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The north-western grasslands of Tunisia; a feed resource to efficiently produce a healthy sheep meat

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Abstract. In the North West region of Tunisia, lambs are produced indoors (S) or at pasture (P).The main meat breeds are: *Barbarine* (BB), *Noire de Tibhar* (NT) and *Queue Fine de l'Ouest* (QFO). This study investigated the effects of feeding system (S *vs.* P) and breed (BB, NT, QFO) on lambs' growth and carcass and meat quality. 36 male lambs (20 kg body weight) were used. S lambs received an increasing amount of concentrate (300 to 600g) with 500g of oat hay. P lambs ingested the same amount of hay and grazed for 6 hours in natural grassland for which the botanical composition was determined. After 67days, the lambs were slaughtered, carcasses were dissected and meat quality was studied. The pasture was composed of 45% grasses, 14% legumes and 41% other species. The average daily gain (ADG) was lower for P than for S lambs (94 vs. 111 g/day). The NT breed had the highest ADG (125 g/day). P lambs accumulated more muscle and less fat than S lambs, with no difference between breeds. In contrast, although the meat of both feeding systems had the same macrochemical composition, saturated fatty acids and lipid oxidation index of meat were higher in S than in P meat.

Keywords. Natural grassland – Sheep – Performance – Meat quality – Breed.

Les prairies du nord-ouest de la Tunisie : une ressource alimentaire pour produire efficacement une viande ovine saine

Résumé. Aunord-ouest de la Tunisie, les agneaux sont produits en bergerie (S) ou aupâturage (P). Les races à viande sont: la *Barbarine* (BB), la *Noire de Tibhar* (NT) et la *Queue Fine de l'Ouest* (QFO). Cette étude a examiné les effets du systèmealimentaire (S vs. P) et de la race (BB, NT, QFO) sur la croissance, la qualité de la carcasse et de la viande. 36 agneaux mâles (20 kg de poids vif) ont été utilisés. Les agneaux S recevaient une quantité croissante de concentré (300 à 600 g) avec 500 g de foin d'avoine. Les agneaux P ingéraient la même quantité de foin et pâturaient pendant 6 h sur une prairie dont la composition floristique avait étédéterminée. Après 67 jours, les agneaux ont été abattus, les carcasses disséquées et la qualité de la viande étudiée. La prairie était composée de 45% de graminées, 14% de légumineuses et 41% d'autres espèces. Les agneaux P avaient le gain moyen quotidien (GMQ) le plus bas (94 vs.111 g/jour), et la race NT le GMQ le plus élevé (125g/jour). Les agneaux P avaient accumulé plus de muscleet moins de gras que les agneaux S, sans différence entre les races. En revanche, bien que la viande des deux systèmes alimentaires ait la même composition macro-chimique, les acides gras saturés et l'indice d'oxydation lipidique de la viande étaient plus élevés pour S que pour P.

Mots-clés. Prairies naturelles – Ovins – Performances – Qualité de la viande – Race.

I – Introduction

In North-western areas of Tunisia, natural grasslands have been increasingly exploited in sheep farming as an alternative to concentrates, mainly due to the increase of cereal prices and to satisfy the societal demands regarding environmental and ethical concerns about food production (Bernués *et al.*, 2011). The objectives of this study were to estimate grassland production in these areas and to acknowledge the impact of such feeding system on the growth of lambs and carcass and meat quality.

II – Materials and methods

1. Animals, diets, slaughter and sampling procedures

A total of 36 male lambs (4 months old; 20.3 ±1.9 kg body weight) were used: 12 from the fat-tailed *Barbarine* (BB) breed, 12 from the thin-tailed *Queue Fine de l'Ouest* breed (QFO) and 12 from the thin-tailed *Noire de Thibar* breed (NT). Lambs from each breed were allocated on the basis of BW to one of two feeding systems : pasture (P) *vs.* stall (S).The three S groups received increasing amounts of concentrate (72% barley,25% faba bean and 3% mineral and vitamin; 300 to 500g) and oat hay (300 to 600 g). The P groups received the same amount of oat hay and grazed for 6 h daily, 2500 m^2 of natural grassland. After 67days, all lambs were weighed (after fasting) to measure body weight at slaughter (SBW), and then slaughtered. The carcasses were placed in a chiller at 4°C for 24 hours, after which each carcass was split along the midline, cut in six joints to be dissected in order to determine carcass tissular composition and *Longissimus Dorsi* (LD) muscle was removed to study meat quality.

2. Measurements and analysis

Oat hay and concentrate intake were recorded daily. For P, biomass availability at pasture was estimated according to the dry-weight-rank method (Tothill *et al*., 1992) and biomass intake was estimated based on the palatability of the dominant species. Samples of meat were dried, ground and analyzed for dry matter (DM), nitrogen (N), ash and intramuscular fat (IMF).Fat extraction to determine fatty acid profile was carried out according to the method of Bligh and Dyer (1959). Lipid oxidation (thiobarbituric acid reactive substances) during 6 days of storage was determined according to Botsoglou *et al*. (1994) and data was analyzed using the MIXED procedureof the Statistical Analysis Systems (SAS, 1999).Data related to the rest of the parameters was analyzed using the GLM procedure to assess the effects of feeding systems, breeds and their interaction.

III – Results and discussion

The feeding system x breed interaction was not significant, for all parameters.

1. Growth performance and carcass tissue composition

The grazed flora was composed of 45% grasses, 14% legumes and 41% other species (mainly 30% thistle). Indoors, lambs of different breeds consumed the same amounts of concentrate(P >0.05) with an average of 570 g. For P lambs, the stockingrate was 72 lambs/ha, allowing an averagegrass intake ofabout 560 g DM per lamb and per day (22g DM/kg BW) (Bouazizi et Mahjoub, 1999). This intake was covered by the biomass offered that was estimated to be1.2 and 2 kg/lamb at the beginning and the end of the trial. The oat hay intake was 440 g of DM. P Lambs had lower average daily gain (ADG) than S lambs (111 v. 94 g, Table1). The NT breed had higher SBW (27.99 kg; P < 0.01) and ADG (125 g/day, Table 1) than both other breeds. Besides, both farming system and breed affected the tissue composition of carcasses. In fact, fat content was higher for S than for P lambs and the BB breed had more subcutaneous fat than thin-tailed breeds (Table 1).

2. Meat chemical composition

The difference in lipid content in the meat of S lambs compared to P lambs was not significant. However, S lambs had more intramuscular fat than P ones which may be explained by a higher energy expenditure during grazing (Atti and Mahouachi, 2009).The breed affected (P = 0.01) both intramuscular lipids and protein content. Meat from the NT breed had the highest protein and the lowest fat content (79.95 and 18.68 %, respectively; Table 1).

Table 1. Effect of feeding system (FS) and breed on growth performance of lambs, carcass tissue composition and *longissimus dorsi* (LD) muscle chemical composition

	Breed[1]		Feeding system			Statistics[2]	
	BB	QFO	NT	P	S	Breed	FS
IBW (kg)	19.75	19.87	21.16	20.30	20.26	ns	ns
SBW (kg)	25.05^{b}	25.00^{b}	27.99^{a}	25.32	26.71	**	ns
ADG (g)	93.1^{b}	90.5^{b}	124.7^{a}	94.5 ^{b}	111.1^{a}	**	*
Muscle (%)	52.97^{a}	56.10^{a}	55.46^{a}	57.38^{b}	52.56^{b}	*	***
Intermusular fat (%)	7.39^{a}	7.42^{a}	6.27^{a}	4.88^{b}	9.04^{a}	ns	***
Subcutaneous fat (%)	7.77^{a}	4.59^{b}	3.84^{b}	3.39^{b}	7.15^{a}	***	***
DM in LD(%)	25.72^{a}	25.47^{a}	25.13^{a}	24.48^{b}	26.33^{a}	ns	*
Proteins in LD (%)	71.78^{a}	70.64^{a}	79.95^{b}	73.89^{a}	72.84^{a}	**	ns
Lipids in LD (%)	23.67^{a}	24.56^{a}	18.68^{b}	21.37^{a}	22.75^{a}	**	ns

[1] BB: Barbarine ; QFO: Queue Fine de l'Ouest ; NT: Noire de Thibar ; ^{a,b} Values within a row with different superscripts differ significantly at $P< 0.05$; IBW: initial Body weight; SBW: slaughter body weight; ADG: average daily gain; *ns:* $P>0.05$*; *:* $P<0.05$*; **:* $P<0.01$; ***: $P< 0.001$.

3. Fatty acid profile

The saturated fatty acids (SFA) content was higher for the S groups than for P ones (50.63 vs. 44.48 %; Table 2). Breed affected SFA concentrations (Table 2). C10:0 and C16:0 fatty acids were higher for the BB breed and C20:0 were higher for the NT breed. C14:0 and the C16:0 SFA are not recommended for human consumption (Costa *et al*., 2011). Total poly-unsaturated fatty acids (PUFA) content was affected by feeding system in favor of the P groups (18.06 vs. 6.97; Table 2). Individual PUFA were not affected by the genetic type.The n-6 PUFA were higher for S, while the n-3 PUFA were higher for P (Table 2). Thus, we confirmed that grass is a good source of n-3 PUFA, as suggested in the scientific literature (Yousefi *et al*., 2012). The n6/n3 and the PUFA/SFA ratios were affected by feeding systemin favorto the P groups. The percentage ofdesirable fatty acids was significantly higher in P meat than in S meat (72.66 vs. 66.84 %; Table 2), which is also consistent with the available scientific literature (Wood *et al*., 2004; Costa *et al*., 2011).

Table 2. Fatty acid ratios of intramuscular fat of lambs

	Breed[1]		Feeding system			Statistics[2]	
	BB	QFO	N	P	S	Breed	FS
∑ SFA	48.21	47.82	46.95	44.48	50.63	ns	**
∑ PUFA	12.4	11.81	13.10	18.06	6.97	ns	***
∑ n6	8.46	8.057	9.18	11.96	5.37	ns	***
∑ n3	1.49	2.51	2.73	4.26	0.99	ns	***
Desirable fatty acids	69.47	67.75	71.76	72.66	66.84	*	***
n6/n3	4.38	3.80	4.34	2.73	5.54	ns	***
PUFA/SFA	0.27	2.26	0.28	0.42	0.14	ns	***

1 : BB= Barbarine ; QFO= Queue fine de l'ouest ; NT= Noir de Thibar ; 2: Breed= breed effect; Diet= diet effect SFA:saturatedfattyacids; MUFA = monounsaturated fatty acids; PUFA = polyunsaturated fatty acids; Desirable fatty acids: 18:0 + unsaturated fatty acids.

4. Lipid oxidation

The evolution of the amount of thiobarbituric acid reactive substances (TBARS) were similar between breeds on the first day(P= 0.002). However, on the 3rd day meat from the QFO breed was more oxidized than meat from BB and NT breeds. This difference lasted for the 6 days of storage and the QFO breed displayed the highest lipid index (1.31 mg MDA/kg). These results confirm pre-

vious findings reporting that differences in the amount of total fat and PUFAs had little effect on the oxidative stability of raw meat. From the first to the third day of storage, meat from the S group had the highest lipid oxidation (0.112 *vs.* 0.048 and0.623 *vs.* 0.370 mg MDA/kg meat, at 0 and 3 days of storage, respectively). This difference was probably due to the higher concentration of antioxidant molecules in green herbage (Wood *et al*., 2004). In the present study, the effect of these substances decreased at 6 days of storage.

IV – Conclusions

Feeding light lambs with concentrate (S) or at pasture (P) in north-western Tunisia lead to similar growth rate and concentrations of lipids and proteins in meat, although P carcasses were leaner and P meat had a longer shelf-life than S meat.

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