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# Lupine and horse-bean seeds in diets of growing and fattening sheep

E.H. El Maadoudi

Département de Zootechnie, Programme Viandes Rouges/INRA Maroc (PVR/INRA),  
BP 4134 Temara, Morocco

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**SUMMARY** – Crude protein (CP) deficiency in ruminant diets is a major constraint for most livestock production systems in Morocco. Utilization of lupine seeds in feeding programs could be a way to overcome this problem and upgrade the nutritional value of animal diets. This study was conducted to evaluate the effect of the incorporation of lupine seeds (*Lupinus albus multolupa*) at 18.5, 9 and 0% of dry matter (DM) of the diet replacing 29, 15 and 0% of horse-bean. Diets A (18.5%), B (9%) and C (0%) of lupine were iso-nitrogenous (14% of CP) and contained 30% of oat-vetch hay and different proportions of barley. Eight lambs per treatment were used, they were fed individually and the experimental period was 105 days with 15 days for adaptation. Results showed that the diet had no significant effect ( $P > 0.05$ ) on weight gain, intake, feed efficiency or carcass yield. Corresponding values for A, B and C were 190, 167 and 171 g/day for weight gain respectively; 72, 73 and 73 g DM/kg<sup>0.75</sup>/day for intake; 6.44, 6.67 and 6.64 kg DM/kg weight gain for feed efficiency and 51.3, 52.1 and 52.5% for carcass yield. Three lambs from each group were used to measure *in vivo* digestibility and nitrogen balance. The diet had no significant effect ( $P > 0.05$ ) on DM, organic matter (OM) and CP digestibility but had significant effect ( $P < 0.05$ ) on neutral detergent fibre (NDF) and acid detergent fibre (ADF) digestibility. Corresponding digestibility coefficients for diets A, B and C were respectively, 70, 60 and 65% for DM; 73, 70 and 69% for OM; 67, 67 and 66% for CP; 69, 64 and 58% for NDF; 66, 61 and 52% for ADF. The diet had no significant effect on nitrogen retained. The values were 4.35, 3.53 and 3.55 g/day respectively for A, B and C diets. Incorporation of lupine instead of horse-bean did not affect the nutritional value of diets but economically, it gave a profit of US\$0.2 per kg of weight gain compared to horse-bean.

**Key words:** Lupine, horse-bean, sheep, growing, fattening, digestibility, nitrogen balance.

**RESUME** – "Incorporation des grains de lupin et de féverole dans les régimes destinés aux ovins en croissance ou engraisés". La déficience des régimes alimentaires des ruminants en protéines brutes est la contrainte majeure de la plupart des systèmes de production animale au Maroc. L'utilisation des grains de lupin dans le rationnement peut résoudre ce problème et améliorer donc la valeur nutritive des rations alimentaires. La présente étude a porté sur l'évaluation de l'effet de l'incorporation des grains de lupin (*Lupinus albus multolupa*) à raison de 18,5, 9 et 0% de matière sèche (MS) de la ration totale en substitution à 29, 15 et 0% de féverole. Les régimes testés sont iso-azotés, 14% de matières azotées totales (MAT), et contiennent 30% de foin de vesce-avoine et différentes proportions d'orge. Huit agneaux par régime ont été utilisés, individuellement alimentés pendant une période expérimentale de 105 jours précédée d'une période d'adaptation de 15 jours. Les résultats obtenus montrent que le régime alimentaire n'a pas d'effet significatif ( $P > 0,05$ ) sur le gain de poids, les quantités ingérées, l'indice de conversion et le rendement vrai en carcasse. Les données respectives des régimes A, B et C sont de 190, 167 et 171 g/j pour le gain de poids ; 72, 73 et 73 g MS/kg<sup>0,75</sup>/j pour les quantités ingérées ; 6,44, 6,67 et 6,64 kg MS/kg de gain de poids pour l'indice de conversion et 51,3, 52,1 et 52,5% pour le rendement vrai en carcasse. Trois agneaux par régime étaient utilisés pour la mesure de la digestibilité *in vivo* et pour le bilan azoté. L'effet du régime était non significatif ( $P > 0,05$ ) sur la digestibilité de la matière sèche, la matière organique (MO) et les MAT mais significatif ( $P < 0,05$ ) sur la digestibilité des parois totales (NDF) et de la lignocellulose (ADF). Les coefficients de digestibilité respectifs pour les régimes A, B et C sont de 70, 60 et 65% pour la MS ; 73, 70 et 69% pour la MO ; 67, 67 et 66% pour les MAT ; 69, 64 et 58% pour NDF et 66, 61 et 52% pour ADF. Pour le bilan azoté, les animaux ont retenu 4,35, 3,53 et 3,55 g/j respectivement pour les régimes A, B et C sans différence significative ( $P > 0,05$ ). La substitution des grains de lupin à la féverole n'a pas affecté la valeur alimentaire des rations mais a permis une économie de 0,2 \$ par kg de gain de poids vif en comparaison à la féverole.

**Mots-clés :** Lupin, féverole, ovins, croissance, engraissement, digestibilité, bilan azoté.

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## Introduction

Livestock rearing is a very important activity for the Moroccan small holders, it is practiced by almost all farmers and plays several roles: save, profit, bank account, etc. Feeding programs practiced

by the majority of stockbreeders are not rationed and are characterized in almost all cases by a nutritive imbalance especially for proteins. The unavailability of protein sources at the market is a feeding constraint that stockbreeders are facing. Protein sources produced within farms are an alternative. Among these sources, lupine (*Lupinus* spp.), is a legume very rich in protein. Lupine grains of the traditional varieties are bitter and toxic for the animals because they contain from 0.5 to more than 2% of dry matter (DM) as an alkaloid. Varieties of sweet lupine contain less than 0.05% DM alkaloid and can contain up to 50% DM of protein. This low level of alkaloids and high protein content in the grains of sweet white lupine, make it a potential source of protein in the rations of the ruminants. However, information on digestion and use of grains of sweet lupine by the ruminants is limited.

The objective of this study is to test the effect of the incorporation of lupine grains in the ration, as a substitution for horse-bean, on the digestibility of the ration and the nitrogen balance and performance of growing and fattening lambs.

## Material and methods

Trials were carried out in the Experimental Center of El Koudia, INRA, and chemical analyses were made at the Laboratory of Animal Nutrition of El Koudia.

### Growth

#### *Animals*

Twenty-four lambs, of Timahdite breed, with an average weight of 25 kg and age of 86 days, were used in this trial. They were divided into 3 groups of 8 animals and randomly assigned to one of the 3 diets (A, B and C).

The grains of barley, lupine and horse-bean were crushed and the hay are chopped. The feed was given as a mixed ration.

#### *Diets*

Diets contained oat-vetch hay, barley grain, lupine grains (*Lupinus albus multolupa*) and horse-bean. Chemical composition of feedstuff used is presented in Table 1. Composition of diets is presented in Table 2.

Table 1. Chemical composition of feedstuffs (% DM)

	Oat-vetch hay	Barley	Lupine	Horse-bean
Dry matter (DM, %)	88.50	88.42	89.72	88.62
Organic matter	92.15	96.50	96.33	96.54
Crude protein	06.07	12.09	34.00	26.00
Neutral detergent fibre	66.77	39.03	26.72	32.25
Acid detergent fibre	39.52	12.29	20.72	13.80
Acid detergent lignin	05.27	01.90	02.74	01.13

#### *Trial schedule*

The duration of trial was 105 days, preceded by a period of 15 days adaptation in order to adapt animals to the rations and the cages. Animals were kept and fed individually twice per day, at 9 a.m. and 4 p.m. water was available at all times. Animals were treated against parasites at the beginning of the trial and one month after. The distributed and refused quantities of feed were weighed daily. Refusals were redistributed with the ration of the following day. Animals were weighed in triplicate at the beginning and the end of the trial and a double weighing was performed every 21 days.

Table 2. Diet composition (% DM)

Feedstuffs	Diets		
	A	B	C
Oat-vetch hay	30.0	30.0	30.0
Barley grain	49.5	44.0	39.0
Lupine	18.5	9.0	0
Horse-bean	0	15.0	29.0
Minerals and vitamins supplement (MVS) <sup>†</sup>	2.0	2.0	2.0
CP (% DM)	14.09	14.10	14.08

<sup>†</sup>Composition of MVS: Minerals – P = 12%, Ca = 18%, NaCl = 15%, Mg = 2%, S = 1%, Mn = 3750 ppm, Co = 30 ppm, I = 75 ppm, Fe = 2600 ppm, Zn = 4300 ppm, = 10 ppm; Vitamins (in 100 kg) – A = 75 000 000 UI, D3 = 40 000 000 UI, E = 100 000 Mg.

The weighing was made before eating (before the distribution rations). At the end of the trial, animals were slaughtered and the following weights were recorded: live weight just before slaughter, weight of the hot carcasses, weight of the full and empty digestive tract, weight of the mesenteric fat.

### Diet digestibility

Measurements were made, for each diet, on 3 lambs of the Timahdite breed. The weight and the age of these animals were identical to those of the animals in the growth trial. These animals were placed in digestibility crates for separation of faeces and urine and were treated against parasites at beginning of the trial. Animals were randomly assigned to the diets and were fed at maintenance (40 g DM/kg<sup>0.75</sup>/d). A period of adaptation of 14 days was used to accustom the animals to the rations, the digestibility crates and with the bags of faeces collection. One experimental period lasted 7 days during which faeces were collected daily, weighed and dried in a ventilated oven at 50°C during 48 hours. The quantities of DM obtained during the week of collection were cumulated for each animal. Faeces were then crushed and a sample was taken for the following chemical analyses: (i) ash by incineration at 525°C; (ii) CP by the method of Kjeldahl; and (iii) parietal components – NDF and direct ADF, by the method of van Soest. The feedstuff used and complete rations were subject of the same analyses.

### Nitrogen balance

This part proceeded simultaneously with the measurement of digestibility. Urines were collected in 25 ml of sulphuric acid 20%. The measurement of the total volume of urine was done each day and a sample was stored pending analysis. The cumulated sample was cooled with 4°C and analysed for nitrogen content (method of Kjeldahl).

### Statistical analyses

The variance analysis to one only criterion of classification (feed ration) and the test of comparison of the averages by the method of the Least Square difference (LSD) were carried out on the collected data.

### Results and discussion

Results (Table 3) show that the effect of the nature of the source of additional proteins had no significant effect ( $P > 0.05$ ) on average daily gain, intake, feed efficiency, weight of hot carcasses, true and economic yields of carcass and weight of mesenteric fat. Values of diet digestibility and nitrogen retention confirmed these results thus indicating that substitution of horse-bean by lupine as source of protein did not affect animal performance.

Table 3. Average performance permitted by the lupine grains in substitution of horse-bean

	Lupine			SE <sup>†</sup>
	18.5	9	0	
Initial weight (kg)	26.13	23.38	25.47	–
Final weight (kg)	46.11	40.92	43.42	–
Average daily gain (g)	190.34	167.05	170.95	24.65
Intake (g DM/kg <sup>0.75</sup> /d)	72	73	73	5.54
Feed efficiency (kg DM/kg weight gain)	6.44	6.67	6.64	0.67
Carcass weight (kg)	20.91	18.81	20.00	1.87
True yield (%) <sup>††</sup>	51.34	52.10	52.47	1.48
Economic yield (%) <sup>†††</sup>	48.30	48.94	49.30	1.54
Weight of mesenteric fat (kg)	1.17	0.90	0.86	0.37
Apparent diet digestibility (%) <sup>††††</sup>				
Dry matter (DM)	70	66	65	2.80
Organic matter (OM)	72	70	69	2.55
Crude protein (CP)	67	67	66	2.41
Neutral detergent fibre (NDF)	69 a	64 ab	58 b	3.64
Acid detergent fibre (ADF)	66 a	61 a	52 b	3.45
Retained nitrogen (g/d) <sup>††††</sup>	4.35	3.53	3.55	0.68
Feeding cost (DH/kg weight gain)	11.66	12.81	13.41	–

<sup>†</sup>SE: standard error.

<sup>††</sup>True yield: weight of hot carcass/empty live weight.

<sup>†††</sup>Economic yield: weight of hot carcass/live weight before eating.

<sup>††††</sup>3 heads per diet.

<sup>a,b</sup>Numbers with different letters, differ significantly ( $P > 0.05$ ).

Examination of diet digestibility, showed that there was no significant difference ( $P > 0.05$ ) between digestibilities of DM, OM and CP for the three diets tested (Table 3). These results agree with those of Purroy *et al.* (1989) which did not find a significant difference between digestibilities of DM, OM, CP and crude fibre (CF) for diets supplemented with grains of lupine in substitution for soybean oil cake. Recorded difference, in our study, for fibre could be explained only by the richness of horse-bean in such component. In addition, the study of the nitrogen balance showed that the nitrogen retention was identical for the three diets (Table 3). This shows that nitrogen of ration was used in a similar way for the three diets. No difference was noted, neither on the level of the digestibility of CP, nor on the level of faecal nitrogen and urinary nitrogen (El Maadoudi, 1993). Our results also agree with those of Masson (1981) who studied the replacement of the soybean oil cake by sources of proteins (horse-bean, pea and lupine) in the feeding of the goat at the beginning of lactation and did not note a significant difference ( $P > 0.05$ ) between the levels of ingestion, milk production and milk composition.

Our results agree with those of Huguet *et al.* (1984) and May *et al.* (1990) who did not find any significant difference ( $P > 0.05$ ) between intakes and milk production of cows receiving diets supplemented with grains of lupine or soybean oil cake. Johnson *et al.* (1986) and Anderson *et al.* (1989) also reported that lupine grains and soybean oil cake are identical as protein supplements for growth of cattle. In the same way, Kung *et al.* (1991) reported that there is no significant difference ( $P > 0.05$ ) between parameters of growth and ingestion of the lambs receiving grains of lupine or soybean oil cake as protein supplement. In addition, Giovanni (1981) found that pea, lupine and soybean oil cake are identical for growing and fattening lambs. On the other hand, these results are contradictory with those of Tracy *et al.* (1988) who indicated a low nitrogen retention and a low weight gain in animals receiving diet supplemented with lupine only compared to diet supplemented with soybean oil cake only. This result is due to the type of protein source used. Soybean oil cake is less degradable in the rumen, it allows the passage of undegradable proteins towards the intestine.

Values, related to the performance, recorded in our study were lower compared to those reported by certain authors. This could be due to the high degradability of the two protein sources (lupine and

horse-bean) in the rumen, which can reduce the quantity of amino acids absorbed by the intestine and limit the nitrogen retention. It would have been interesting to measure the flow of nitrogen at the entry and the exit of the intestine. In addition, the hay used in our study was of a bad quality and a high rate of feeding probably limited the ingestion of the complete ration.

## Conclusion

Results obtained in this study show that lupine grains could play an interesting role in animal feeding. According to chemical analyses, grains of lupine are rich in crude protein (34% DM) and low in fibre (NDF 26% DM) in comparison with horse-bean used in this study. Moreover, under our experimental conditions, substitution of grains of lupine to horse-bean in the ration of the growing and fattening sheep does not seem to have an undesirable effect on its palatability, growth or slaughter parameters. Results of digestibility and nitrogen balance experiment were similar for the two protein sources.

Calculation of the feeding cost showed that total substitution of lupine grains with horse-bean generates a profit of 1.75 Dirhams (US\$0.2) per kg of live weight gain. This shows an economic outcome from the incorporation of lupine grains in this type of rations.

In the future it is important to characterize local varieties/ecotypes of some lupine for their chemical composition, alkaloid content, degradability of protein, the suitable rate of incorporation in the ration of different animals (ewes and lambs) and their effect on intake and on the growth and milk production.

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