA modification by the dietary inclusion of linseed as extruded meal, oil or seeds treated with heat or chemical substances (see review of Glasser *et al.,* 2008). On the contrary, only few publications describe the effects of whole unprocessed linseed (flaxseed; Petit, 2002; Petit *et al.*, 2004; 2005; da Silva *et al.*, 2007), which is a farm feed resource directly available for dairy cow feeding.

Therefore, the objective of the present experiment was to study the effects of feeding flaxseed to dairy cow on milk yield and fatty acid profile.

Material and methods – Eight Italian Friesian primiparous dairy cows, having the calving data within a period of 30 d, were kept in stalls equipped for individual feeding at the Agricultural Experimental Station "Servadei" of Udine University. Animals at 200-220 days in milk were divided into two homogeneous groups: the diet of control group was composed by corn silage, fescue hay and a concentrate (7.6, 5.5 and 8.6kg DM/d, respectively), while 0.9Kg DM of the concentrate was replaced by coarsely grounded flaxseed in the diet of the treated group. Daily amounts of corn silage and hay were delivered into two equal portions (at 08.00 and 16.00 h) and the concentrate into three equal portions (at 08.00, 12.00 and 16.00h). The feed refusals of each cow were daily collected and weighted, and the amount of ingredients were daily adjusted to have a total DM refusals less than 10%. The trial was divided into two experimental periods of 21 d where the last 5 d were for data collection and the two groups of cows were changed in respect to the dietary treatments at the end of first experimental period according to a change-over design. Cows were milked in the morning and afternoon and, during the collection period, the milk of each milking was weighed and sampled. Milk samples were analysed for fat and protein contents with a Milkoscan (Foss Electric, DK). Milk fat extraction was performed according to the Rose-Gottlieb method modified as described by Secchiari *et al.* (2003). The fatty acids methyl esters (FAME) were prepared with a base catalysed Sodium methylate 2M as indicated by Antongiovanni *et al.* (2007). Gas cromatografy analyses were performed with a Varian system (Saturn 2100T Ion Trap GC/MS); the FAME were separated on a capillary column (SP-2380; L=60m, I.D. 0.25mm, d_f=0.20μm, Supelco, Bellafonte, PA, USA) and quantified using nonadecanoic acid (C19:0) methyl ester as an internal standard. Data were analysed (SAS, 1999) according to a change-over model, which included the period, cow and dietary treatment effects.

Results and conclusions - The inclusion of flaxseed in diets (about 4-5% DM) supplied about 380 g/d of lipids more than the control diet (P<0.01) and had a positive effects on DMI (P<0.01), as found in previous trials (Gonthier *et al.* 2005; Petit*,* 2002; Ward *et al.,* 2002). Both MY and FCM were significantly higher (P<0.01) in treated than control group of cows according to Petit *et al.* (2004). No effects were found for fat and protein concentrations in milk, while other studies found that linseed addition cause a depression in fat (Secchiari *et al.*, 2003) and protein yield (Petit, 2002, Petit *et al.,* 2005; Ward *et al.,* 2002). In present trial, the absence of any detrimental effect of flaxseed supplementation on animal performance (e.g. DMI, MY and milk fat) could be due to the coarsely grounded seeds which allow a slow and partial release of oil in the rumen.

Table 1. Dry matter intake, milk production and composition.

		control diet	flaxseed diet	SE	P-value	
					period	cow
DMI	Kg/d	21.3^B	22.2^A	0.3	<0.01	ns
lipid intake	g/d	699^B	1082^A	120	ns	ns
		milk composition				
MY	Kg/d	26.1^B	26.9^A	0.2	ns	<0.01
FCM	Kg/d	26.7^B	27.7^A	0.5	ns	<0.01
milk fat	%	4.17	4.20	0.18	ns	<0.01
milk protein	%	3.47	3.46	0.15	<0.01	<0.01

^{A,B}means within a row with different letters differ (P<0.01);
DMI, dry matter intake; MY, milk yield; FCM, milk fat 4% corrected yield.

As shown in table 2, dietary whole linseed inclusion significantly (P<0.01) increased total n-3 and 6 PUFA concentrations, lowered n-6/n-3 ratio and improved the concentrations of total C18:1 FA, CLA_{c9-t11} and $CLA_{c10-t12}$. Overall, the flaxseed diet reduced (P<0.01) the medium chain FA and increased (P<0.01) both PUFA and long chain FA. However, in this last class we did not detect the C20:5 and C22:6 FA, suggesting a very low intensity of elongation and desaturation processes of C18:3 (n-3) PUFA. Finally, the SFA/UFA ratio was reduced by the flaxseed addition in the diet and these results were in agreement with several other studies (Petit, 2002, 2003, Petit *et al.*, 2004, Ward *et al.*, 2002).

Feeding whole unprocessed linseed to dairy cows has positive effects on dairy cow performances (e.g. DMI and MY) and changes the FA profile improving the dietetic value of milk from human health.

Table 2. Fatty acid composition of milk fat.

		control diet	flaxseed diet	SE	P-value	
					period	cow
total n-3	%	0.18^B	0.70^A	0.05	ns	ns
total n-6	%	2.01^B	2.26^A	0.12	<0.05	<0.01
n-6/n-3 ratio		11.25^A	3.25^B	1.26	ns	ns
total C18:1	%	25.17^B	29.90^A	1.20	ns	<0.05
$C18:3_{c9\text{-}c12\text{-}c15}$	%	0.184^B	0.695^A	0.045	ns	ns
$CLA_{c9\text{-}t11}$	%	0.690^B	0.879^A	0.081	ns	<0.05
$CLA_{c10\text{-}t12}$	%	0.021^B	0.032^A	0.001	<0.01	ns
classes of fatty acids						
SCFA	%	6.23	5.78	0.42	ns	<0.05
MCFA	%	53.83^A	45.22^B	1.25	ns	<0.05
LCFA	%	38.90^B	48.82^A	1.44	ns	ns
SFA	%	64.58^A	60.84^B	1.16	ns	<0.01
UFA	%	34.14^B	38.87^A	0.85	ns	<0.01
SFA/UFA		1.91^A	1.57^B	0.05	ns	<0.01
MUFA	%	31.22^B	34.64^A	1.16	ns	<0.05
PUFA	%	2.84^B	3.93^A	0.11	ns	<0.01

[A,B]means within a row with different letters differ (P<0.01).
CLA, conjugat linoleic acids; SCFA, MCFA, LCFA, respectively short, medium and long chain fatty acids; SFA, UFA, saturated and unsaturated fatty acids; MUFA, PUFA, mono and polyunsaturated fatty acids.

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