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Effects of feeding system and *Acacia cyanophylla*-condensed tannins on lamb growth and meat characteristics

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Abstract. This experiment was conducted to investigate the effects of two feeding systems (pasture and feedlot (FL)) and natural protection of protein from microbial degradation in the rumen by acacia tannins on lamb's growth, carcass and meat characteristics. For this trial, 28 lambs were divided into four groups, two groups were raised in FL and fed a hay concentrate ration; the two remaining groups were reared on vetch pasture (VP). Animals of all groups received 400 g/day of concentrate in stalls. In each feeding system, one group received 100 g of acacia as a tannin source (FL-T and VP-T); the two others were tannin-free (FL-TF and VP-TF). At the end of the growth trial (77 days), all lambs were slaughtered and meat quality was determined in the longissimus dorsi muscle. Average daily gain (ADG) was higher (P< 0.01) for pasture than FL lambs (184 vs. 130 g), but it was not affected by dietary condensed tannins. However, the interaction between feeding system and tannin incorporation was significant (p<0.05); ADG was higher for FL-T than FL-TF, while VP-T has lower ADG than VP-TF. Lambs from all groups had similar muscle and fat proportions. Meat lightness (L*) was higher for FL-T and VP-TF (p<0.05) than FL-TF and VP-T, respectively. The cooking loss was reduced by tannin introduction in both feeding systems. No differences were found in meat chemical composition and ultimate pH. Inclusion of tannins decreased intensity of flavour (P< 0.05) but had no effect on overall acceptability. It could be concluded that tannin inclusion did not affect meat and carcass characteristics; however, it improved lamb's growth on poor tannin basal diet but lead to a decrease in growth rate on rich tannin basal diets (vetch).

Keywords. Lambs' growth – Carcass – Meat – Condensed tannins – Feeding system.

Effets du mode de conduite et des tannins condensés de l'*Acacia cyanophylla *sur la croissance et les caractéristiques des carcasses et de la viande des agneaux

Résumé. *Ce travail a été entrepris pour étudier les effets de deux systèmes d'alimentation (bergerie (B) et pâturage) et de l'apport de feuillage d'*Acacia cyanophylla *(acacia) riche en tanins condensés comme protecteur naturel des protéines de la dégradation microbienne dans le rumen sur la croissance et les caractéristiques de la carcasse et de la viande de moutons. Vingt-huit agneaux de race Barbarine ont été répartis en 4 lots ; deux lots ont été maintenus en bergerie avec du foin d'avoine à volonté, les deux autres ont été conduits sur pâturage de vesce (PV). Les agneaux de tous les lots reçoivent en bergerie 400 g de concentré/j/tête. Dans chaque système d'alimentation, un lot reçoit 100 g d'acacia (B-T et PV-T) et les deux autres n'en reçoivent pas (B-0T et PV-0T). À la fin de l'essai (77 jours), tous les agneaux ont été abattus et la qualité de la viande a été déterminée sur le muscle* Longissimus dorsi*. Le gain moyen quotidien (GMQ) a été plus élevé (p<0,01) sur pâturage qu'en bergerie (184 vs. 130 g), mais il n'a pas été affecté par l'apport d'acacia (P>0,05). Cependant, l'interaction entre le système d'alimentation et l'incorporation d'acacia dans la ration était significative (p<0,05); le GMQ a été plus élevé pour B-T que pour B-0T, alors que PV-0T avait un GMQ supérieur à celui de PV-T. Les carcasses des agneaux de tous les lots avaient les mêmes teneurs en muscle et gras. La luminosité de la viande (L*) était plus élevée (p<0,05) pour B-T et PV-0T que pour B-0T et PV-T. Le pH final et la composition chimique de la viande n'étaient pas affectés par les deux traitements alimentaires. La perte à la cuisson a été réduite par l'apport d'acacia dans les deux systèmes d'alimentation. Cet apport a induit une réduction de l'intensité de saveur mais n'a pas affecté l'acceptabilité globale de la viande. On peut conclure que l'apport d'une source de tanins en l'occurrence l'acacia n'affecte pas les caractéristiques des carcasses et de la viande, cependant il améliore la croissance des agneaux ayant des régimes pauvres en tanins et réduit celle des agneaux sur régimes riches en tanins.*

Mots-clés. *Agneaux – Croissance – Carcasses – Viande – Tanins – Système alimentaire.*

I – Introduction

The lamb meat is perceived by consumers as a natural product with a distinctive flavour and utile nutrients for human health. The feeding system and supply nature have considerable effects on meat quality (Atti *et al*., 2005; Priolo *et al.* 2001). The intake of rumen undegradable protein (RUP) may favour the production of less fatty carcasses (Fattet *et al.*, 1984; Vipond *et al.*, 1989) than that product by rumen degradable protein (RDP). The manipulation of dietary protein in order to protect them from microbial degradation has been generally achieved by using chemical formalin. This method can have undesirable effects on the quality of product. Tannins, naturally occurring plant metabolites, can protect proteins against ruminal degradation. The use of small amounts of Acacia cyanophylla Lindl foliage, rich in tannin, can naturally play this role (Ben Salem *et al.*, 2005; Maamouri *et al.*, 2011) and allows a better flow of amino acids. On the other hand, the meat of grazing animals is generally preferred by consumers who consider it natural, healthy and respectful of animal welfare. Therefore, it is important to differentiate between meat from lambs reared on pasture or kept in feedlot (FL) throughout the carcass characteristics. The carcasses and meat of ruminant reared on grazing conditions has different characteristics compared to stall-based production systems (Atti and Abdouli, 2001; Priolo *et al.*, 2001). The aim of this work is to study the growth performance and carcass and meat quality of Barbarine lambs grazing a cultivated vetch pasture or kept in FL condition and receiving a small quantity of acacia as a source of tannin.

II – Material and methods

The experiment was conducted at Lafareg, experimental farm of the National Institute of Agricultural Research of Tunisia (INRAT). Twenty eight lambs (22.5 ± 3.6 kg and 150 days old) were divided into four groups. Two groups were raised in FL and fed a hay concentrate ration; the two remaining groups were reared on vetch pasture (VP) on rotational grazing with a stocking rate of 90 lambs per ha. Animals of all groups received 400 g/day of concentrate in stall. Within each feeding system, one group received 100 g of acacia as a tannin source (FL-T and VP-T); the two others were tannin-free (FL-TF and VP-TF). Concentrate was administered to lambs after complete consumption of acacia. At the end of the growth trial (77 days), all lambs were slaughtered.

Lambs BW before slaughter and then carcass weights were recorded. The left half-carcasses were cut into six joints; all joints were dissected. Samples of *longissimus dorsi* (LD) muscle were taken for meat quality determination, chemical and sensorial analysis.

The initial and ultimate pH was measured with an Orion 9106 penetrating probe after calibrating with two buffers (7.00 and 4.00) 1 and 24 h post mortem, respectively. Color variables (L* (lightness), a* (redness), b* (yellowness)) were measured, 24 h post mortem, using a Minolta CR 400 color meter calibrated to a standard white tile. Cooking loss in muscle samples aged in plastic bags at 4℃ until 72 h post mortem was determined. Meat samples were weighed (Wi), held in plastic bags and then immersed in a water-bath at 75℃ and heated for 30 min until the internal temperature reached 75℃. The bags were then cooled under running tap water for 30 min and blotted dry with paper towels. The cooked meat was weighed again (final weight, Wf) and cooking loss was calculated as 100 (Wi - Wf)/Wi. For sensory evaluation, meat samples were roasted in aluminum paper in a pre-heated oven at 180ºC. Each sample had been cut into six coded pieces and served to panelists in random order for testing. Panelists were trained during two sessions on sensory properties of meat from different animal species before the assessment of meat samples.

Data statistical analysis was performed by analysis of variance using the GLM procedure of SAS (SAS, 1987). A 2x2 factorial design was adopted to test the effect of feeding system and tannins supplementation

III – Results and discussion

1. Forage production, diet intake, and lamb growth

The contents of condensed tannins (CT) were 0, 31.6 and 15.9 (g tannic acid equivalent per kg DM) in hay, acacia and vetch foliage, respectively; the vetch CT is very close to mean value reported by Makkar *et al.* (1996).

The grass yield in the whole plot during the grazing period was 880 kg DM. The mean daily herbage availability was 1.084 kg DM per lamb of grass, while average hay DM intake was 450 g/d. The mean CP content of grass was 220 vs. 67 g/kg DM for hay. The Average daily gain (ADG) was higher ($p<0.01$) for pasture than FL lambs (184 *vs.* 130 g). This difference could be related to the higher forage consumption and quality in VP. Growth of animals receiving tannin was 160 vs. 150 g/d for none tannin without significant difference. However, the interaction between feeding system and tannin incorporation was significant ($p<0.05$). The ADG was higher for FL-T than FL-TF (152 *vs.* 110 g), while VP-T had lower ADG than VP-TF (167 *vs.* 192 g). As consequence, slaughter BW was significantly affected by feeding system ($p<0.001$). The tannin supply had no significant effect on this parameter but the interaction was significant (Table 1). Dressing percentage and testicular weight were improved by condensed tannins supplementation particularly for FL animals (83 for FL-T *vs.* 58 g for FL-FT).

For FL feeding system the tannin content was weak; so the supply with small amount of acacia, rich in tannin, lead to an improvement of amino acids flow and absorption which resulted in a higher growth rate. While grazing regimen, based on vetch, containing tannins; the acacia supply lead to an excess of tannin supply and resulted in a negative reaction and lower growth rate (Ben Salem *et al.*, 2005).

2. Carcass composition, meat characteristics and sensory evaluation

Lambs from all groups had similar muscle and fat proportions (Table 1). This result was in contradiction with previous studies showing that grazing animals had significantly less fat than FL ones (McClure *et al.*, 1994; Atti and Abdouli, 2001; Nuerberg *et al.*, 2005).

Table 1. Average daily gain (ADG), slaughter body weight (SBW) and carcass tissue

	VP-FT	VP-T	FL-FT	FL-T	FS effect	TS effect	Interaction FS x TS
ADG (g)	192	167	110	152	0.01	0.11	0.02
SBW (kg)	33.2	32.2	28.0	29.6	0,05	0,731	0.05
Muscle (%)	61.1	61.8	63.0	62.8	0,541	0,159	0.25
Fat (%)	15.9	16.5	12.9	14.2	0,047	0,138	0.36

VP: reared on vetch pasture; FL: reared in feed-lot; T: supplemented with acacia (tannin source); FT: tannin-free; FS: feeding system; TS: tannins supplementation.

Both initial and ultimate pH values were similar for all groups, while cooking loss was affected by tannin supply which decreased this parameter (Table 2). Meat of all treatments presented lightness in the range of 41 - 45, L* values remained in the range of acceptability. Meat with a lightness value equal to or exceed 34 was acceptable on average and above 44 was acceptable by 95% of consumers (Khliji *et al.*, 2010). The lightness and redness parameters were not significantly affected by both dietary treatments (Table 2); However the interaction between feeding system and tannin incorporation was significant ($p<0.05$). The yellowness was significantly higher for grazing lambs than FL ones.

No significant differences were found for moisture (25%), crude protein, ash and fat contents

between groups. However, the interaction between feeding system and tannin incorporation tended to be significant ($p<0.08$ for CP and 0.05 for crude fat). The tannin supplementation resulted in an increase of CP and decrease of fat for FL lambs and in an opposite situation for VP lambs (Table 2). This result converged with that of lamb's growth concerning the positive effect of tannin supply on poor basal regimen tannin content (fat reduction for FL animals).

The results of sensory analyses were summarized in Table 2. No significant effect ($P>0.05$) of dietary treatment was recorded on the sensory attributes except intensity of flavour, which was decreased ($P<0.05$) by tannin incorporation. Meat for all groups was judged moderately tender (5.9) and juicy (5.5). Inclusion of tannins had no effect on overall acceptability.

Table 2. Physical, chemical and sensorial characteristics of meat

	VP-FT	VP-T	FL-FT	FL-T	FS effect	TS effect	Interaction FS x TS
pH1	6.8	6.9	6.8	6.7	0.149	0.640	0.149
pH 2	5.9	5.8	5.8	5.7	0.083	0.384	0. 831
Cooking loss	16.6	14.3	16.6	13.4	0.758	0.062	0.758
L*	43.5	40.9	43.4	45.4	0.096	0.637	0.05
a*	13.7	16	15.1	13.6	0.533	0.208	0.133
b*	9.1	8.6	7	7.3	0.005	0.916	0.225
Ash (%)	6.0	4.7	5.5	4.5	0.579	0.102	0.795
Crude protein	86.5	83.8	84.1	85.7	0.880	0.578	0.080
Fat (%DM)	8.5	10.5	11.4	8.8	0.720	0.872	0.052
Tenderness	6	5.7	5.9	6	0.662	0.884	0.356
Juiciness	5.7	5.1	5.8	5.6	0.370	0.113	0.865
Flavour	6.7	6.3	6.8	6.2	0.924	0.051	0.253
Overall acceptability	5.9	5.5	6	5.6	0.761	0.165	0.542

VP: reared on vetch pasture; FL: reared in feed-lot; T: supplemented with acacia (tannin source); FT: tannin-free; FS: feeding system; TS: tannins supplementation.

IV – Conclusion

Grazing animals had higher growth rate than FL lambs. Tannin inclusion improved lamb's growth on poor tannin basal diet but lead to a decrease in growth rate on basal diets containing tannins (vetch). It tends to improve the meat composition (reducing meat fat and increasing meat protein for FL) in the same way and did not affect meat overall acceptability. Hence, the supply of tannins should take into account the basal diet composition to avoid negative effects on animal performance.

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