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in

Baumont R. (ed.), Carrère P. (ed.), Jouven M. (ed.), Lombardi G. (ed.), López-Francos A. (ed.), Martin B. (ed.), Peeters A. (ed.), Porqueddu C. (ed.).
Forage resources and ecosystem services provided by Mountain and Mediterranean grasslands and rangelands

Zaragoza : CIHEAM / INRA / FAO / VetAgro Sup Clermont-Ferrand / Montpellier SupAgro
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 109

2014
pages 269-273

Carcass and lamb quality from agro-pastoral system in the Middle Atlas (Morocco)

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Abstract. In Moroccan Middle Atlas and its foothills sheep farming based on Timahdite breed and on the deliberate combination of the various components of the agro-pastoral system. From spring to early fall, feeding of weaned animals and early pregnant females is based exclusively on pasture. It yields carcasses and meat increasingly appreciated by consumers. In order to study the quality of these products, 3 groups of lambs received 3 different rations, were monitored for 3 months. Five animals from each group were slaughtered to study carcass and meat quality. The study of carcass concerned conformation and fatness, using measurements and European grids. Meat quality evaluation concerned the instrumental study of color, according to CIE L*a*b*model, ultimate pH, and sensory parameters with a taste panel. Preliminary results show that animals fed mainly on concentrate feed had better carcass yield, conformation and fatness than those raised on pastoral resources. Lightness of the meat and yellowness of the subcutaneous fat were higher for lambs raised in the extensive system than animals from intensive farming system. They have lower pH and more preferred by the consumer than that from concentrate and hay based-diet animals.

Keywords. Timahdite – Quality – Lamb meat – Carcass – Agro-pastoral system – Middle-Atlas.

Qualité des carcasses et de la viande des agneaux issus du système agro-pastoral dans la région du Moyen Atlas au Maroc

Résumé. *Au Moyen Atlas marocain et ses piémonts, l'élevage de la race ovine Timahdite se base sur des combinaisons de différentes ressources alimentaires du système agro-pastoral. Du printemps jusqu'au début de l'automne, l'alimentation des jeunes sevrés et des brebis en début de gestation se base exclusivement sur la pâture. Les animaux issus de ces élevages donnent des carcasses et des viandes de plus en plus appréciées par le consommateur. Dans le but d'étudier la qualité de ces produits, trois lots d'agneaux, qui différaient par la conduite alimentaire, ont été suivis pendant 3 mois. Cinq animaux de chaque lot ont été abattus. La conformation et l'état d'engraissement ont été étudiés en utilisant des mensurations et les grilles de classification européennes. L'évaluation de la qualité de la viande a concerné l'étude instrumentale de la couleur, selon le modèle CIE L*a*b*, le pH ultime et la qualité sensorielle évaluée par un jury de dégustation. Le rendement et l'état d'engraissement des carcasses du lot élevé sur les aliments concentrés ont été plus importants que ceux des animaux élevés sur la pâture et leur viande était plus foncée alors que leur gras était plus clair. La viande issue du système extensif a présenté un pH plus bas et a été préférée par le consommateur par rapport à celle issue du système intensif.*

Mots-clés. *Timahdite – Qualité – Viande – Carcasse – Agneau – Système agro-pastoral – Moyen Atlas.*

I – Introduction

The national demand for red meat is increasing because of the increase in population consumption. During these last years, an intensification of management on rangelands and a gradual growth in Timahdite-breed-lamb-feedlot had been observed in the Middle Atlas area to cover this demand. However, recently it was remarked that consumers are interested more to meat originating from extensive system than that from intensive system. As lamb's quality depends on a various intrinsic and extrinsic factors, of which the diet constitutes one of the bases of the con-

nection of the meat to its origin, it was important to undertake a study to evaluate carcass characteristics and meat quality of lambs raised on grass compared to those fed partially or completely on concentrate and hay.

II – Materials and methods

1. Animals and feeding system

The experiment was conducted in the Middle Atlas during 3 months (Mai to June), on 15 male lambs' entire of Moroccan Timahdite breed, about 6 months of age, originating from the same farm, weaned at 3 months of age and divided into three equal groups according to live weight (average initial weight of 23 kg). The first group was allowed to graze natural pasture (PP) during the whole experiment period, the second was fed a diet containing about 50% commercial concentrate feed and 50% oat hay (CC) and the last one was allowed to graze pasture and received hay and concentrate as supplements (PC). The commercial concentrate feed provides 18% of crude protein, 10% of minerals, 0.3% of phosphorus and 0.6% of calcium. PP and PC animals grazed the whole day while CC animals received an average of 620 and 800 g/head/day of concentrate and oat hay respectively. Before going to the pasture, PC animals had half of hay and concentrate-quantity given to CC group. Water was available for PP and PC animals when returning from pasture and at all time for CC group.

2. Slaughtering and carcass measurements

The five lambs used in each group, about 9 months age, were slaughtered as the Muslim slaughtering way at the end of the trial at average live weight of 41 kg. Animals were slaughtered on different days each time they reached approximately a 41 kg live weight. Thus the slaughtering process lasted 20 days.

Animals had access to water until approximately 12 hours before slaughtering and then were transported by truck for about 80 km to the slaughter house. Immediately after slaughter, carcasses were weighed and graded for fatness using the European grids. Measurements on carcasses were carried out using compasses, ribbon for tailors and calipers to determine the main indicators of carcass conformation. The index of carcass compacted was calculated through formulas (Ilişiu *et al*., 2010).

Subcutaneous fat color was measured by a Minolta CR410 spectro-colorimeter (CIEL *L*a*b**) at 12h post mortem. The carcasses were then let for 6 h at ambient temperature and then transported to a cold room set to 4°C.

3. Meat quality assessment

At 24 h post mortem the ultimate-pH was determined. Color measurements were taken by a Minolta CR410 after 12h post mortem on the *semimembranous* muscle.

Taste scoring test concerned meat from PC and CC groups. The day after of slaughtering, two legs from each group were used to carry out the test. Thick pieces were cooked under steam during 1.15 hour and two-cm thick pieces were served warm to 20 inexperienced panelists. During two sessions, panelists evaluated two samples presented in randomized order. Panelists were asked to evaluate the intensity of tenderness, juiciness and meat flavor using a scoring grid for each parameter.

4. Statistical analysis

Analysis of variance was performed by GLM procedure (SAS, 1991). The effect of the diet as a fixed effect on all variables was analyzed according to the following model: Yij = a + Di + Eij, where "Yij" is the variable analyzed; "a" is the overall mean, "Di" is the effect of diet (i = PP, CC and PC). The error term was "Eij". The Student-Newman Keul's procedure was used to separate least squares means when significant main effects were detected.

Taste test data were evaluated using the X^2 test.

III – Results and discussion

1. Carcass characteristics

Effects of diet on carcass characteristics are presented in Table 1. Diet had a significant effect on dressing percent (*P* = 0.05). Carcasses did not differ for carcass compactness index (P = 0.5). Carcasses from lambs raised on pasture had lower fatness score than those of animals raised with the concentrate based diet. This could be related to the physical activity compared to stall ones.

Subcutaneous fat color from grass lambs was more yellow (*b** higher) than that from stall lambs (*P* <0.001). The yellowness of fat is related to the presence of carotenoids in grass lambs (Prache and Theriez, 1999; Priolo *et al*., 2002). Carotenoids are pigments found in a higher concentration in fresh grass and give a yellow color to the subcutaneous fat (Jacques and Baba-Khelil, 2010).

Table 1. Carcass characteristics of lambs as affected by diet

	Feeding system			*SEM*	*P-value* =
	PP	CC	PC		
Number of lambs	5	5	5	–	–
Live weight at slaughter (kg)	40.9	40.7	41.4	1.48	0.5
Carcass weight (kg)	19.4	19.5	19.7	0.33	0.6
Dressing percent (%)	47.4^{b}	48.0^{a}	47.5^{b}	0.08	0.05
Fatness (1 to 5 scale)	2	3	2		–
Carcass compactness index (kg/cm)	0.35	0.36	0.35	0.00008	0.5
*L**	76.50^{b}	84.50^{a}	76.90^{b}	0.49	0.0001
*a**	3.68^{b}	5.23^{a}	3.37^{b}	0.09	0.0001
*b**	7.9^{b}	6.63^{a}	7.93^{b}	0.17	0.001

^{ab}: values having the same letter not significant.

2. Meat instrumental and sensorial quality

Impacts of diet on muscle instrumental quality are presented in table 2. Diet affected significantly the ultimate pH (P = 0.0001). However, values were higher than those reported by Muller (2011) for a good quality meat. It ranged between 5.67 and 5.98 *vs* 5.5 and 5.7 for a normal ultimate pH (Muller, 2011). As opposed to the results found by Priolo *et al.* (2002), ultimate pH muscle tended to be higher for the stall lambs compared to the grass lambs (P = 0.0001). Such differences may be attributed partially to the pre-slaughter factors.

According to Institut de l'Elevage (2006), pre-slaughter factors i.e. transport and slaughter process can stress animals, cause the decrease of glycogen reserve in the muscle and therefore increase ultimate pH. In fact, during the slaughter period the transport of stall lambs were done

during the hotter days of June (T > 35°C) for a large distance (81 km) separating the farm and slaughter house.

At 12 h post mortem, meat lightness was higher for PP and PC groups than for CC group meat (P = 0.0001). This difference in meat lightness could be linked to the difference in the ultimate pH since high pH meats tend to have a darker colour (Ledward *et al.*, 1986). The index of redness (*a**) is higher in meat from pasture systems (PP and PC) than that from intensive system (CC) which means that grass lamb meat is redder than stall lamb meat.

The results of sensory evaluation are shown in table 3 and. Meats from PC lambs were more tender, juicy and tasty than that from CC lambs. However, the chi-square test results (table 3) show that diet impacted significantly the tenderness and the juiciness of meat (P < 0.05) but not the flavor (P = 0.1).

Table 2. Effect of diet on *semimembranous* muscle characteristics

	Feeding system			*SEM*	*P-value* =
	PP	**CC**	**PC**		
Number of lambs	5	5	5		
Ultimate pH	5.67^{b}	5.98^{a}	5.67^{b}	0.004	0.0001
*L**	46.7^{b}	42.2^{a}	46.4^{b}	0.47	0.0001
*a**	21.9^{a}	21.4^{a}	21.8^{a}	0.28	0.5
*b**	6.8^{ab}	5.3^{a}	6.8^{b}	0.57	0.05

^{ab}: values having the same letter not significant.

Table 3. Effects of feeding systems *semimembranous* muscle sensory evaluation

	X^2 Pearson value	**Minimum Theoretical effective**	**P-value =**
Tenderness	8.9	1.48	0.011
Juiciness	12.3	2.96	0.006
Flavor	4.4	5.92	0.11

IV – Conclusions

This experiment was designed to compare grass-fed and concentrate-fed lambs, when animals were slaughtered at the same body weight.

Lambs raised on pasture had lower dressing percent, lower and more yellow subcutaneous fat. They have lower pH and more preferred by the consumer than that from concentrate and hay based-diet animals.

Acknowledgments

This work was carried out under the project ARIMNet-DoMEsTIc (http://www.arim-domestic.net/) with the financial support of the Ministry of Higher Education, Scientific Research and Professional Training (Morocco).

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