EFFECT OF DIFFERENT HAY – CONCENTRATE RATIOS ON CARCASS TRAITS, MEAT QUALITY AND FATTY ACID COMPOSITION ON CORRIEDALE HEAVY LAMBS

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Abstract— The aim of this study was to determine the effect of different hay (H) – concentrate (C) ratios on performance, carcass characteristics, meat quality traits and fatty acid composition of intramuscular fat on Corriedale heavy lambs. Forty-eight male Corriedale lambs at 9 months age were randomly assigned in four groups according different hay (H) – concentrate (C) ratios, being the treatments: T1) 80:20; T2) 60:40; T3) 40:60; T4) 20:80, H – C, respectively. The animales were slaughtered after 115 days of feeding and their carcass and meat quality were evaluated. Lambs from T3 had heavier cold carcasses weight (CCW) than those from others treatments (P<0.01). Frenched rack weight (FRW) was higher on T3 and T4 than T1 (P<0.05), however, it not observed differences on boneless leg weight (BLW) among treatments (P>0.05). It was not found any difference (P>0.05) among treatments on meat color parameters, tenderness of the meat aged for 2 and 10 days and intramuscular fat (IMF) content. In regard to fatty acid composition, stearic acid (18:0) content was higher (P<0.01) on T1 and T2 than T3 and T4. Linolenic acid (18:3 n-6) content was higher (P<0.05) on T1 than other treatments, and oleic acid (18:1 cis) content was lower on T1 than T2 and T4 (P<0.05), and similar than T3. Nevertheless, it was not found any difference (P>0.05) on conjugated linoleic acid (CLA) content, polyunsaturated:saturated fatty acids (PUFA:SFA) and omega 6: omega 3 (n6:n3) ratios. In general, the differences among treatments in meat quality were minimal, but differences could be bigger whether fresh forage would be used hay instead and lambs were younger.

Index Terms **– heavy lamb, hay, concentrate, meat quality, fatty acid composition.**

I. INTRODUCTION

Uruguayan livestock production is based on pastures, in general on extensive systems. However, supplementation with concentrate is an important tool to intensify grazing systems production. In this way, more intensive systems including supplementation to grazing lambs have been increased during the last years. Several research carried out by INIA showed that supplementation improves performance and attributes of carcass and meat quality and reduces seasonal production (Montossi *et al*., 2003). Nevertheless, is important to known how fatty acid profile can be changed in relation to hay:concetrate ratio, because fatty acid composition of intramuscular fat can be influenced by factors such as diet, amongst others (Bas *et al*.,2000; Raes *et al*.,2003). Besides, fatty acid composition influences the flavour and the nutritive value of the meat, related the latter to human health (Wood *et al*., 1997). At the same time, consumers are more worried about healthy meat and demand meat quality traits. Therefore, it proposal attempt to know how can to intensify grazing systems production without affecting fatty acid profile. The objectives of this trial were to evaluate the effect of different hay – concentrate ratios on performance, carcass characteristics, meat quality traits and fatty acid composition of intramuscular fat on Corriedale heavy lambs.

II. MATERIALS AND METHODS

Forty-eight castrated Corriedale lambs (9 to 10 months of age), with an average initial live weight (LW) 26.4 kg ± 2.2, and body condition score (BCS) 3.27 ± 0.39 units (scale 1 to 5) (Rusell *et al*., 1969), were randomly assigned in four equal groups according different hay (H) – concentrate (C) ratios, being the treatments: T1) 80:20 (n=12); T2) 60:40 (n=12); T3) 40:60 (n=12); T4) 20:80 (n=12), H – C, respectively. The concentrate was a grounded mix of corn grain (75%) and soybean (25%) with an average: 14.4% CP, 12.2% NDF and 6.0% ADF. The lucerne hay presented an average: 16.0% CP, 49.4% NDF and 40.4% ADF. Animales were housed in individual indoor pens and the feeding was offered at 3.5% of LW. The animales were slaughtered in a commercial abattoir at 12 months age, after 115 days of feeding and their carcass and meat quality were evaluated. At the slaughterhouse, it was recorded cold carcass weight (CCW) and GR point; frenched rack weight (FRW) and boneless leg weight (BLW) were registered after 36 hours of chilling at 2-4°C. Meat measurements were done in Longissimus thoracis muscle samples, determining ultimate pH (24 hours after slaughter, between 12th and 13th rib), muscle color (L*=brightness, a*=redness and b*=yellowness) and shear force (Warner Bratzler) after 2 and 10 days of ageing. The muscle pH was measured using a hand-held pH meter (Orion A 230) with a probe type electrode (BC 200, Hanna Instruments), standardized against two pH buffers (4 and 7). The temperature was determined by a thermometer (Barnant 115) with stainless steel thermocouple (type E). Muscle

color measurements were made using a Minolta Colorimeter (model C-10). They were recorded in triplicate from the approximate geometric center of the exposed *Longissimus dorsi* muscle at the 13th rib, after 24 hours *pos mortem*, taking the readings of L*, a* and b* parameters on the muscle, according to the Hunter system. A portion of *Longissimus dorsi* was removed from the left side of carcasses, labelled, vacuum-packaged and aged for 2 and 10 days at 2-4 ^{o}C before the shear force analysis was done. The samples were cooked by immersion within a plastic bag in a water bath until an internal temperature in the muscle of 70 ^{o}C was reached. The internal temperature was monitored using type E thermocouples placed in the approximate geometric center of the sample. Six cores (2.54 cm in diameter) parallel to the muscle fiber orientation were removed from each sample. Tenderness was obtained for each core using a WBSF machine (G-R Electric Manufacturing Co, Manhattan, KS). Individual shear force (SF) values were averaged to assign a mean peak WBSF value to each sample. Total lipid was determined following the chloroform-methanol procedure of Folch *et al.* (1957) modified by using a 10:1 ratio of chloroform-methanol to sample. Extract containing approximately 25 mg of lipid was converted to fatty acid methyl esters (FAME) following the method of Park and Goins (1994). The FAME was analyzed using a Konik HRGC 4000B gas chromatograph and separated using a 100-m SP 2560 capillary column (0.25 mm i.d. and 0.20 μm film thickness, Supelco, Bellefonte. PA). Individual fatty acids were identified by comparison of retention times with standards (Sigma. St. Louis. MO, Supelco, Bellefonte, PA). Results were analyzed by analysis of variance using the GLM procedure of SAS (SAS Inst. Inc., Cary. NC).

III. RESULTS AND DISCUSSION

The effect of feeding treatments on animal performance and meat quality attributes is shown in Table 1. It was observed a very important effect ($P<0.01$) of the treatments on cold carcasses weight (CCW). Lambs from T3 had heavier CCW than those from other treatments ($P<0.01$), indicating that 40(H):60(C) ratio allowed to achieve the highest animal performance during the fattening period (data not shown). Also, in reference to valuable cuts, FRW was higher on T3 and T4 than T1 ($P<0.05$), and differences were not found among treatments T2, T3 and T4. However, BLW was similar among treatments. Although, it was not observed differences ($P>0.05$) in GR point, carcasses from T4 tended to have higher subcutaneous tissue thickness than T1, T2 and T3 (5.4, 6.9, 7.5 and 9.6, to T1, T2, T3 and T4, respectively), according to increase concentrate level. Priolo *et. al* (2002) founded that grass lambs had a lower proportion of fat compared to the stall lambs. On the other hand, it was not observed any differences in WBSF, pH 24 hours and meat color parameters among treatments. This is in contrast with the results reported by Priolo *et. al* (2002) in meat color comparing grass fed lambs and stall fed lambs, obtaining lighter meat (higher L*) in the latter.

The IMF content and fatty acid composition of *longissimus dorsi* is presented for all treatments in Table 2. It was not found differences in IMF content ($P>0.05$) among treatments. These values are higher than the mean IMF content stated by Priolo *et al*. (2002), but in the present study the lambs are older than last study. The lambs were slaughtered at 12 months of age, meanwhile the age of the lambs was 5 months old in Priolo´s research. It was not found any differences ($P > 0.05$) for myristic (C14:0) and palmitic (C16:0) content among treatments. The percentage of stearic (C18:0) was higher ($P<0.05$) in IMF of T1 and T2 than T3 and T4; this could be explained by the concentrate level, being at least 60% of the diet on T3 and T4. These results are concordant with Demirel *et al*., (2006), who reported higher value in hay fed lambs (20.2%) compared to concentrate fed lambs (17.9%). These researchers explained that this could indicate higher rumen biohydrogenation in grass hay fed lambs. The presence of a greater proportion of available carbohydrates in concentrate reducing the residence time of food in the rumen, decreasing biohydrogenation of the polyenoic and producing lower level of stearic. The oleic (C18:1 *cis*) percentage was lower ($P<0.05$) on T1 (80% H: 20%C) than other treatments. Bas *et al*. (2000) reported that concentrate diet presented the highest C18:1 percentage comparing with grass fed lambs. It was not observed differences on linoleic (C18:2) and CLA content. This data is not according to Demirel *et al.* (2006) research, who found higher levels of linoleic acid in concentrate fed lambs compared to hay fed lambs. The linolenic (C18:3 n-6) content was higher on T1 than the other three treatments, probably due to the effect of the diet (lucerne hay). The lower ($P<0.05$) MUFA content was displayed on T1, and it was not observed differences among T2, T3 and T4, in concordance with several previous research. It was not found differences among treatments on SFA, PUFA, PUFA/SFA and n-6/n-3 ratios. Raes *et al*. (2004) stated that PUFA/SFA ratio is mainly influenced by genetics and n-6/n-3 ratio is influenced by the diet. In all treatments n-6/n-3 ratio was lesser than 4, according to the recommendation from the Department of Health of United Kingdom (1994). On the other hand, PUFA/SFA ratios were in all treatments lower than 0.45, below the recommended level from the mentioned Department of Health. Link *et al.* (1970) found that the proportion of PUFA decreased when animal age and intramuscular neutral lipid deposition increased. The accumulation of SFA increased with age, whilst PUFA decreased (Lengyel *et al*., 2003). In this way, it must consider that the lambs were slaughtered at 12 months of age. The similar fatty composition among treatments could be explained by several hypotheses. The older age of lambs and the type of hay (Lucerne), could be affecting the results. Also, these differences could be bigger if a fresh forage would be used instead hay.

Table 1. Mean carcass and meat quality parameters of heavy lambs.

Parameters	T1	T2	T3	T4	P
CCW (kg.)	14.9[c]	17.1[b]	19.1[a]	16.3[b]	**
BLW (kg.)	1.54	1.55	1.63	1.69	ns
FRW (kg.)	0.40[b]	0.44[ab]	0.45[a]	0.46[a]	*
GR point (mm)	5.4	6.9	7.5	9.6	ns
WBSF 2 days	4.53	4.71	4.44	4.35	ns
WBSF 10 days	2.59	2.52	2.74	2.57	ns
pH 24 hours	5.85	5.79	5.83	5.79	ns
L* 20 days ageing	37.2	36.9	37.3	37.7	ns
a* 20 days ageing	17.0	16.9	16.7	17.2	ns
b* 20 days ageing	8.8	8.8	8.7	9.3	ns

References: ns: not significant (P>0.05), *: P<0.05 and **: P<0.01.
a, b, c: means with different letters within each variable are statistically different.

Table 2. Intramuscular fat content (%) and intramuscular fatty acid composition (% of total fatty acids identified).

Variable	T1	T2	T3	T4	P
IMF (%)	4.30	4.46	4.70	4.71	ns
Fatty acids (%)					
C14:0 (myristic)	1.78	1.56	1.72	1.69	ns
C16:0 (palmitic)	21.29	21.12	21.76	21.16	ns
C18:0 (stearic)	18.24[a]	18.01[a]	16.30[b]	16.10[b]	**
C18:1 trans (oleic)	2.23[b]	2.54[b]	3.18[a]	2.72[ab]	*
C18:1 cis (oleic)	36.41[b]	39.10[a]	38.90[ab]	40.60[a]	*
C18:2 cis (linoleic)	4.95	4.58	4.82	4.37	ns
C18:2 trans (linoleic)	1.19	1.21	1.33	1.42	ns
CLA	0.45	0.39	0.34	0.51	Ns
C18:3 n-6 (linolenic)	1.02[a]	0.59[b]	0.60[b]	0.54[b]	*
C18:3 n-3 (linolenic)	0.53	0.58	0.55	0.53	Ns
C20:5 (EPA)	1.66	1.73	1.76	1.56	Ns
C22:6 (DHA)	0.57	0.51	0.45	0.37	Ns
SFA	44.4	43.6	428.8	42.2	Ns
MUFA	40.7[b]	43.6[ab]	44.3[a]	45.3[a]	*
PUFA	11.3	10.2	10.5	9.9	Ns
PUFA/SFA	0.25	0.23	0.25	0.24	Ns
n-6/n-3	2.23	2.21	2.12	2.11	Ns

IV. CONCLUSION

Fattening process of heavy lambs based on grazing systems can be intensified by including concentrates. Lambs from T3 had heavier CCW than those from other treatments (P<0.01). FRW was higher on T3 and T4 than T1 (P<0.05), however, it was not observed differences on BLW among treatments (P>0.05). It was not found any difference (P>0.05) among treatments on meat color parameters, WBSF of the meat aged for 2 and 10 days and IMF content. In regard to fatty acid composition, stearic acid (18:0) content was higher (P<0.01) on T1 and T2 than T3 and T4. Linolenic acid (18:3 n-6) content was higher (P<0.05) on T1 than other treatments, and oleic acid (18:1 cis) content was lower on T1 than T2 and T4 (P<0.05), and similar than T3. Nevertheless, it was not found any difference (P>0.05) on CLA content, PUFA/SFA and n-6/n-3 ratios. In general, the differences among treatments in meat quality and fatty acid composition were minimal, but differences could be bigger whether fresh forage would be used instead hay and lambs would be younger. More studies related to different H:C ratio will be needed because diet, amongst other factors (Bas *et al*., 2000; Raes *et al*., 2003), affects fatty acid profile .

REFERENCES

Bas, P., Morand-Fehr, P. 2000. Effect of nutritional factors on fatty acid composition of lamb fat deposits. Livestock Production Science, 64, 61-79.

Demirel, G., Ozpinar, H., Nazli, B., Keser, O. 2006. Fatty acids of lamb meat from two breeds fed different forage: concentrate ratio. Meat Science, 72, 229-235.

Department of Health. (1994). Report on health and social subjects. No. 46. Nutritional aspects of cardiovascular disease. London:HMSO.

Folch. J., Lees. M., & Sloane Stanley. G.H. 1957. A simple method for the isolation and purification of total lipids from animal tissues. Journal of Biological Chemistry, 226, 497-509.

Lengyel Z., Husvéth F., Polgár P., Szabó F and Magyar L. 2003. Fatty acid composition of intramuscular lipids in various muscles of Holstein-Friesian bulls slaughtered at different ages. Meat Science, 65, 593-598.

Link, B.A., Bray R.W., Cassens R.G. and Kauffman R.G. 1970. Fatty acid composition of bovine skeletal muscle lipids during growth. Journal of Animal. Science, 30, 726.

Montossi, F., San Julián, R., Brito, G., De Los Campos, G., Ganzábal, A., Dighiero, A., De Barbieri, I., Castro, L., Robaina, R., Pigurina, G., De Mattos, D. and Nolla, M. 2003. Production of quality lamb meat with the Corriedale breed: recent advances and challenges of technological innovation in the context of the Sheep Meat Chain of Uruguay. Summaries of the 12th World Corriedale Congress. Montevideo, Uruguay. pp. 74-90. (In Spanish).

Park, P.W., & Goins, R.E. 1994. In situ preparation of fatty acid methyl esters for analysis of fatty acid composition in foods. Journal of Food Science, 59, 1262-1266.

Priolo, A., Micol, D., Agabriel, J., Prache, S., Dransfield, E. 2002. Effect of grass or concentrate feeding systems on lamb carcass and meat quality. Meat Science, 62, 179-185.

Raes, K., De Smet, S., Demeyer, D. 2004. Effect of dietary fatty acids of incorporation og long chain polyunsatured fatty acids and conjugated linoleic acid in lamb, beef and pork meat: a review. Animal Feed Science and Technology, 113, 199-221.

Wood, J.D., and M. Enser. 1997. Factors influencing fatty acids in meat and the role of anti-oxidants in improving meat quality. British Journal of Nutrition, 78 (Suppl.1), S49-S60.

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