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Effects of forage feeding and the inclusion of Quebracho in ewes' diet on suckling lamb's meat quality

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Abstract. Churra Tensina ewe-lamb pairs grazed in mountain pastures (n = 20; Pasture) or were fed hay indoors (n = 19; Hay). Half of the ewes of each treatment received daily 300 g/head of a commercial concentrate (Control) or 300 g/head of the same concentrate with 10% of Quebracho (*Schinopsis Balansae*) with 75% of condensed tannins (QUE). Lambs suckled their dam's milk, being slaughtered when reached 10-12 kg live weight. The effects of forage, the inclusion of QUE in the dam's diet and the lamb's sex were evaluated on intramuscular fat content (IMF), color (Lightness (L*), redness (a*), yellowness (b*), Hue angle (H*) and Chroma (C*)), and lipid oxidation at 0, 2, 5, 7 and 9 days of ageing in the *Longissimus dorsi* muscle. Meat of Hay lambs had greater IMF, L*, b* and H* than that of Pasture lambs (P<0.001), but meat had similar lipid oxidation (P>0.05). The inclusion of QUE had no effect on IMF (P>0.05) but affected color, meat of QUE lambs having greater L*, b* and H* than that of Control lambs (P<0.05). Lipid oxidation tended to be lower in QUE than in Control lamb meat (P = 0.07). Regarding the effect of sex, meat of females had greater IMF (P<0.01) and lower b* and C* than that of males (P<0.05) with no differences on lipid oxidation.

Keywords. Sex – Condensed tannins – Color.

Effets, sur la qualité de la viande des agneaux allaitants, de la distribution de fourrage et de l'inclusion de Quebracho dans le régime des brebis

Résumé. *Des paires brebis-agneau de race Churra Tensina ont été mises en pâturages de montagne (n = 20; Pasture) ou alimentées en stabulation avec du foin (n = 19; Hay). La moitié des brebis de chaque traitement recevait par jour 300 g/tête d'un concentré commercial (Control) ou 300 g/tête du même concentré avec 10% de Quebracho* (Schinopsis balansae) *avec 75% de tannins condensés (QUE). Les agneaux tétaient le lait de leur mère et étaient abattus à 10-12 kg de poids vif. Les effets du fourrage, de l'inclusion de QUE dans la diète des mères et du sexe des agneaux ont été évalués pour la teneur en gras intramusculaire (IMF), la couleur (Lightness, L*), le rouge (a*), le jaune (b*), l'angle de la teinte (Hue angle, H*) et la saturation (Chroma, C*), et l'oxydation des lipides à 0, 2, 5, 7 et 9 jours de maturation dans le muscle* Longissimus dorsi. *La viande des agneaux recevant du foin (Hay) présentait des valeurs plus fortes de IMF, L*, b* et H* que celle des agneaux de pâturage (Pasture) (P<0,001), mais la viande avait une oxydation des lipides similaire (P>0,05). L'inclusion de QUE n'avait pas d'effet sur IMF (P>0,05) mais affectait la couleur, la viande des agneaux QUE ayant un niveau plus élevé pour L*, b* et H* que celle des agneaux Control (P<0,05). L'oxydation des lipides tendait à être plus faible pour la viande des agneaux QUE que pour celle des agneaux Control (P = 0,07). Concernant l'effet du sexe, la viande des femelles avait une plus grande IMF (P<0,01) et de plus faibles b* et C* que celle des mâles (P<0,05) sans différences sur l'oxydation des lipides.*

Mots-clés. *Sexe – Tannins condensés – Couleur.*

I – Introduction

In dry mountain areas, as the Pyrenees, ewes are usually stalled around parturition and hay-fed plus concentrate during lactation. To produce a traditional food product, the suckling lambs are fed exclusively on maternal milk from birth to slaughter (average age of 40 days and body weight of 10-12 kg). However, grazing pasture is an interesting alternative (Joy *et al*., 2012) because ewes and lambs had good performance and the use of natural resources is increased. The inclusion of

condensed tannins in the ewe´s diet has been studied to reduce methane emissions and to improve production parameters, but it depend on the dose and the type of tannins (Ramírez-Restrepo and Barry 2005). Condensed tannins affected positively meat quality of fattening lambs because they are antioxidants (Vasta and Luciano, 2011). However, there is scarce information of their effect on meat quality of suckling lambs.

Therefore, the aim of this study was to evaluate the effect of two types of forages (pasture *vs.* hay) and the inclusion of condensed tannins from Quebracho in the concentrate fed to Churra Tensina lactating ewes on meat quality of the suckling lambs.

II – Materials and methods

The experiment was conducted in the facilities of La Garcipollera Research Station, in the mountain area of the Southern Pyrenes (North-Eastern Spain, 42º 37'N, 0º 30' W, 945 m a.s.l.). The experimental and slaughter procedures met the guidelines of Council Directive 86/609/EEC on the protection of animals used for experimental and other scientific purposes.

Spring-lambing adult ewes of Churra Tensina breed (n = 39; at lambing: age: 6.9 ± 0.54 year; bodyweight (BW): 47 ± 1.0 kg; body condition score (BCS) 2.4 ± 0.05) and their single-reared lambs (BW at birth: 4 ± 0.1 kg) were used in a 35-day feeding trial. At lambing, ewe-lamb pairs were randomly distributed, according to BW, BCS and age of ewe and sex of the lamb, to 1 of 4 treatments in a 2 x 2 factorial experimental design, with 2 forages: Pasture *vs.* Hay; and 2 pelleted concentrates: a Control concentrate *vs.* a QUE concentrate with 10% of Quebracho extract (SYLVAFEED ByPro Q, Spain). The extract contained 75% of condensed tannins. Pasture dams and lambs had access to a permanent pasture, where samples were taken weekly and analysed (239 g crude protein (CP)/kg dry matter (DM), 175 g of neutral detergent fibre (NDF)/kg DM and 16.45 MJ metabolizable energy (ME)/kg DM). The remaining pairs were stalled and ewes received hay (69 g CP/kg DM, 633 g NDF/kg DM and 8.24 MJ ME/kg DM). The concentrates were available only for the dams, which were daily fed 300 g/head. Half of the dams of each type of forage were fed the QUE concentrate (141 g CP/kg DM, 175 g NDF/kg DM and 16.45 MJ ME/kg DM) while the other half were fed the Control concentrate (140 g CP/kg DM, 249 g NDF/kg DM and 15.13 MJ ME/kg DM). Lambs suckled their dams and had access to pasture or hay. Water and mineral blocks were offered *ad libitum.*

When the lambs reached the target slaughter weight (10-12 kg), they were slaughtered weekly, in the experimental abattoir of the Research Centre. Carcasses were hung by the Achilles tendon and chilled at 4 ºC for 24 h in total darkness. After this time, the *Longissimus thoracis et lumborum* (LTL) muscle was extracted and sliced into five 2.5-cm samples. One slice was lyophilized to determine the intramuscular fat content. The other 4 slices were used to determine the color and lipid oxidation during storage. The samples were randomly placed in 4 trays, wrapped with oxygen-permeable PVC film and kept in darkness (4ºC) for 2, 5, 7 and 9 days. The 0 d samples were bloomed for 1 h before color measurement. Immediately after the color measurement, the samples were vacuum-packed and frozen (-20ºC) until TBARS analysis.

Lyophilized meat samples were minced to determine the intramuscular fat (IMF) using an Ankom (USA, NY). The color was measured using a Minolta CM-2006d spectrophotometer (Konica Minolta Holdings, Inc., Osaka, Japan) in the CIELAB space. The lightness (L*), redness (a*) and yellowness (b*) were recorded, and the hue angle (H*) = arctan (b*/a*) x 57.29, expressed in degrees, and $C^* = (a^{*2}+b^{*2})^{0.5}$ were estimated. To determine the lipid oxidation, TBARS analysis was carried out as described by Ripoll *et al*. (2013), and results were expressed as mg of maldonaldehyde (MDA) per kg of muscle.

Data were analysed using the SAS statistical software (SAS V.9.3). Intramuscular fat was analysed with a general lineal model (GLM) with forage feeding, the inclusion of QUE, lamb sex and their interaction as fixed effects. Color and lipid oxidation of LTL muscle were analysed with a mixed model

(MIXED procedure) for repeated measures including the forage feeding, the inclusion of QUE in the concentrate, lamb sex, the storage time, and their interactions as fixed effects and the lamb as the random effect. Results were reported as least square means and their associated standard errors (SE). Differences were significant or a trend at a probability value of P<0.05 and P<0.10, respectively.

III – Results and discussion

The interactions between the type of forage, inclusion of QUE and lamb sex were not significant in the parameters studied. Consequently, results are presented separately for the main effects in Table 1.

The forage fed to the ewe affected meat intramuscular fat content, lightness, yellowness and hue angel value (P < 0.001), but did not affect the lipid oxidation of the muscle of suckling lambs. Hay treatment had 27% greater IMF than Pasture one. This difference can be due to the longer time animals spend walking and eating in pasture, increasing the energy requirement for maintenance (Osuji, 1974). The differences in the color are in line with Joy *et al*. (2012) between suckling lambs from pasture- and hay-fed ewes in autumn.

The inclusion of Quebracho in the ewe´s diet increased lightness, yellowness, hue angle value (P<0.05) and tended to reduce lipid oxidation of suckling lamb, which could prolong meat shelf life. The greater lightness has been previously reported by other authors with the inclusion of different tanniferous plant species in lamb diets (Priolo *et al*., 2002; 2005). In the same sense, several authors observed that the inclusion of different tanniferous plant species in lamb diets originates a reduction in the lipid oxidation (Francisco *et al*., 2015; Jerónimo *et al*., 2012). In contrast, Luciano *et al*. (2009) studying the inclusion of Quebracho in fattening diets of lambs did not find effect on lipid oxidation. There is controversy about the absorption of tannins and its depots in animal tissues. Quebracho tannins seems not to be degraded or absorbed in gastrointestinal tract (López-Andrés *et al*., 2013), what can involve the lack of the antioxidant effect expected.

The sex of the lambs affected IMF content, yellowness and hue angle value (P<0.01). Females presented 19% greater IMF content than males according with Diaz *et al*. (2003) and Santos *et al.* (2015) in Manchego suckling lamb and “Cordeiro Mirandês”, respectively. Males had greater yellowness and chroma than females but similar lightness and redness.

As expected, time affected all color traits studied and lipid oxidation of the LTL muscle (P<0.001). Meat oxidation increased during the 9 days of storage, reaching 1 mg MDA/kg muscle at 7 day, which is an acceptability limit in meat of light lambs (Ripoll *et al*., 2011).

Table 1. Effect of type of forage (F), the inclusion of Quebracho in the concentrate (C), lamb sex (S) and time of storage (T) on intramuscular fat (IMF), color and lipid oxidation (TBARS) of the LTL muscle

	Forage	Concentrate			Sex		SE	Significance			
	Pasture	Hay	QUE	Control	Female	Male		F	C	S	T
IMF, %	8.10	10.34	9.17	9.28	10.00	8.45	0.52	***	NS	**	-
L*	41.73	43.95	43.39	42.29	42.53	43.15	0.335	***	*	NS	***
a*	12.05	11.81	11.77	12.09	11.71	12.14	0.178	NS	NS	NS	***
b*	6.18	7.37	7.11	6.44	6.39	7.15	0.185	***	*	**	***
H*	27.06	31.70	30.90	27.87	28.43	30.34	0.879	***	*	NS	***
C*	13.63	13.97	13.80	13.80	13.44	14.16	0.168	NS	NS	**	***
TBARS	0.73	0.88	0.71	0.90	0.79	0.82	0.078	NS	†	NS	***

L*: Lightness; a*: redness; b*: yellowness; H*: Hue; C*: Chroma.
Significance level: P<0.05*; P<0.01**; P<0.001***; P <0.1†; P>0.05 NS.

IV – Conclusions

The use of condensed tannins from Quebracho in the ewe diet at a dose of 7.5%, showed a tendency to decrease the lipid oxidation in meat of suckling lambs. The type of forage offered to dams affected most of the color parameters but did not affect the lipid oxidation.

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