Performance, carcass characteristics and meat quality of Timahdite-breed lambs finished on pasture or on hay and concentrate

Araba A., Bouarour M., Bas P., Morand-Fehr P., El Aïch A., Kabbali A.

in

Papachristou T.G. (ed.), Parissi Z.M. (ed.), Ben Salem H. (ed.), Morand-Fehr P. (ed.). Nutritional and foraging ecology of sheep and goats

Zaragoza : CIHEAM / FAO / NAGREF
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 85

2009
pages 465-469

Performance, carcass characteristics and meat quality of Timahdite-breed lambs finished on pasture or on hay and concentrate

A. Araba*, M. Bouarour, P. Bas***, P. Morand-Fehr***, A. El Aich* and A. Kabbali****

*Institut Agronomique et Vétérinaire Hassan II, PO Box 6202, 10101 Rabat-Instituts (Morocco)
**Ecole Nationale d'Agriculture, PO Box S/40, 50001 Meknès (Morocco)
***INRA/INAPG, 16 rue Claude Bernard, 75231 Paris Cedex 05 (France)

Abstract. Two experiments in two consecutive years were carried out in the Middle Atlas Mountains of Morocco to evaluate the effect of pasture or hay and concentrate feeding on performance and quality of meat. It involved 18 (Experiment 1) and 39 (Experiment 2) Timahdite-breed lambs fattened for 3 months to reach a slaughter weight of about 25 kg (Experiment 1) and 40 kg (Experiment 2). After weaning at about 6 months of age, the lambs were divided in each experiment into three groups. The first group of lambs was fattened on pasture (PP), the second group was kept on a drylot and received hay and a commercial fattening concentrate (CC) and the third was fattened on pasture and received half of the drylot group ration (PC). In Experiment 2, in order to avoid effects of growth rate on meat quality, amount of concentrate and hay was monitored to ensure similar growth rates between the 3 groups. Six lambs from each group were slaughtered to study carcass and meat quality. Carcass assessment was based on linear dimensions and meat quality measurements were made on semi-membranous muscle taken from Experiment 1 lambs. Average daily gain was not affected ($P > 0.05$) by diet in Experiment 2 (186, 203 and 189 g/d for PP, PC and CC groups respectively), while it decreased with increasing pasture in the diet in Experiment 1. Drylot lambs displayed better carcass dressing, and less digestive tract development than those fed on pasture. The other carcass characteristics were not significantly affected by diet. Meat from pasture-fed lambs was considered more favourable for human health because of higher poly-unsaturated fatty acid percentages, higher n-3 fatty acids, and lower n-6/n-3 ratio.

Keywords. Pasture – Timahdite-breed – Sheep – Meat quality.

Performances d'engraissement et qualité de la viande d'ovins Timahdite conduits sur pâturage ou alimentés à base de concentré et de foin

Résumé. *Deux essais en 2 années successives sur des agneaux de race Timahdite ont été conduits dans le Moyen Atlas Marocain pour évaluer les performances d'engraissement et la qualité des carcasses et de la viande d'agneaux élevés sur parcours ou en bergerie. Dix-huit (Essai 1) et 39 (Essai 2) agneaux d'environ 6 mois d'âge ont été répartis en 3 lots correspondant respectivement à du parcours intégral (PP), du concentré et du foin (CC), du concentré, du foin d'avoine et du pâturage (PC). Les essais ont été menés pendant 3 mois pour atteindre un poids vif d'abattage d'environ 25 kg (Essai 1) et 40 kg (Essai 2). Lors de l'Essai 2, la quantité de concentré et de foin a été ajustée régulièrement pour que les animaux des différents lots aient des croissances similaires. Six agneaux par lot ont été abattus à la fin des essais pour étudier les carcasses (Essai 2) et des prélèvements du muscle semimembraneux (Essai 1) ont été effectués pour l'étude de la qualité de la viande. Les GMQ enregistrés dans l'Essai 2 sont de 186, 203 et 189 g/j ($P > 0,05$) respectivement pour les lots PP, PC et CC, alors que dans l'Essai 1, les GMQ des animaux sur pâturage ont été inférieurs à ceux des animaux conduits en bergerie. Les animaux du lot CC ont présenté un meilleur rendement en carcasse, et un plus faible développement du tube digestif que ceux des lots PC et PP. Les autres caractéristiques des carcasses n'ont pas été sensiblement affectées par le régime. La viande des agneaux élevés sur pâturage a été considérée plus favorable pour la santé humaine en raison des pourcentages plus élevés des acides gras poly-insaturés, et des acides gras n-3, et d'un rapport n-6/n-3 plus faible.*

Mots-clés. *Pâturage – Race Timahdite – Ovins – Qualité de la viande.*

I – Introduction

In the Middle Atlas, cradle of the Timahdite breed, sheep breeding is the principal agricultural activity of the rural population. The Timahdite breed, known by its rusticity and its adaptation to the conditions of the area, makes better usage of the pastoral resources. However, changes are occurring in the production system because of the disappearance of great transhumance, the sedentarisation of the stockbreeders, the appropriation of the land, the extension of the crops at the expense of the pasture, and the drought-enduring plants. These resulted in more frequent supplementation of animals during a long period of the year. In parallel, more fatteners exerting on the level of the peripheries of large urban centres start to purchase sheep from Middle Atlas in order to finish them indoors before marketing them. Knowing that the quality of the lamb meat depends on a great number of intrinsic and extrinsic factors, of which the diet constitutes one of the bases of the connection of the meat to its origin, it was considered important to undertake a study to evaluate performance, carcass characteristics and meat quality of lambs raised on grass compared to those fed partially or completely on concentrate and hay. The present study aims to investigate the effect of different systems of feeding on meat quality of Timahdite lambs. The results of this work could be used to give an added value to the meat produced on pasture from that produced by sheep fed concentrate and hay.

II – Materials and methods

Two experiments were conducted on lambs of Moroccan Timahdite breed, during two consecutive years (2006, Experiment 1, and 2007, Experiment 2) in the Middle Atlas. In Experiment 1, 18 entire male lambs, with about 6 months of age and about 16 kg of liveweight, purchased from a local market, and in Experiment 2, a total of 39 lambs, about 6 months, originating from the same farm were used to assess effect of pasture *vs* concentrate and hay feeding on growth performance and carcass and meat quality of lambs. Experiment 1 was conducted at the end of the grass season (June, July and August) and Experiment 2 was planned in March, April and May when grass was of high quality. The duration of the two experiments was planned for about 3-4 months. Animals were randomly allocated to one of three diets: pasture (PP), oat hay and concentrate (CC), and pasture and hay and concentrate (PC). CC lambs were collectively fed indoor, and in Experiment 2, feed intakes for CC and PC animals were adjusted with a target daily gain similar to PP group to avoid eventual effect of growth rate on meat quality. Animals from CC group were fed a diet containing about 50% commercial concentrate feed and 50% oat hay. Animals from PC group received half of CC diet, at night, and spend the whole day on pasture. PP animals grazed the whole day. Water was available for PP and PC animals when returning from pasture and at all time for CC group.

Animals were weighed at 30 day intervals. Feed intake of pasture fed animals (Experiment 2) was estimated through hand clipping technique in the middle of the trial. At termination, all lambs from Experiment 1 and 6 lambs from each group for Experiment 2 were slaughtered. Carcass information was collected, and a sample from the semimembranosus muscle (Experiment 1) was collected to assess meat quality. Information collected at slaughter included warm carcass weight, omental and perirenal adipose tissues weights, fifth quarter (offal) constituents, carcass conformation.

Dry matter of semimembranous muscle samples from Experiment 1 was determined after 48-h freeze-drying. Total fatty acid (FA) content was determined by the method of Rule (1997), but using tricosanoic acid as internal standard. Methyl esters were separated as described by Bas *et al.* (2003).

All data were analyzed using SPSS GLM procedure for analysis of variance, analysis of covariance and regression routines, following the model: $Yij = m + Mi + (a \times IWt) + Eij$, where Yij is the variable analysed; m is the overall mean, Mi is the effect of diet (i = 1, 2, 3), IWt is the covariate carcass weight (kg) used when analysing carcass data, and a is the coefficient of regression. The error term was Eij. The Student-Newman Keul's procedure was used to separate least squares means when significant main effects were detected.

III – Results and discussion

1. Growth performance

Table 1 summarizes the effect of diet on overall growth and performance of lambs. There were no differences (P > 0.05) between lambs on the three diets with respect to initial live weight and final live weight, respectively, since these weights were set constant by design. In Experiment 1, Average daily gain (ADG) decreased (P = 0.001) with increasing level of pasture in the diet consequence of the scarcity of grass supply at this period of the year, i.e. July and August, but was similar for the three groups in Experiment 2 (P = 0.20), as it was set by design. Daily dry matter intake averaged 1.30, 1.39 and 1.29 kg for PP, PC and CC groups respectively. As a consequence, PP animals seemed to require more feed/gain (7.01 kg DM/ kg of gain) than those from PC group (6.83) and CC group (6.61). Changing diet from concentrate and hay to pasture decreased feed efficiency, due to the higher energy content of CC diet, and reduced movements of animals fed this diet.

Table 1. Growth performance of lambs as affected by diet

	Experiment 1				Experiment 2			
Variable and diet†	**CC**	**PC**	**PP††**	**P**	**CC**	**PC**	**PP**	**P**
Number of animals	6	6	5	–	13	13	13	–
Initial live weight	21.2	24.8	24.2	–	23.4	23.0	23.2	0.96
Final live weight	28.8	26.4	21.7	0.109	40.0	41.3	39.7	0.58
Average daily gain (g)	63.5	18.2	–31.1	0.001	189	203	186	0.20
Daily DM intake (kg)	–	–	–	–	1.29	1.39	1.30	–
Feed conversion (kg DM/kg of gain)	–	–	–	–	6.61	6.83	7.01	–

†Oat hay and concentrate (CC), pasture (PP) and pasture and hay and concentrate (PC). DM: Dry Matter.
††One lamb from PP group (Experiment 1) died one month before the end of the trial for reasons not related to trial.

2. Carcass characteristics

Animals were slaughtered with the target of a constant live weight in Experiment 2. But, despite similar live weight, hot carcass weight differed (P < 0.003) with diet. Dressing percentage decreased from concentrate-fed to pasture-fed animals (P = 0.001 for Experiment 1 and P = 0.004 for Experiment 2). No significant difference was found between groups with regard to trait considered to be related to bone tissue, i.e. feet weight (average of 0.89 kg). Traits reflecting importance of muscle development and conformation were negatively impacted by pasture (Table 2). Sheep from CC, PC and PP groups had a round thickness of 21.92, 22.03 and 21.30 cm (P = 0.23), a carcass compactness of 0.36, 0.36 and 0.35 kg/cm (P = 0.58) and a round compactness of 0.32, 0.31 and 0.30 (P = 0.006), respectively. Omental fat and kidney fat were lower for lambs raised on pasture only (Table 2). Fat deposition followed the trend that faster gaining animals deposited more fat. The trend observed in dressing percentage difference between groups may be partly due to differences in digesta weights linked to the different levels of fibre ingested, and in internal fat weights. Fat deposition seemed to be related to growth rate in agreement with the results of Gaili (1993) who showed a positive and significant relationship between fat and growth rate. This finding indicate that animals have a lower priority for partitioning feed energy into omental and kidney fats *vs* other tissues until greater rates of gain are achieved.

Table 2. Carcass characteristics of lambs as affected by diet

	Experiment 1				Experiment 2			
Variable and diet†	**CC**	**PC**	**PP**	**P**	**CC**	**PC**	**PP**	**P**
Number of animals	6	6	5	–	13	13	13	–
Carcass weight	11.6	10.6	8.2	0.017	19.4	19.6	19.3	0.69
Dressing percent	43.2	40.2	37.6	0.001	48.0	47.5	47.4	0.004
Omental fat (kg)	358	288	45	0.011	413	466	407	0.15
Perirenal fat (kg)	170	123	43	0.002	398	431	382	0.128
Carcass compactness (kg/cm)	–	–	–	–	0.36	0.36	0.35	0.58
Round thickness (cm)	–	–	–	–	21.92	22.03	21.30	0.23
Round compactness	–	–	–	–	0.32	0.31	0.30	0.006

†Oat hay and concentrate (CC), pasture (PP) and pasture and hay and concentrate (PC).

3. Fatty acid composition

Effect of diet on semimembranous muscle FA composition was determined for animals in Experiment 1 (Table 3). The higher C16:0 percentages in indoor raised animals was the result of higher rate of *de novo* synthesis and greater fat deposition in omental and perirenal areas. The between group difference of C16:0 percentage in muscle could be considered as more favourable for health of consumers in meat produced from pasture-raised lambs, because of potentially increased risks of atherogenicity of C16:0 (Ulbricht and Southgate, 1991).

Table 3. Fatty acid composition of semimembranous muscle of lambs as affected by diet (Experiment 1)

Variable and diet†	**CC**	**PC**	**PP**	**P**
C16:0	30.1	27.5	24.1	0.004
C18:0	12.8	12.9	13.9	0.094
C18:1c9	30.7	25.7	24.4	0.003
C18:2n6	5.8	7.0	8.7	0.414
C18:3n3	0.62	2.12	1.47	0.001
C18:2 c9,t11	0.51	0.96	0.81	0.011
ESFA	47.7	47.0	42.4	0.042
MUFA	37.7	34.2	33.7	0.170
cMUFA	34.0	29.3	27.3	0.003
n6	8.4	9.9	13.2	0.139
n3	1.37	2.66	4.35	0.001
PUFA	10.4	13.8	18.6	0.082
n6/n3	6.0	3.7	3.1	0.001

†Oat hay and concentrate (CC), pasture (PP) and pasture and hay and concentrate (PC).

The C18:2n-6 in muscle (5.8, 7.0 and 8.7% of total FA, P = 0.41) such as the total PUFA percentages (10.4, 13.86 and 18.6% of total FA, P = 0.08) for CC, PC, and PP groups, respectively, were in the range of those found in other studies on lamb (Bas and Morand-Fehr, 2000), and tended to increase as diet changed from concentrate and hay to pasture. C18:3n-3 percentages were lower (P = 0.001) for CC animals as compared to PC and PP (0.62 *vs* 2.12 and 1.47,

respectively). C18:2n-6 accounted for about 69.7% and 70.7% of total n-6 FA for CC and PC groups but only 66% for PP, while C18:3n-3 represented 45.3, 79.7 and 33.8% of n-3 FA, respectively. These C18:2n-6 and C18:3n-3 represented 55.7, 50.9 and 47%, and 5.9, 15.4 and 7.9% of total PUFA for CC, PC and PP groups, respectively.

The main difference in FA percentages between lambs raised outdoor (PC and PP) on the one hand, and those raised indoors (CC) on the other hand, concerned higher percentages of PUFA, and a lower percentage of MUFA. This increase in PUFA percentage was mainly at the expense of MUFA and the even straight-chain saturated FA (ESFA). The increase in the PUFA percentages as pasture increased in the diet concerned each n-6 FA and n-3 FA, but it was relatively higher for n-3 FA than n-6 FA series, so that n-6:n-3 ratio was lower for outdoor reared lambs (6.0, 3.7 and 3.1 for CC, PC and PP groups, respectively).

Meat from outdoor raised animals is considered more favourable for human health because of higher PUFA percentages, higher n-3FA content in muscle in accordance with Ulbricht and Southgate (1991), and better n-6:n-3PUFA ratio (below 4.0; Wood and Enser, 1997) and lower C18:2n-6:C18:3n-3 ratio (below 5.0; AFSSA, 2001).

IV – Conclusions

Growth performance and carcass characteristics were improved with increasing concentrate and hay in the diet. However, the decrease in animal performance (i.e. weight gain) was compensated by the better quality (healthier meat) and probably the lower cost of production which makes the advantage of animal supplementation a liability. These results could be used to give an added value to the meat produced on pasture from that produced by sheep fed concentrate and hay.

References

AFSSA, 2001. *Apports Nutritionnels Conseillés pour la Population Française*, 3rd edn. Paris, France: Tec & Doc Lavoisier. 605 p.

Bas P., Archimède H., Rouzeau A. and Sauvant D., 2003. Fatty acid composition of mixed-rumen bacteria: Effect of level and type of forage. In: *J. Dairy Sci.*, 86. p. 2940-2948.

Bas P. and Morand-Fehr P., 2000. Effect of nutritional factors on fatty acid composition of lamb fat deposits. In: *Livest. Prod. Sci.*, 64. p. 61-79.

Gaili E.S.E., 1993. Breed and sex differences in body composition of sheep in relation to maturity and growth rate. In: *J. Agric. Sci.*, 118. p. 121-126.

Rule D.C., 1997. Direct transesterification of total fatty acids of adipose tissue, and of freeze-dried muscle and liver with boron-trifluoride in methanol. In: *Meat Science*, 46. p. 23-32.

Ulbricht T.L.V. and Southgate D.A.T., 1991. Coronary heart disease: Seven dietary factors. In: *The Lancet*, 338. p. 49-56.

Wood J.D. and Enser M., 1997. Factors influencing fatty acids in meat and the role of antioxidants in improving meat quality. In: *Brit. J. Nutr.*, 78(Suppl. 1). p. S49-S60.