EFFECT OF LAMB FEEDING WITH LINSEED MEAL ON SOME MEAT QUALITY TRAITS

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Background

The EC Regulation n. 1829/2003 sets at 0.9% the limit of genetically modified organisms (GMO) allowed in feeds for animals without any mention in the label. Such a limit dramatically stresses the need to identify raw materials free from genetically manipulated substances. Nowadays, about 63% of the soy cultivated all over the world is genetically modified, thus representing a serious problem for animal feeding since soybean is still considered as the main protein source. The possibility of using some traditional oilseeds can be a valid alternative to soy in order to obtain quality performances. Contrary of other seeds, normally rich in linoleic acid (LA), linseed is particularly rich in α-linolenic acid (approximately 350 g fat/kg fresh material, of which LNA accounts for about 50% of the total fatty acids). Omega-3 fatty acids, that may be only partially transferred to ruminant fat (Dufrasne *et al.*, 1991; Enser *et al.*, 1999; Choi *et al.*, 2000; Scollan *et al.*, 2001; Raes *et al.*, 2002; Raes *et al.*, 2004), are very important in the human diet, since they reduce the risk of cardiovascular diseases with their anti-thombogenic and anti-atherogenic effect. They inhibit tromboxane A2 synthesis, starting from the arachidonic acid in platelets, and the migration of monocytes in the atherosclerotic plaque (Condor, 1997). Several authors have used linseed meal in ruminant nutrition, especially for cattle, with positive results on digestibility (Khorasani *et al.*, 1994; Dufrasne *et al.*, 1991, Dixon *et al.*, 2003a; Dixon *et al.*, 2003b), productive performances (Dufrasne *et al.*, 1991; Berge *et al.*, 1993; Dumont *et al.*, 1997; Dixon *et al.*, 2003a; Dixon *et al.*, 2003b; Raes *et al.*, 2004) and meat quality traits (Dufrasne *et al.*, 1991; Berge *et al.*, 1993; Enser *et al.*, 1999; Choi *et al.*, 2000; Raes *et al.*, 2002; Scollan *et al.*, 2001; Raes *et al.*, 2004). There are, however, few reports in literature concerning the use of linseed meal in lamb production.

Objectives

The present study aimed to investigate some of the most important meat quality traits in lambs fed a linseed meal in comparison with a traditional diet based on soybean meal.

Materials and methods

The experiment was carried out on samples of *Longissimus lumborum* (Ll) and *Semimembranosus* (Sm) muscles isolated from Comisana male lambs (n. = 14). Lambs were fed *ad libitum* for 6 weeks from the age of 50 days on either a concentrate pelleted diet (Control group) or on a diet containing 20% linseed meal (LM). Diets were planned to contain approximately the same amount on dry matter of protein (16.5%), fat (5.0%) and crude fibre (10.5%). Following 24 hours of refrigeration at 4 °C, the lumbar region and the pelvic limb were excised from the right half carcass and dissected into their tissue components, i.e. lean, fat and bone. Ll and Sm muscles were assessed for pH using a glass electrode at slaughter (pH_1) and after 24 hours refrigeration at 4 °C (pH_2). Samples of both muscles were evaluated for colour and tenderness, while chemical analysis (ASPA, 1996) and the fatty acid profile were performed only on Ll samples. Lipids were extracted according to the 2:1 chloroform-methanol method described by Folch *et al.* (1957), whereas the acidic profile was assessed using a Chromopack CP 9000 gas chromatograph. Meat colour was estimated by the Hunter Lab system using a colorimeter (illuminant D 65), which measures the values of Lightness (L), Redness (a) and Yellowness (b) by making 5 readings for each meat sample, approximately 2.5 cm thick. Tenderness was measured using a Warner Bratzler shear device applied to an Instron 5544 and expressed as the shear force (kg/cm^2) required to cut perpendicularly to the direction of the fibres half an inch diameter cylinders of raw meat, taking three measurements for each muscle per subject. The atherogenicity and thrombogenicity indexes were calculated accordingly to Ulbricht and Southgate (1991). The PCL/PCE (plasma cholesterol lowering/plasma cholesterol elevating) ratio was also determined (Reiser and Shorland, 1990). Data were analysed for variance using the GLM procedure of SAS (1999/2000).

Results and discussion

By the end of the trial, the lambs had achieved similar live weights in both groups (23.67 *vs* 23.59 kg, respectively for the LM and control group), thus proving the productive efficiency of the linseed meal diet. As for pH values, no significant differences between groups were detected for Ll and Sm muscles at slaughter, nor after refrigeration (Figure 1). Dissecting data of the lumbar region and pelvic limb were not markedly different, although a higher incidence of lean was observed in the experimental group (Figure 2). The Sm meat colour parameters were quite similar between the two groups, while the yellowness of the Ll muscle was significantly lower ($P<0.01$) in the linseed meal diet (Figure 3). In both muscles, tenderness was slightly improved by LM feeding (Table 1). With regard to the chemical composition of meat, no statistical differences were assessed (Table 2). However, a slight increase of the protein content was found in the experimental group, corresponding to the greater amount of lean found at the dissection in the same group, in accordance with the results of Berge *et al.* (1993). Meat from lambs fed on the LM diet showed better dietetic properties, as evidenced by a markedly higher amount of unsaturated fatty acids and a lower one of saturated (Table 3), along with a lower percentage of C12:0 and C14:0 ($P<0.05$). As a consequence, lower indexes of atherogenicity and thrombogenicity and a higher PCL/PCE ratio were found in meat of the LM group ($P<0.05$). No significant differences were found in meat PUFA content of either group concerning the ω6 or the ω3 fractions. However, the LM diet significantly improved the ω6/ω3 ratio, as well as the UFA/SFA ($P<0.05$).

Conclusions

The results obtained in this research suggest that without altering the productive efficiency of lambs, the use of a linseed meal positively affected meat healthiness and dietetic properties, since a lower concentration of C12:0 and C14:0 fatty acids was found, corresponding to an increase in the total unsaturated fatty acids as well as the ratio of unsaturated to saturated fatty acids. Furthermore, this diet improved the atherogenicity and thrombogenicity indexes as well as the PCL/PCE ratio, with positive effects for human health. Finally, meat lean content and its tenderness were also better following linseed meal feeding.

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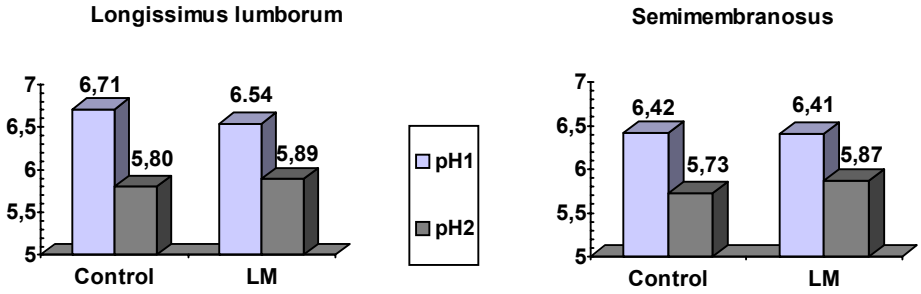

Figure 1. pH measurement in *Longissimus lumborum* and *Semimembranosus* muscles

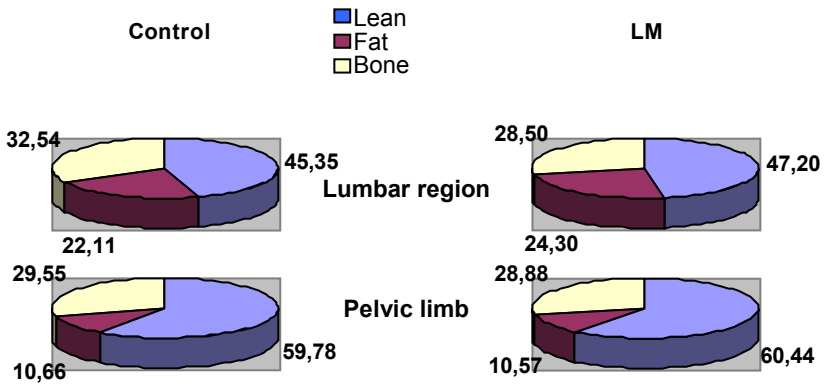

Figure 2. Dissecting data (%)

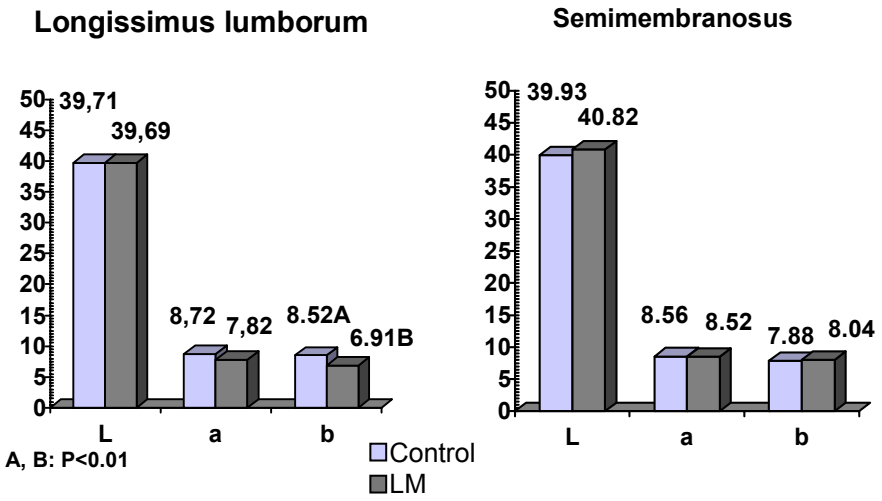

Figure 3. Meat colour of Longissimus lumborum and Semimembranosus muscles

Table 1. Meat tenderness of *Longissimus lumborum* and *Semimembranosus* muscles

	Control	LM	SED
Samples (n.)	7	7	(DF = 12)
WBS Ll (kg/cm^2)	5.38	4.14	1.896
WBS Sm (kg/cm^2)	5.18	4.74	2.192

Table 2. Chemical composition of Longissimus lumborum muscle (%)

	Control	LM	SED
Samples (n.)	7	7	(DF = 12)
Moisture	75.50	75.68	0.719
Protein	18.60	18.83	0.398
Fat	3.93	3.73	0.694
Ash	1.31	1.18	0.222
N-free extract	0.45	0.60	0.282

Table 3. Fatty acid composition of Longissimus lumborum muscle (%)

	Control	LM	SED
Samples (n.)	7	7	(DF = 12)
C12:0	0.63^a	0.40^b	0.199
C14:0	5.58^a	4.10^b	1.111
C16:0	24.13	22.33	1.937
C18:0	15.41	17.38	2.368
Total Saturated	48.91^a	46.90^b	1.658
Total Monounsaturated	42.60	44.60	2.069
Total Polyunsaturated	8.46	8.54	1.788
Total Unsaturated	51.06^b	53.14^a	1.647
ω6	7.67	7.51	1.649
ω3	0.78	1.03	0.329
ω6/ω3	10.08	8.49	3.354
Unsaturated/Saturated	1.05^b	1.13^a	0.072
Atherogenicity index	0.92^a	0.74^b	0.125
Thrombogenicity index	1.64^a	1.50^b	0.113
PCL/PCE	0.99^b	1.16^a	0.145
Polyunsaturated/Saturated	0.17	0.18	0.039

a, b: P<0.05