Session 24, presentation 14
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ANIMAL PERFORMANCE AND FATTY ACID COMPOSITION OF LAMBS FED WITH DIFFERENT VEGETABLE OILS

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ABSTRACT

Twenty seven lambs were used to investigate the effects of the inclusion of 4% hydrogenated palm oil (HPO) or sunflower oil (SFO) in the concentrate on feed intake, animal performance and fatty acid composition. Animals (16.2±0.27 kg initial weight) were fed concentrate (Control, HPO or SFO) and barley straw ad libitum and slaughtered at 25 kg. Vegetable oils did not affect (P>0.05) feed intake and animal performance. SFO caused an increase (P<0.001) in C18:1 *trans*-11 and tended to increase (P<0.10) total CLA in subcutaneous fat. Atherogenicity index was lower (P<0.05) in subcutaneous fat and tended to be lower (P<0.10) in intramuscular fat of lambs receiving SFO. Therefore, SFO improves fatty acid composition of fattening lambs without affecting animal performance.

Keywords: palm oil, sunflower oil, fattening lambs, fatty acid, atherogenicity

INTRODUCTION

In the Mediterranean area, intensively reared lambs are usually fed with barley straw and concentrate ad libitum in order to achieve great growth rates. Over the last decade, fat supplementation became a common practice to increase the energy density of the diet for ruminants (Bauman et al., 2003), palm oil supplements being the most used. However, the type of fat in the ration is known to affect the amount, distribution and composition of body fat (Castro et al., 2005).

Lamb fat is characterized by a high saturated fatty acid (SFA) content, and a low polyunsaturated fatty acid (PUFA) content (Enser et al., 1996), due to the biohydrogenation of unsaturated fatty acids by rumen microflora (Doreau and Ferlay, 1994). Nevertheless, meat from ruminant animals (Pariza and Ha, 1990) is within the primary sources of conjugated linoleic acid (CLAs) for humans, which has been associated with a wide range of positive health benefits. One of the options of enhancing the beneficial effects of animal products is through diet manipulation, such as the use of finishing diets supplemented with sunflower oil with high purities of linoleic or oleic fatty acids to improve the concentration of CLAs and thus their health benefits (Kott et al., 2003). On the other hand, the use of such oil has been proposed as an alternative to increase the content of PUFA in lamb tissues (Yu et al., 2008).

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The present work was conducted to study the effects of 4% hydrogenated palm oil (HPO) or sunflower oil (SFO) supplementation in the concentrate for fattening lambs on feed intake, animal performance and meat and subcutaneous fatty acid composition.

MATERIAL AND METHODS

Animals and diets

Twenty seven male Merino lambs (initial age 8-9 weeks) were allocated by stratified randomisation on the basis of live body weight (LBW, 16.2±0.27 kg) into three equal groups. All the groups received concentrate and barley straw ad libitum.

The 'Control' group was offered a commercial concentrate (52% barley, 21.4% soybean meal, 15.3% corn, 4.2% molasses, 3.1% mineral vitamin premix, 2.9% sunflower meal and 1% sodium bicarbonate). The chemical composition of the concentrate was as follows (dry matter basis): 18.5% crude protein, 1.8% crude fat, 14.3% neutral detergent fibre. 'HPO' and 'SFO' groups received the concentrate plus 4% hydrogenated palm oil (Nucleovit-99, Lemasa, Spain) and 4% sunflower oil, respectively.

The amount of feed offered was adjusted daily on the basis of the previous day intake, allowing refusals of 20%.

Animals were housed individually and animal handling followed the recommendations of European Council Directive 86/609/EEC for protection of animals used for experimental and other scientific purposes.

Experimental procedure and analyses

LBW was recorded twice a week before morning feeding to about 24 kg, and then every day until slaughter. When an animal reached the intended LBW (approx. 25 kg), feed and water were withdrawn, and after 1 h the lamb was weighed again, stunned, bled, skinned and eviscerated.

Dressed carcass as defined by Colomer-Rocher et al. (1988) was obtained from the whole body of each lamb, weighed, chilled at 4ºC for 24 h and then weighed again. Chilling losses were calculated as the difference between hot (HCW) and cold carcass weight (CCW) expressed as a proportion of the initial HCW. Killing-out percentage was calculated as CCW expressed as percent of slaughter body weight.

The longissimus lumborum of the left half carcass and a sample of dorsal subcutaneous fat were removed and stored at -30ºC until chemical analyses were performed. In situ transesterification of fatty acids was carried out following the method described by Carrapiso et al. (2000). Methyl esters of fatty acids were quantified by GC (HP 5890 GC, Hewlett-Packard, Avondale, USA) using a capillary column (SP-2380, 60 m × 0,25 mm, Supelco, Bellefonte, USA).

Data were subjected to one-way analysis of variance using the GLM procedure of SAS package (1999).

RESULTS AND DISCUSSION

Mean values of feed dry matter intake and animal performance are shown in Table 1. The inclusion of 4% HPO or SFO did not cause changes in these parameters ($P > 0.05$). Values observed in the current experiment for these parameters are within those recorded in the bibliography for lambs reared under similar conditions (Rodríguez et al., 2008; Preziuso et al., 1999). Previous works (Manso et al., 2006) showed a slight depression on forage

intake and a better feed to gain ratio in response to 4% palm oil supplementation. However, the supplementation with a more unsaturated oil (10% soybean oil) in concentrate based diets has been reported to have no effects on either concentrate intake or average daily gain, thus not affecting animal performance (Bessa et al., 2005). According to these results, no changes were found for carcass characteristics studied in this work (chilling losses and killing-out percentage).

Table 1. Mean values of dry matter intake, average daily gain, feed to gain ratio, chilling losses and killing out percentage.

	Control	HPO	SFO	rsd[1]	LS[2]
Dry matter intake ($g \cdot animal^{-1} \cdot day^{-1}$)					
Concentrate	910	972	851	103.9	n.s.
Barley straw	53	27	46	23.8	n.s.
Total	962	999	897	98.7	n.s.
Daily gain ($g \cdot animal^{-1} \cdot day^{-1}$)	243	273	255	40.1	n.s.
Feed to gain ratio	4.01	3.72	3.63	0.693	n.s.
Chilling losses	2.79	2.89	2.94	0.260	n.s.
Killing out percentage	48.6	47.5	47.3	1.70	n.s.

[1]Residual standard deviation.
[2]Level of significance: n.s.: $P > 0.05$.

Mean values of fatty acids composition for intramuscular and subcutaneous fat, expressed as percentage of total fatty acids are shown in Table 2. Values of fatty acid composition agree with those found in the bibliography (Castro et al., 2005), the most abundant fatty acid being oleic (C18:1 *cis*-9), followed by palmitic (C16:0) and stearic (C18:0). Palm oil supplementation did not cause changes in fatty acid composition, whereas lambs receiving SFO concentrates showed lower values of C18:1 *cis*-9 and C18:3 ($P < 0.05$), a tendency to lower concentration of C16:0 and lower atherogenicity index ($P < 0.10$).

Sunflower oil, added at a rate of 6%, has been reported to increase CLA content in lambs intramuscular fat (Mir et al., 2000). In the current study, CLA tended to increase (contrast 'Control' vs. SFO $P<0.10$), and an increase in C18:1 *trans*-11 (vaccenic acid, VA) was observed in subcutaneous fat. Mir et al. (2000) also reported a decrease in C18:3 and an increase in C18:2 in all tissues when lambs were supplemented with SFO.

It has been proposed that oleic acid in the rumen is either not hydrogenated, isomerized to C18:1 *trans* (double bonds at positions 6 to 16), or hydrogenated directly to stearic acid (Collomb et al., 2006). Our results seem to support the latter hypothesis, since stearic acid seems to increase in SFO diets.

On the other hand, CLA and VA are two key intermediates in the biohydrogenation process in the rumen (Bauman et al., 2003). Feeding the animals with SFO provides with linoleic acid, which is hydrogenated in the rumen to produce CLA and VA (Mir et al., 2000). These intermediates are present in appreciable quantities in ruminant fat, but it

seems that the hydrogenation from VA to stearic acid is slower than CLA to VA, this acid being accumulated.

Fat with high atherogenicity index value is assumed to be more detrimental to the human health. Conversely, some unsaturated fatty acids have a protective effect against the risk of cardiovascular disease (Williams, 2000). In the present study, a significant decrease in the atherogenicity index was found in response to SFO supplementation in subcutaneous fat. Also intramuscular fat showed a tendency to have lower atherogenicity index. This could probably be related to the numeric changes in saturated and monounsaturated fatty acids, which did not reach the required significance level to be statistically different.

Table 2. Fatty acid composition (percentage of total fatty acids)

	Control	HPO	SFO	rsd[1]	LS[2]
Intramuscular					
C14:0	2.63	2.35	2.34	0.416	n.s.
C16:0	23.68^{b}	23.55^{b}	22.41^{a}	1.192	t
C18:0	16.35^{a}	16.12^{a}	17.53^{b}	1.327	t
C18:1 *cis*-9	39.48	39.17	38.27	2.184	n.s.
C18:1 *trans*-11	3.53^{a}	4.33^{a}	6.36^{b}	1.377	**
C18:2 *cis*-9 *cis*-12	5.95	5.88	5.81	1.714	n.s.
Total CLA[3]	0.41	0.38	0.45	0.097	n.s.
C18:3	0.44^{b}	0.40^{b}	0.31^{a}	0.097	*
Saturated	46.23	45.40	45.13	1.465	n.s.
Monounsaturated	46.93	47.90	48.20	1.874	n.s.
Polyunsaturated	6.84	6.70	6.67	1.731	n.s.
Atherogeniciy index	0.493^{b}	0.478^{ab}	0.454^{a}	0.0369	t
Subcutaneous					
C14:0	3.11	2.81	2.72	0.598	n.s.
C16:0	22.74^{b}	23.55^{b}	20.40^{a}	1.777	**
C18:0	18.61	17.02	19.91	3.559	n.s.
C18:1 *cis*-9	34.63	34.67	32.62	3.845	n.s.
C18:1 *trans*-11	6.13^{a}	7.18^{a}	11.85^{b}	2.469	***
C18:2 *cis*-9 *cis*-12	2.97	3.11	2.93	0.946	n.s.
Total CLA[3]	0.43	0.50	0.63	0.223	n.s.
C18:3	0.30^{b}	0.30^{b}	0.19^{a}	0.081	**
Saturated	50.14	48.86	47.75	3.474	n.s.
Monounsaturated	45.99	47.12	48.30	3.545	n.s.
Polyunsaturated	3.87	4.02	3.95	1.011	n.s.
Atherogeniciy index	0.525^{b}	0.520^{b}	0.450^{a}	0.0634	*

[1]Residual standard deviation.
[2]Level of significance: n.s.: P > 0.05; *: P < 0.05; **: P < 0.01; ***: P < 0.001
[3]Total CLA = C18:2 *cis*-9, *trans*-11 + C18:2 *trans*-10, *cis*-12

It can be concluded that SFO improves intramuscular and subcutaneous fatty acid composition of young fattening lambs without affecting feed intake and animal performance.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the financial support received from Junta de Castilla y León (Project VA084/04).

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