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Carcass traits and meat quality of lambs from two grassland ecosystems in the Middle Atlas area

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Abstract. Timahdite sheep (TH) are the native breed of the Moroccan Middle Atlas. The objective of this study is to compare carcass and meat quality of TH lambs from two grassland ecosystem i.e. mountain and steppe ecosystems, in the Middle Atlas area. For that purpose a total of ten TH female lambs from each ecosystem were slaughtered at an average age of 179±2 days and a mean live weight of 23.3 ±3.6 kg to study carcass conformation indices and instrumental and sensory meat quality. Results showed no significant differences between systems neither in carcass quality (P>0.05), except the carcass compactness index (P=0.002), nor in ultimate-pH, WHC and *semimembranous* muscle color (P >0.05). However, meat sensory evaluation showed that lamb from steppe was discerned by the panel tasters as more tender than that from mountain (P <0.05). These results show that raising lambs on two different grassland ecosystems affect significantly the carcass compactness and the consumer's perception of tenderness, but do not affect the instrumental meat quality.

Keywords. Grassland ecosystem – Meat and carcass quality –Timahdite lambs –Middle Atlas –Morocco.

Qualité de la carcasse et de la viande des agneaux élevés sur pâturage dans deux écosystèmes différents dans la région du Moyen Atlas

Résumé. *La Timahdite (TH) est la race ovine locale dans le Moyen Atlas marocain. L'objectif de cette étude est de comparer la qualité de la carcasse et de la viande des agneaux broutards TH élevés dans deux écosystèmes différents, montagneux et steppique, dans la région du Moyen Atlas. Pour cela, un total de dix agnelles TH de chaque écosystème ont été abattues à un âge moyen de 179 ± 2 jours et à un poids moyen de 23,3± 3,6 kg pour étudier les indices de conformation de carcasse et la qualité instrumentale et sensorielle de la viande. Les résultats ont montré qu'il n'y a pas de différences significatives entre les agneaux ni pour la qualité de carcasse, excepté l'index de compaction (P = 0,002), ni pour le pH ultime, la capacité de rétention de l'eau ou la couleur du muscle semi-membraneux (P > 0,05). Toutefois, l'évaluation sensorielle des viandes a montré que l'agneau de steppe a été discerné plus tendre par les dégustateurs du panel par rapport à celui de montagne (P <0,05). Ces résultats montrent qu'élever des agneaux sur deux pâturages d'écosystèmes différents affecte significativement la compaction de la carcasse et la perception du consommateur quant à la tendreté de la viande, alors que ceci n'affecte pas la qualité instrumentale de la viande.*

Mots-clés. *Écosystème de Pâturage – Qualité de la viande et de la carcasse – Agneau Timahdite – Moyen Atlas – Maroc.*

I – Introduction

In Morocco, lamb meat from the Middle Atlas area is known as one of the best meats in the country (Boujenane, 2005). It is considered as a nutritious and lean meat since it is mainly produced on pastures. Middle Atlas is characterized by differences in altitude, generating diversity in topography, climate, feed resources, and eventually in ecosystems. Based on this, the relationship between these ecosystems and the quality of the produced grass-lamb meat needs to be clarified. Indeed, few studies compared lamb meat produced on different types of pastures. In this sense, the aim of the present study is to determine the effect of grazing on two different pastures on the main indicators of quality in traditional ovine meat and carcass of local sheep raised in the Eastern Middle Atlas area in Morocco.

II – Materials and methods

A total of 20 weaned Timahdite female lambs, mean age and live weight 89 ± 2 days and 15.3 ± 1.7 kg, originated from a same agro-silvo-pastoral farm in the Middle Atlas area, were used for our study. Lambs were chosen based on sex, age and weight. They had been raised, from March until May 2014, either on steppe (P1, n= 10) or forestry (P2, n= 10) pastures. No supplementary feeding was provided during the trial. Lambs were slaughtered at age of 179 ± 2 days and a mean live weight 23.3 ± 3.6 kg. The steppe pasture was dominated by the following plant species: *Poa* sp. and *Artemisia herba-alba*, *Stipa tenassissima*, *Thymus ciliates* and *Hordeum murinum*. The forestry pasture harbored as predominant plants *Quercus rotundifolia*, along with various shrubs species like *Thymelaea* sp. and *Genista quadriflora*, and lower proportions of herbs. During the trial, the average measured temperatures on P1 and P2 was 27ºC and 21ºC, respectively. The average spent time on pasture was 9 and 12h for P1 and P2 lambs, respectively.

After slaughter, hot carcasses were weighed and the dressing percentages were calculated as follows: **HCW/SLW** (%) = Hot carcass weight x 100 / slaughter live weight. Measurements on carcasses were carried out using a ribbon and a distance gauge to determine carcass conformation indices as cited by Bonvillani *et al.* (2010): internal carcass length (**L**), carcass compactness (**HCW/L**), hind limb length (**F**), buttock width (**G**) and hind limb compactness (**G/F**).Then, carcasses were let for 6 h at ambient temperature and then transported to a cold room set to 4°C. *Semimembranous* muscles were excised to measure meat color and ultimate-pH. A Minolta CR410 spectro-colorimeter was used to obtain *L*, a**, and *b** readings on caudal subcutaneous fat color at 0 and 24h post mortem and on *semimembranous* muscle color at cutting time (0 h) and after 24h of air exposure. Additional reflectance data collected include Hue angle *H**, a measurement where a vector radiates into the red-yellow quadrant, and the color saturation index Chroma *C**. These indices were calculated according to Murray (1995), as Hue angle = arctangent (b^*/a^*) x [360°/ (2x3.14)] and Chroma = $(a^{*2}+b^{*2})^{0.5}$. At 24 h after cutting time, ultimate-pH was measured by a meat pH-meter, and samples of 20 g from every *semimembranous* muscle were taken to determine the Water Holding Capacity (**WHC**), according to Grau and Hamm (1953) method. In parallel, meat tenderness was evaluated using the Lab Pro Tenderometer. The hardness of the meat is expressed by the maximum value of this force. Meat sensory evaluation was performed with two tests i.e. a scoring test, which evaluated the intensity of different sensory parameters using a scoring grid for each, and a triangle test to detect differences between the two meat origins. Thick pieces were prepared by slow cooking as the Moroccan traditional dash "*Tagine*" during 1.30 hour then served warm with sauce to 20 panelists. During two sessions, panelists were asked to evaluate the intensity of: tenderness, juiciness and meat flavor, using a scoring grid (scale 1–5) for each parameter, of two samples presented in randomized order. Then they were asked to determine the difference between 3 samples (of which 2 of similar origin), presented at randomized order in plates with three labeled letter codes.

Analysis of variance was performed by GLM procedure (SAS, 1997). The effect of the pasture as a fixed effect on all variables was analyzed. For the triangle test, the significance thresholds were evaluated according to the Norme AFNOR (2002), which shows in its first table the minimum number of correct answers that make a significant difference at different levels for the triangle test (5%, 1% and 1 ‰).

III – Results and discussion

Mean values for live weight at slaughter, carcass characteristics and subcutaneous fat color per pasture group are given in Table 1. Lambs on the P1 were significantly lighter at slaughter than those on P2 (P <0.05). This might be related to the abundance of pasture on the mountain area after snow melting compared to the steppe area. However, lambs from both groups presented similar dressing percentages. In addition, grazed pasture did not affect the hind limb compactness (P >0.5) but affected significantly the carcass compactness index (P <0.05). Lambs raised on P1 presented lower HCW/L ratio than those raised on the P2. This is probably due to the highest internal carcass length (Carrasco *et al*., 2009). On the other hand, there was no difference in the subcutaneous fat color coordinates (*L*a*b**) at 0 and 24 h. .

Table1. Effect of the pasture's type on live weight at slaughter, carcass characteristics and subcutaneous fat color

Site	P1	P2	SEM	Effect
SLW (kg)	19.75[a]	26.10[b]	7.24	**
HCW (kg)	9.51[a]	12.64[b]	0.57	***
HCW/SLW (%)	48.20	48.44	0.27	N.S
G/F	0.93	0.91	0.22	N.S
HCW/L (kg/cm)	0.15[a]	0.18[b]	0.87	**
$L^*_{0\,h}$	75.84	71.26	1.71	N.S
$a^*_{0\,h}$	3.51	4.60	0.93	N.S
$b^*_{0\,h}$	7.83	9.19	1.31	N.S
L^*_{24h}	77.18	73.94	1.50	N.S
a^*_{24h}	4.76[a]	7.15[b]	3.12	N.S
b^*_{24h}	11.96	11.50	0.46	N.S

P1= steppe pasture; P2=forestry pasture; SE =standard error; *L**=Lightness; *a**=Redness index; *b**=Yellowness index*;* N.S: no significant; **P*≤0.05; ***P*≤0.01; ****P*≤0.001.[a,b] Values within a row with different superscripts differ significantly at *P*≤0.5.

Table 2 shows that data regarding meat characteristics, i.e. pH, meat color, WHC and texture, were not significantly affected by the type of pasture (P> 0.05). Absence of statistical significance in carcass and meat characteristics is likely due to the small number of animals investigated (Dell *et al*., 2002).

Table 2. Effect of pasture's type on instrumental quality of *semimembranous* muscle

Site	P1	P2	SEM	Effect
Ultimate-pH	5.68	5.45	1.97	N.S
$L^*_{0\,h}$	44.44	40.77	1.09	N.S
$a^*_{0\,h}$	17.91	18.10	0.18	N.S
$b^*_{0\,h}$	3.20[a]	1.66[b]	2.95	*
$H^*_{0\,h}$	10.15	5.28	2.84	*
$C^*_{0\,h}$	18.19	18.20	0.002	N.S
L^*_{24h}	45.37	44.03	0.43	N.S
a^*_{24h}	19.08	20.67	1.70	N.S
b^*_{24h}	7.13	7.35	0.26	N.S
H^*_{24h}	20.52	19.66	0.35	N.S
C^*_{24h}	20.39	21.97	1.89	N.S
WHC (%)	26.61	27.92	0.28	N.S
Shear force (N)	20.19	23.05	0.64	N.S

P1= steppe pasture; P2=forestry pasture; SE =standard error; *L**=Lightness; *a**=Redness index; *b**=Yellowness index; *H*= Hue angle; C*= Chroma;*N.S: no significant; **P*≤0.05; ***P*≤0.01; ****P*≤0.001.[a,b] Values within a row with different superscripts differ significantly at *P*≤0.5.

On the other hand, results of the triangle test showed that there was no difference between the three samples of lamb meat. The number of correct answers needed to conclude the presence of a difference was less than that of the standards of Norme AFNOR (2002) with a certainty of 95% (8 *vs* 11, respectively).

Least square means for the sensory attributes of the M. *semimembranosus* samples are presented in Table 3. The ANOVA results show that lamb meat tenderness differed significantly between the two pastures P1 and P2 (P <0.05), while similar juiciness and flavor is detected for the two meats (P >0.05). Difference in slaughter live weight can explain the panelist's perception of tenderness (Martínez-Cerezo *et al.,* 2005). However, the shear force values were not linear with the taste test results and were similar for both treatments (P > 0.05).

Table 3. Effect of pasture's type on sensory quality of *semimembranous* muscle

Site	P1	P2	SEM	Effect
Tenderness	4.29^{a}	3.70^{b}	0.11	**
Juiciness	3.67	3.38	0.11	N.S
Flavor	3.65	3.68	0.11	N.S

P1= steppe pasture; P2=forestry pasture; SE =standard error; **P*≤0.05; ***P*≤0.01; ****P*≤0.001.[a,b] Values within a row with different superscripts differ significantly at *P*≤0.5.

IV – Conclusion

This investigation highlights that raising lambs on two grassland ecosystems affected only the carcass compactness index and the lamb meat tenderness. Observed differences were attributed to the difference in live weight at slaughter and carcass measurements, while absence statistical significance in carcass and meat characteristics was explained by the small number of investigated animals. More investigations on fatty acids as well as lipid and protein oxidation are needed to detect any additional effects.

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