THE INFLUENCE OF FEEDING REGIMENS ON MEAT QUALITY AND FATTY ACIDS COMPOSITION OF LAMBS IN URUGUAY

Z. Ramos, F. Montossi, X. Lagomarsino, G. Brito, R. San Julián and F. Cazzuli

Meat and Wool Production National Research Program, National Institute of Agricultural Research.

INIA Tacuarembó, Ruta 5 Km 386, Tacuarembó, Uruguay

Corresponding author (phone: +598-63-22407; fax: +598-63-23969; e-mail: zramos@tb.inia.org.uy)

Abstract – The purpose of this study was to evaluate the effect of different feeding strategies on meat quality traits and fatty acid composition of crossbred lambs (12% Corriedale x 88% Merino Dohne) in Uruguay. The experiment was carried out in summer on natural grasslands (NG) using three isoenergetic supplements (S; 2.9 MCal ME/kgDM) with three different crude protein (CP) contents (12, 16 and 20% CP). One single stocking rate was used (10 lambs/ha). Eighty crossbred lambs, with an initial average live weight (LW) of 28.5 ± 3.6 kg were randomly allotted to four treatments (T) with a single supplementation level (2% LW), being: T1=NG (control), T2=NG + S 12% CP, T3=NG + S 16% CP and T4=NG + 20 % CP. Ultimate pH and tenderness of the *Longissimus dorsi* (LD) muscle at 5 and 10 days of aging were not affected by T (P>0.05). Meat colour parameters (L*, a* and b*) with 5 days of aging did not differ between T (P>0.05). Nonetheless, with 10 days of aging, L* decreased as the protein content of the diet increased (P<0.01). In fatty acid concentration, overall *n6* and *n3* showed differences according to T (P>0.01). The *n6/n3* ratio was significantly lower (P>0.01) for T1 and increased as the protein level of the diet raised. Total saturated (SFA), monoinstaturated (MUFA) and poliinsaturated (PUFA) fatty acid concentration did not differ among T. The conjugated linoleic acid (CLA) concentration raised as the protein content of the diet increased (P<0.01). This trial proved that different nutritional strategies applied after weaning mostly did not modify the meat quality traits evaluated, but, even so, they have an important effect on intramuscular fat content as well as on fatty acid composition. Therefore post weaning feeding and PC content in the diet could influence the production of more healthy meat. These interesting findings require further research.

KEYWORDS: feeding regimes, lamb, meat quality, fatty acid composition.

I. INTRODUCTION

Fat intake and its relationship with human health are considered to be an important worldwide issue. An appropriate fat intake is necessary because of its energy and essential fatty acid contribution to the human diet. Furthermore, it has been demonstrated that PUFA intake presents benefits to human health (Montossi, 2007). It has also been demonstrated that animal nutrition has paramount importance on meat fatty acid composition, which additionally affects human health and consumer´s perceptions (Alvarez *et al*, 2007). There is abundant information in Uruguay about how supplementation affects lamb performance and meat and carcass quality traits under grazing conditions. However, studies are scare related to the effect of different protein levels using isoenergetic supplements used to boost lamb growth after weaning gazing natural grasslands in the Basaltic Region of Uruguay. It is also unknown their subsequent effect on meat quality traits and fatty acid composition. Therefore, the aim of this trial was to evaluate the effect of protein supplementation during lamb summer rearing and its subsequent influence on animal performance during fattening as well as meat quality traits and fatty acid composition.

II. MATERIALS AND METHODS

This experiment was carried out at "Glencoe" Experimental Unit – INIA Tacuarembó, situated in the Basaltic Region of Uruguay. Eighty crossbred lambs, with an initial average LW of 28.5 ± 3.6 kg, grazing natural grasslands at the same stocking rate (10 lambs/ha) were supplemented at identical level (2% LW) using an isoenergetic commercial supplement (S) which varied on its crude protein (CP) levels. The animals were randomly allotted to four treatments (T) during the summer rearing, being: T1= NG (control), T2=NG + S 12% CP, T3=NG + S 16% CP and T4= NG + 20 % CP. Animals were distributed in two repetitions per treatment. At the beginning of the experimental period, all animals had an intake adaptation period until they reached the desired level of intake (7-10 days). After this period, animals were supplemented twice a day (7:30 – 8:30 AM and 5:30 – 6:30 PM), offering half of the total daily amount of feed on each period. Animals had free access to mineral blocks and clean water. For the supplemented treatments, feed intake was adjusted every 7 days according to the average LW of each repetition. Once the experimental period was over (105 days; from January 24th to August 8th), lambs were finished during 84 days (from August 8th to July 31st) until they achieved slaughter weight. During the finishing period lambs of all T were managed similarly grazing an annual winter Oat crop without supplementation. Lambs were slaughtered at a commercial slaughter plant with an average overall LW of 47.0 kg. At 24 hours *post mortem* a *Longissimus dorsi* (LD) muscle sample was taken from the lumbar area to measure ultimate pH and to evaluate meat quality traits and fatty acid composition. Ultimate pH was registered using a pHmeter (Hanna HI 9125) with gel device. From the steak samples collected at the slaughter plant, subsamples were taken to determine meat tenderness (Warner Bratzler D2000-WB model) and colour (L*, a* y b* parameters using a Minolta CR 400 colorimeter) for 5 and 10 days of aging. LD beefs were packaged in polyethylene bags and cater bathed until reaching an internal temperature of 70°C. From each steak subsample, six 1.27 cm diameter samples were taken, parallel to the orientation of muscle fibers. Every sample rendered a shear cutting force value and an average value for every steak was obtained. Total lipid content was measured through the Folch *et. al.* (1957) method based on solvent extraction, and fatty acid content was quantified by gas chromatography. Fatty acid content is expressed as the % of the overall sum of all measured fatty acids. Results were analyzed by the GLM procedure (SAS Institute Version 9.2, 2010). Averages and differences among T were contrasted with LS means (P<0.05 o P<0.01).

III. RESULTS AND DISCUSSION

The effect of the feeding regime on meat quality traits is presented in Table 1. Ultimate pH at 24 hours *post mortem* did not show statistical differences among T (P>0.05). These results are similar to those reported on local research studies, where several lamb genotypes and genders were evaluated with different grazing feeding systems (Brito *et al.*, 2002) as well as the use of different kind of supplements (Montossi *et al*., 2011). The tenderness results at 5 and 10 days of aging were similar between T (P>0.05). It is important to highlight that longer aging periods increase tenderness, even when is considered the natural high values of tenderness of sheep meat. These results agree with those obtained by Montossi *et al.* (2009, 2011) where different feeding systems using diverse levels of supplementation were evaluated, exclusively under grazing conditions. Muscle colour parameters at 5 days of aging did not present any difference among T (P>0.05). Nonetheless, at 10 days of aging, the L* parameter was lower as protein concentration increased (P<0.01) in the supplement, while the a*and b* parameters did not show any differences among T. The intramuscular fat content and fatty acid composition of the LD muscle for all T is presented in Table 2. The intramuscular fat content was affected (P<0.01) by T, being T1 the one that presented lower value. Similarly for fatty acid composition, the different feeding strategies had also an important effect on some of them. SFA analysis showed statistical differences among T, but they evidenced different trends according to the saturated fatty acid considered. Palmytic acid content (16:0) was higher (P>0.05) in the supplemented T, whereas Myristic (14:0) and Sterakic (18:0) acids were lower in T1 (P<0.05 and P<0.01, respectively). The overall sum of SFA did not present differences among T (P>0.05). MUFA concentration (individual and total) was not affected by the different feeding regimes (P>0.05). In the forage system (T1), *n6* PUFA concentration was lower (P>0.01) and *n3* PUFA concentration was higher (P>0.01) than those from supplemented T. Local research studies (Montossi *et al.*, 2009) found no differences in fatty acid composition when the combination of improved pastures and supplementation (sorghum grain) is used. The UK Health Department (1994) recommendations for PUFA/MUFA and *n6*/*n3* ratios are above 0.45 and under 4 respectively. In this study, the feeding regime did not affect the PUFA/MUFA ratio (P>0.05). The *n6*/*n3* ratio was lower for T1 compared to T2, T3 and T4 (P<0.01), but all the rations evaluated fall into the recommended threshold.

Table 1. Mean values for meat quality traits under the influence of different nutritional regimes.

Variable	T1	T2	T3	T4	P
pH 24 hs	5.69	5.74	5.67	5.70	ns
WB kg SF (5d)	4.37	4.15	3.62	4.11	ns
WB kg SF (10d)	3.00	2.93	2.68	3.14	ns
L* (5d)	36.5	36.1	36.3	35.4	ns
a* (5d)	19.3	20.8	19.9	19.8	ns
b* (5d)	8.1	8.5	8.3	7.8	ns
L* (10d)	39.1a	38.0ab	37.9ab	37.3b	**
a* (10d)	20.4	21.1	21.4	21.3	ns
b* (10d)	8.8	9.0	9.1	8.9	ns

Note: a, b = means with different letters among columns are significant different (*; P<0.05) and (**; P<0.01). ns= not significant.

Table 2. Fatty acid profile (%) composition of the *Longisimus dorsi* muscle under the influence of different nutritional regimes.

Fatty acid (%)	T1	T2	T3	T4	P
Intramuscular fat	3.98b	4.72ab	5.21a	4.60ab	**
14:0 *myristic*	1.93a	1.86a	1.75ab	1.63b	*
16:0 *palmitic*	23.65c	25.45a	24.83ab	24.23b	*
18:0 *stearic*	20.36a	18.44b	16.21ab	19.07b	**
20:0 *arachidic*	0.12	0.09	0.11	0.13	ns
14:1 *myristoleic*	0.26	0.25	0.24	0.27	ns
16:1 *palmitoleic*	1.89	1.88	1.69	1.73	ns
18:1 *oleic*	45.72	46.01	46.39	46.21	ns
18:2 *n-6 linoleic*	2.51b	3.00ab	2.91ab	3.49a	**
18:3 *n-6 linolenic*	0.07	0.06	0.07	0.09	ns
18:3 *n-3 linolenic*	0.91a	0.77ab	0.65b	0.66b	**
20:2 *n-6 eicosadienoic*	0.10	0.09	0.09	0.08	ns
20:3 *n-3 ETE*	0.13	0.07	0.07	0.09	ns
20:3 *n-6 DGLA*	0.08	0.08	0.07	0.07	ns
20:4 *n-6 arachidonic*	0.65	0.75	0.68	0.87	ns
20:5 *n-3EPA*	0.43a	0.24b	0.20b	0.23b	**
22:5 *n-3DPA*	0.36a	0.26b	0.22b	0.27b	**
22:6 *n-3DHA*	0.054a	0.041b	0.044ab	0.038b	*
CLA	0.79ab	0.68b	0.79ab	0.85a	**
SFA	46.06	45.84	45.89	45.07	ns
MUFA	47.87	48.14	48.32	48.22	ns
PUFA	5.28	5.35	4.99	5.87	ns
n6	3.40b	3.96ab	3.81ab	4.58a	**
n3	1.88a	1.39b	1.18b	1.29b	**
PUFA/SFA	0.12	0.12	0.11	0.13	ns
n6/n3	1.85c	2.89b	3.34ab	3.65a	**

Note: a, b = means with different letters among columns are significant different (*; P<0.05) and (**;P<0.01). ns= not significant. ETE: eicosatrienoic acid; DGLA: dihomo-gamma-linolenic acid; EPA: eicosapentaenoic acid; DPA: docosapentaenoic acid; DHA: docosahexanoic acid; CLA: conjugated linoleic acid; SFA: satured fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids.

IV. CONCLUSION

The implementation of an intensified lamb rearing system had no subsequent effect on the evaluated meat quality traits, excepting for L* parameter at 10 days of aging. However, supplemented T during rearing had a further effect on intramuscular fat content and fatty acid composition at the time of slaughter. The intramuscular fat level increased by supplementation. The grazing production system promote the production of healthier meats, anyway, using the *n6/n3* ratio, all the T generated meats with the recommend values. PUFA/MUFA ratios did not present differences among T and was below the recommended value. The importance of the feeding regime during lamb rearing by the time of slaughter in promoting healthy meat production system was proved. Therefore post weaning feeding and PC content in the diet could influence the production of more healthy meat. These interesting findings require further research.

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