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Effects of different fat-enriched concentrates on fatty acid profile of cheese from grazing dairy sheep

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ABSTRACT – A trial on different fatty acid supplementation was run in grazing dairy sheep. Forty-eight lactating Sarda ewes were randomly allocated to four homogeneous groups: PAS, control group grazing for 22h/d without supplementation; NOF, group supplemented with a cereal based non-fat enriched concentrate; C182, group supplemented with a concentrate rich in sunflower seeds; and C183, group supplemented with a concentrate rich in linseeds. The results showed that the concentrates, based on oilseeds from both sunflower and linseed sources determined high C18:1 t11 and CLA c9 t11 cheese fat content. Moreover linseeds supplementation improved the concentration in the cheese of other beneficial fatty acids such as LN and PUFAω3.

Key words: Dairy sheep, Sunflower seeds, Linseeds, Cheese FA.

Introduction – Feeding management is the mainly influencing factor of milk and cheese fatty acid (FA) profile (Jensen, 2002). The level in dairy products of substances beneficial to consumer health such as PUFA, ω3, CLA c9 t11 and vaccenic acid (C18:1 t11), increases along with the grass supply (Jahreis *et al*., 1997). Beneficial FA content in milk fat from grazing sheep usually shows two nadirs, one in winter, at the beginning of lactation, when the herbage on offer is usually low and one at pasture maturing phase. In early lactation period, diet supplementation with grain based concentrates is widespread in sheep farms. However the use of this kind of supplements often brings about the depression of some beneficial FA of the resulting dairy products. Maximising the nutritional value of milk and cheese fat can be achieved by the addition of whole oilseeds or plant oils rich in linoleic and/or linolenic acids, the main precursors of milk PUFA, CLA and C18:1 t11 (Dhiman *et al*., 2000). In dairy sheep and goat management, lipid supplementation is utilized primarily as energy source to enhance milk production, but there is a shortage of information on its effect on milk and cheese FA composition (Zhang *et al*., 2006; Mele *et al*., 2007; Nudda *et al*., 2006). The objective of the present study was to determine, the effects of the supplementation with different fatty acid precursors on cheese fatty acid composition. Two sources of fatty acid precursors: whole sunflower seeds rich in linoleic acid (C18:2 c9 c12, LA) and whole linseeds rich in linolenic acid (C18:3 c9 c12 c15, LN) were tested.

Material and methods – Forty-eight lactating sheep, homogeneous for liveweight and milk yield, were randomly allocated to the following experimental treatments (12 sheep per treatment group): PAS, control group without supplementation; NOF, supplemented with 900g/d of concentrate based on cereal; C182, supplemented with 900g/d of concentrate high in LA (10% sunflower seeds and 12% linseed); C183 receiving

Table 1. Fatty acids composition of offered feeds (% of DM).

	Treatments			
	Italian ryegrass	NOF	C182	C183
C18:2 c9 c12 (LA)	0.184	0.458	3.329	1.752
C18:3 c9 c12 c15 (LN)	1.570	0.039	1.188	2.332

900 g/d of concentrate high in LN (3% sunflower seeds and 24% linseed). PAS group grazed an Italian ryegrass (*Lolium multiflorum*) pasture for 22 h/d (average stocking rate: 20 ewes/ha); all supplemented groups were allowed to graze for 3 h/d (average stocking rate: 40 ewes/ha). Supplementation was iso-energetic and isoproteic. Table 1 shows the level of fatty acids precursors in offered feeds. Milk from each group was transformed into uncooked cheese on three consecutive days (3 cheeses per treatment). Fatty acid composition was determined in cheeses at 30 days of ripening. A sample cheese of 4g was homogenized in deionized water. Fatty acids extraction from the slurry was performed according to Jiang *et al*., (1996). Transmethylation and quantification of fatty acids were performed according to Cabiddu *et al*., (2009). To evaluate the effect of treatments all data were analysed by GLM (General Linear Model, α=0.05) using Minitab statistical package, release 15 (Minitab Inc., USA).

Results and conclusions – Grazing treatment (PAS, Table 2) gave high content of beneficial fatty acids and low content of substances that may be harmful to human health (C18:1 t10 and PUFA ω6). Cheese from grazing group was characterised by the highest content of CLA t11 c13, considered as a marker of pasture intake (Kraft *et al*., 2003) and the highest ω3/ω6 ratio (1.617, Table 2). The supplements exerted a marked effect on cheese fatty acid composition. As expected, the intake of NOF significantly reduced the level of beneficial FA (LN, C18:1 t11, CLA c9 t11 and PUFAω3) in cheese as compared with the PAS group. The transfer of LA and LN from the diet to milk and cheese fat is often low, due to their extensive biohydrogenation in the rumen (Harfoot *et al*., 1997), nevertheless the amount of LA and LN increased significantly in the cheese from C182 and 183 groups, respectively. The lipid supplementation (groups C182 and C183) enhanced the concentration in cheese of C18:1 t10, a trans FA potentially harmful to the consumer health. In particular, the C182 concentrate, rich in sunflower seeds and LA, induced the highest content of C18:1 t10 (Table 2). As found by many authors in cows, rumen environment can be modified by plant and animal oil supplementation, so that a shift of biohydrogenation oc-

Table 2 Fatty acid composition of cheese at 30 days of ripening (mg/g of fat).

	Treatments				SEM	Significance
	PAS	NOF	C182	C183		level
C18:2 c9 c12 ω6, LA	8.72^{C}	15.19^{B}	21.60^{A}	18.03^{AB}	1.77	**
C18:3 c9 c12 c15 ω3, LN	9.17^{B}	6.814^{C}	7.97^{BC}	11.01^{A}	0.57	**
C18:1 t10	3.70^{C}	4.03^{C}	14.19^{A}	10.02^{B}	1.87	**
C18:1 t11	38.59^{A}	27.70^{B}	44.78^{A}	45.35^{A}	2.30	**
CLA c9 t11	20.00^{B}	15.53^{C}	24.90^{A}	24.53^{A}	1.32	**
CLA t11 c13	1.32^{A}	0.49^{B}	0.49^{B}	0.70^{B}	0.11	**
SFA	625.30^{A}	654.30^{A}	577.99^{B}	574.00^{B}	11.11	**
SCFA	173.34^{AB}	195.60^{A}	155.01^{B}	156.18^{B}	5.56	**
MCFA	325.76^{B}	364.30^{A}	326.30^{B}	316.42^{B}	5.73	**
UFA	291.97^{B}	255.61^{C}	336.01^{A}	338.74^{A}	12.70	**
PUFA	64.42^{B}	58.22^{B}	77.67^{A}	80.52^{A}	3.64	**
PUFAω3	19.34^{A}	13.88^{B}	15.06^{B}	20.56^{A}	0.93	**
PUFAω6	12.37^{C}	18.91^{B}	26.43^{A}	22.69^{AB}	2.01	**
Σω3/Σω6	1.62^{A}	0.74^{B}	0.57^{B}	0.92^{B}	0.13	**

*Means with unlike superscripts within row differ according to P value indicated; **=P<0.01. SFA: saturated fatty acids; SCFA: saturated short chain fatty acids; MCFA: saturated medium chain fatty acids; UFA: unsaturated fatty acids: PUFA: polyunsaturated fatty acids.*

curs, favouring pathways whose intermediate products are C18:1 t10 and CLA t10 c12 (Bauman *et al*., 2003). Cheese from both oilseeds supplemented groups (C182 and C183) showed similar and significantly higher levels (P<0.01) of both C18:1 t11 and CLA c9 t11, than other cheeses (PAS and NOF), as a result of the high content of CLA precursors in oilseed based concentrates (Table 1) according to Lock *et al*. (2002), who found in cows similar results. On the contrary Zhang *et a*l. (2006), found, that sunflower supplementation was more effective than flaxseeds in increasing milk and cheese CLA concentration in dairy sheep. These differences can likely be attributed to the different FA precursors ratio in offered feeds used in the various works and to differences in the basal diet which interact with supplement effect. The inclusion of oilseeds rich in LA and LN in the sheep diet decreased the concentration of saturated fatty acids (SFA), in particular medium chain saturated fatty acids (MCFA, Table 2), and raised the level of unsaturated fatty acid (UFA, Table 2) in C182 and C183 cheeses respect to that found in cheese from non-fat enriched supplemented group (NOF). In terms of human health, the decrease of medium chain fatty acids (particularly C14:0 and C16:0) represents an improvement in the FA profile of milk and cheese because of the potential effects of these FA in cholesterol-raising activity. Linseeds (C183) treatment showed the best results in terms of high concentration in cheese of PUFA ω3 beneficial FA, similar to that found in cheese from the grazing group. In conclusion, the supplementation based on oilseeds from both sunflower and linseed sources determined a C18:1 t11 and CLA c9 t11 cheese fat content similar to that found in products from grazing animals during the period of higher quality of pasture (Addis *et al*., 2007). Similar contents of LN and PUFA ω3 in cheese fat were measured in the C183 and in the PAS groups, suggesting that concentrates rich in linolenic acid could be a good choice as complement of pasture for the production of cheese of high nutraceutical value during periods of herbage scarcity. Future research should be directed to evaluate the effects of lipid supplementation on the sensorial value of produced cheeses.

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