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Effects of the supplementation of olive cake and cactus pad silage on sheep intramuscular fatty acid composition

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SUMMARY – Twelve Barbarine lambs were fed barley and soybean meal concentrate: six lambs were also supplemented with oat hay (H group), while the other six animals were supplemented with silage based on olive cake and cactus pads (S group). Lambs were slaughtered after 92 days of treatment at the age of 242 days. Intramuscular fatty acid composition was determined on m. *longissimus dorsi*. Meat of the animals supplemented with the silage contained higher levels of C18:2n-6 (P<0.05) and lower C18:3n-3 (P<0.01) compared to the meat from the lambs supplemented with hay. Saturated fatty acids (SFA) were present at higher levels (P<0.05) in the meat of animals of the H group compared to meat from the animals of the S group. The n-6/n-3 ratio was higher (P<0.000) in the fat of the sheep fed the silage diet compared to meat of the animals fed the hay diet.

Keywords: Cactus pads, fatty acids, lamb, meat quality, olive cake.

RESUME – *"Effets de la supplémentation avec un ensilage de grignon d'olive et de raquettes de cactus sur la composition en acides gras intramusculaire des ovins". Douze agneaux de race Barbarine ont reçu pendant 92 jours un régime à base d'orge et de tourteau de soja supplémenté avec soit du foin d'avoine (groupe H; n = 6), soit un ensilage à base de grignon d'olive et de raquettes de cactus (groupe S; n = 6), puis ont été abattus à l'âge de 242 jours. La composition en acides gras intramusculaires a été déterminée sur le muscle* Longissimus dorsi*. Comparée à celle des agneaux du groupe H, la viande des agneaux du groupe S présentait des proportions de C18:2n-6 plus élevées (P<0,05), des proportions de C18:3n-3 et d'acides gras saturés plus faibles (P<0,01 et P<0,05, respectivement), et un rapport n-6/n-3 plus élevé (P<0,001).*

Mots-clés : *Acides gras, agneau, grignon d'olive, qualité de la viande, raquettes de cactus.*

Introduction

In recent years there is an increasing interest for the exploitation of some alternative feedstuffs for animal farming in the Mediterranean Countries. Some agro-industrial by products (olive cake, citrus pulp) and some arid-environment shrubs (cactus, *Acacia cyanophylla*, *Atriplex* spp.) have a good potential use as alternative feeding resources (AFR). Among the agro-industrial by-products, olive cake presents a high level of crude fat and a low content of crude protein (Molina Alcaide and Nefzaoui, 1996) and recent studies have focused on the nutritional value of olive cake in small ruminant diets (Martín García *et al*., 2003). Cactus pads are characterized by high percentages of water (85-95%) and soluble carbohydrates, but they are low in crude protein and fibre (Ben Salem *et al*., 2002; Atti *et al*., 2006). Recent researches have reported that the supplementation of cactus pads in small ruminants diet in combination with a source of nitrogen is an effective resource for animal nourishing (Ben Salem *et al*., 2002).

Meat fatty acid composition exerts important effects on consumers' health. It has been demonstrated that high levels of saturated fatty acids (SFA) as well as a high value of the n-6/n-3 fatty acids ratio in human diet increase the incidence of cardiovascular diseases (Enser *et al*., 1998), while fatty acids of the n-3 series and conjugated linoleic acid (CLA) are beneficial to human health (McGuire and McGuire, 1999). The aim of the present study was to investigate the intramuscular fatty acid composition of meat of lambs offered a silage based on olive cake, cactus pads and wheat barn as supplement to a concentrate diet.

Materials and methods

Twelve male Barbarine lambs at age 143 d were randomly assigned to one of two experimental treatments: six animals were offered oaten hay *ad libitum* (H group), while the second group of lambs (S group) received *ad libitum* a silage based mainly on olive cake, and containing also chopped cactus pads and wheat bran. Both groups of lambs received also 300g/d of a concentrate based on barley and soybean meal and they were gradually adapted to the experimental diets trough a 7 days period. After 92 days of experimental trial, animals were slaughtered. Carcasses were halved into side and stored at 4°C. Twenty-four hours post-mortem the right muscle *longissimus dorsi* was excised and stored at -25°C until chemical analysis. Intramuscular fatty acids were extracted from a 5 g meat sample according to Folch *et al*. (1957). Fatty acids were quantified as fatty acids methyl esters (French *et al*., 2000). The gas-chromatograph used was a Thermo Finnigan, TRACE. Separation of 1 *µ*l of fatty acid methyl esters in hexane was done by a capillary column Supelco SP-2340 in fused silica. Feed fatty acid composition was determined according to Sukhija and Palmquist (1988) (Table 1). Data on meat fatty acid composition were analysed by ANOVA with a model including treatment effects and experimental error.

Table 1. Chemical composition of the ingredients in the diets

	Ingredients			
	Oaten hay	Silage	Soybean meal	Barley
Dry matter (%)	93.6	93.5	93.1	92.2
Crude fat†	1.10	10.7	1.12	1.77
Fatty acids††				
C 12:0	0.27	0.03	0.04	0.05
C 14:0	1.53	0.09	0.12	0.28
C 16:0	20.15	11.80	15.71	17.83
C 16:1	0.72	0.26	0.23	0.32
C 18:0	6.15	2.90	4.16	1.96
C 18:1 cis-9	17.99	55.30	11.66	18.55
C 18:2n-6	37.37	23.72	51.42	50.56
C 18:3n-3	15.81	5.90	16.64	10.44
SFA	28.10	14.82	20.04	20.12
UFA	71.90	85.18	79.96	79.88

†Values expressed as percent of dry matter.
††Values expressed as g/100g fatty acids methyl esters.

Results and discussion

Oaten hay and silage had the same dry matter content, while the silage contained considerably higher levels of crude fat compared to oaten hay. Oleic acid (C18:1 cis-9) was three times higher into the silage diet compared to oaten hay while C16:0, C18:0, C18:2n-6 and C18:3n-3 were at higher levels in oaten hay compared to silage. Silage contained higher percentages of unsaturated fatty acids (UFA) compared to oaten hay (Table 1).

The high level of oleic acid in the silage diet was expected because this fatty acid is largely predominant in olive oil and wastes. According to Atti *et al*. (2006) chopped cactus pads is rich in linoleic and linolenic acids; however cactus has a low ether extract content and moreover in the present trial the percentage of cactus pads included in the silage was too low to increase the content of C18:2n-6 and C18:3n-3 of the diet.

Interestingly, the content of oleic acid in lambs intramuscular fat was not different (P>0.05) among the two treatments. The replacement of oaten hay with the silage did not influence the content of conjugated linoleic acid (CLA) and of C18:1 11-trans, which are produced during the

biohydrogenation of linoleic and linolenic acids by microrganisms in the rumen (Bauman *et al*., 1999). The meat of the lambs of the S group contained higher levels (P<0.05) of linoleic acid than the animals of the H group. Silage had a higher ether extract (10.7% *vs* 1.1% of DM, Table 1) compared to oaten and this can have played an effect on the intramuscular content of linoleic acid. Moreover, the higher NDF content of the hay diet could have favoured ruminal biohydrogenation of linoleic acid (Sackmann *et al*., 2003) resulting in a lower accumulation of C18:2n-6 in the fat of the H lambs compared to the fat of the S lambs. Linolenic acid was detected at higher (P = 0.003) percentages in meat of the lambs offered oaten hay compared to lambs fed the silage, and this result reflected diet fatty acid composition (Table 1). Total saturated fatty acids (SFA) were present at lower (P<0.05) percentages in the intramuscular fat of the animals receiving the silage, while mono-unsaturated fatty acids (MUFA) and poly-unsaturated fatty acids (PUFA) were not affected by treatments. Meat of the animals of the H group contained higher percentages of total n-3 fatty acids and lower n-6 fatty acids (P<0.05) compared to meat of the lambs of the S group. The n-6/n-3 ratio was higher (P<0.001) for the meat of the silage-fed animals compared to the hay-fed lambs (Table 2).

Table 2. Effects of the treatments on intramuscular fatty acid composition† of m. *longissimus dorsi*

	Treatments			
	Hay	Silage	SEM	P††
No. of lambs	6	6	-	-
C 16:0	21.44	20.18	0.037	NS
C 18:0	13.08	12.81	0.315	NS
C 18:1 11-trans	1.96	2.36	0.126	NS
C 18:1 9-cis	26.22	26.07	0.551	NS
C 18:1 11-cis	2.35	2.57	0.064	NS
C 18:2 n-6	13.27	17.19	0.841	0.011
C 18:2 9-cis, 11-trans (CLA)	0.85	0.86	0.029	NS
C 18:3n-3	1.81	1.30	0.098	0.003
C 20:2n-6	0.12	0.13	0.015	NS
C 20:3n-3	0.16	0.12	0.014	NS
C 20:4n-6	6.19	6.86	0.367	NS
C 22:1	0.17	0.20	0.022	NS
C 20:5n-3	1.99	1.69	0.131	NS
C 22:5n-3	2.08	1.89	0.097	NS
C 22:6n-3	0.71	0.87	0.082	NS
SFA	39.87	36.48	0.825	0.032
MUFA	31.83	31.88	0.616	NS
PUFA	28.30	31.61	1.180	NS
Total n-6	20.87	24.73	1.220	0.032
Total n-3	6.99	5.68	0.273	0.047
n-6/n-3 ratio	2.99	4.37	0.240	0.000
Other fatty acids†††	7.60	5.03	-	-

†Values expressed as g/100g identified fatty acids methyl esters.
††NS = not significant.
†††C12:0 + C14:0 + C14 :1 + C15:0 + C15:1 + C16:1 + C17:0 + C17:1 + C18:2 10-cis, 12-trans + C18:3n-3 gamma linolenic.

Conclusions

The replacement of oaten hay with a silage based on olive cake and cactus pads in lamb diet induced a higher content of linoleic acid and lower percentages of linolenic acid in the fat of

m. *longissimus dorsi* of the S lambs compared with the H lambs. Treatments did not affect the concentration of conjugated linoleic acid in meat. The total amount of saturated fatty acids (SFA) was lower in the fat of the lambs offered the silage compared to lambs supplemented with oaten hay. However, meat of the animals fed the silage had a value of n-6/n-3 ratio higher compared to animals fed hay, resulting in a fatty acid composition less favourable for human health.

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