

Utilization of different leguminous seeds in the diets of lactating goats. Food intake, digestive utilization of nutrients and nitrogen balances

Ramos E., De la Torre G., Fernández J.R., Gil Extremera F., Sanz Sampelayo M.R.

in

Priolo A. (ed.), Biondi L. (ed.), Ben Salem H. (ed.), Morand-Fehr P. (ed.).
Advanced nutrition and feeding strategies to improve sheep and goat

Zaragoza : CIHEAM

Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 74

2007

pages 279-283

Article available on line / Article disponible en ligne à l'adresse :

<http://om.ciheam.org/article.php?IDPDF=800392>

To cite this article / Pour citer cet article

Ramos E., De la Torre G., Fernández J.R., Gil Extremera F., Sanz Sampelayo M.R. **Utilization of different leguminous seeds in the diets of lactating goats. Food intake, digestive utilization of nutrients and nitrogen balances.** In : Priolo A. (ed.), Biondi L. (ed.), Ben Salem H. (ed.), Morand-Fehr P. (ed.). *Advanced nutrition and feeding strategies to improve sheep and goat*. Zaragoza : CIHEAM, 2007. p. 279-283 (Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 74)



<http://www.ciheam.org/>
<http://om.ciheam.org/>

Utilization of different leguminous seeds in the diets of lactating goats. Food intake, digestive utilization of nutrients and nitrogen balances

E. Ramos, G. de la Torre, J.R. Fernández, F. Gil Extremera and M.R. Sanz Sampelayo
Unidad de Nutrición Animal, Estación Experimental del Zaidín (CSIC)
Profesor Albareda, 1, 18008 Granada, Spain

SUMMARY – The leguminous seeds are considered a good protein source for domestic animals. In this study four different leguminous seeds were used as alternative sources of meat meals for lactating goats. Four different diets were designed in which 30% of the total protein content was derived from one leguminous seed, namely: lupine seeds, faba beans, bitter vetch seeds and vetch seeds. Food intake, digestive utilization and nitrogen balance data were derived from the corresponding balance assays. The results obtained revealed the good acceptance and nutritional utilization of the four diets. Lupine seeds were outstanding for energy utilization and faba bean seeds were best for nitrogen utilization.

Keywords: Leguminous seeds, food intake, digestive utilization, N balances, lactating goats.

RESUME – "Utilisation de graines de différentes légumineuses dans les régimes pour chèvres en lactation. Ingestion alimentaire, utilisation digestive de nutriments et bilans azotés". Les graines de légumineuses sont considérées une bonne source de protéines pour les animaux domestiques. En accord avec ce fait, quatre graines de légumineuses différentes ont été utilisées dans cette étude, en tant qu'alternative aux farines animales chez les chèvres en période de lactation. Quatre régimes alimentaires différents ont été conçus dans lesquels 30% du contenu total en protéines provenait d'une graine de légumineuse, à savoir lupin, fève, ers, vesce. A partir des analyses d'équilibre correspondantes, on a établi l'ingestion d'aliments, parallèlement à l'utilisation digestive et aux bilans azotés. A partir des résultats obtenus, nous avons déduit la bonne acceptation des régimes ainsi que leur utilisation nutritive. La graine de lupin a donné d'excellents résultats quant à l'utilisation énergétique, et les fèves quant à l'utilisation de leur azote.

Mots-clés : Graines de légumineuses, ingestion, utilisation digestive, bilan azoté, chevreaux.

Introduction

The bovine spongiform encephalitis (BSE) crisis obliged authorities to ban the use of meat meals for animal feeding. An alternative source for such meals could be autochthonous leguminous seeds, whose use in animal nutrition in Spain has decreased for various reasons. Today, the cultivation of these seeds is increasing, as a result of their increasingly attractive yield, the quantity and quality of their protein content and even their price, and thus they are being considered for use as animal feed, particularly for the autochthonous livestock. In the light of these circumstances and with the aim to identify alternative sources of meat meals for lactating goats, we designed diets in which the 30% of the total protein content was derived from a leguminous seeds, namely: lupine seeds (*Lupinus albus*), faba beans (*Vicia faba*), bitter vetch seeds (*Ervum ervilia*) and vetch seeds (*Vicia sativa*). Food intake, digestive utilization and nitrogen balances were determined by means of the corresponding balance assays.

Material and methods

Experimental design and procedure

Eight goats of the Granadina breed, midway through second or third lactation, were used. They were homogenous in regards to body-weight and milk production. Goats were allocated to a 4x4 Latin square with two repetitions. They were fed the experimental diets for 20 days before the start of the

trials. The goats were then housed individually in metabolic cages for the next 7 days. All goats received a daily ration consisting of 1.0 kg of forage (alfalfa hay) and 1.0 kg of concentrate; the specific N and energy requirements of this species and breed were considered in the dietary formulation (Aguilera *et al.*, 1990). The composition of mineral and vitamin mixture was designed to satisfy especially the Ca and P requirements of the goats (National Research Council, 1981). Treatments consisted of four diets, and 30% of the total protein was supplied by the four experimental leguminous seeds: lupine seeds, faba beans, bitter vetch seeds and vetch seeds. The four diets were similar in terms of N and gross energy contents. The ingredient composition of the concentrates and the chemical composition of these and the alfalfa hay are shown in Table 1. The first 20 days of the experimental period were for adaptation and the last 7 days constituted the principal trial period. At 09.00 h every day and when the orts from the ration that was offered the previous day had been collected, the goats were hand-milked. Subsequently, the daily rations were distributed. Water was available at all times. During the 7 days of the principal experimental period, a balance trial was performed. Faeces and urine were collected daily to determine the digestibility of the diets and the N balances.

Table 1. Ingredient composition of the concentrates (g/kg) and chemical composition of the concentrates and the alfalfa hay used (% dry matter)

Ingredient	Concentrate [†]				Alfalfa hay
	1	2	3	4	
Oats	211	363	300	300	
Corn	419	177	90	226	
Lupine seeds	330	-	-	-	
Beans	-	420	-	-	
Bitter vetch seeds	-	-	570	-	
Vetch seeds	-	-	-	404	
Chemical composition					
Dry matter	88.74	89.61	89.28	90.76	91.80
Organic matter	93.78	92.99	93.34	93.16	88.20
Crude protein	16.13	15.95	15.98	15.79	18.59
Fat	5.05	3.82	3.74	3.35	1.66
Ash	6.22	7.01	6.66	6.84	11.80
NDF	34.96	38.38	39.71	38.66	41.90
ADF	9.50	9.10	7.26	9.22	21.60
ADL	1.17	1.58	1.16	1.66	5.45
Gross energy (MJ/kg DM)	18.80	18.37	18.48	18.50	18.00

[†]Concentrate 1-4: 30% of the total protein in the diet supplied by lupine seeds, faba beans, bitter vetch and vetch, respectively

Measurements and analyses

Samples of the forage, concentrate and orts were collected to determine the composition of the diet fed and of that consumed. Aliquots of the faecal samples taken during the balance trial were frozen at -20°C until analysis. Similarly, samples of urine with no added preservatives were stored at -20°C until analysis.

The DM and N contents of the samples of the feedstuffs, orts, faeces and urine were analysed in fresh samples. All other analyses were performed on dried samples. The DM of the feedstuffs and orts was determined by oven-drying at 100±2°C for 24 h and that of the faeces was carried out by lyophilization. The N contents of the feedstuffs, orts, faeces and urine were measured using the Kjeldahl method. For the feedstuffs, orts and faeces, the results were converted to crude protein by

multiplying N by a factor 6.25. The neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) contents of feedstuffs, orts and faeces were determined using the method of Goering and Van Soest (1970) and the fat content was measured by extraction with petroleum ether (boiling point, 40 to 60°C). The ash content of all these samples was determined by incineration in an electric muffle furnace at 550°C. Finally, the energy content of the samples was determined by adiabatic bomb calorimetry.

The model accounted for variation caused by the leguminous seed used in the concentrate. The results were submitted to an ANOVA in accordance with the general linear models procedure (Statgraphics, 1991). Table 2 reports mean values, residual standard deviations and the level of significance effects.

Results and discussion

Table 2 gives the values for dry matter intake, apparent digestibility of dry matter, organic matter, crude protein, fat, ash, NDF, ADF and energy as well as those for N balances, for the four diets assayed. With regard to the food intake, the values were very similar in the four groups; not significant ($P>0.05$) differences were detected. However, the apparent digestibility of dry matter, organic matter, ADF and energy were found to be different ($P<0.05$) according to the leguminous seed supplied. At the same time the N balance data were also affected ($P<0.05$) by the leguminous seed in the concentrate mix. However, type of diet had no significant effect ($P>0.05$) on the digestibility of crude protein, fat, ash and NDF. The dry matter and organic matter digestibility values corresponding to lupine seed in the concentrate mix were higher ($P<0.05$) than those measured for the bitter vetch seed diet. In the same way, ADF and energy digestibility values corresponding to the lupine seed diet, were also higher ($P>0.05$) than those measured for the bitter vetch seed and vetch seed diets. At the same time, the N balance data corresponding to the faba bean diet, were higher ($P<0.05$) than those from the other three diets (N retained/N intake) or than those measured for the bitter vetch seed and vetch seed diets (N retained/N digested).

Table 2. Effect of the type of concentrate on dry matter intake (DMI; g/kg^{0.75}/day) digestibility coefficients (DC) and N balances

	Concentrate [†]				RSD	Level of significance
	1	2	3	4		
DMI	89.6	92.7	92.7	92.0	12.87	NS
DC						
Dry matter	75.27 ^a	74.25 ^{a,b}	72.75 ^b	73.09 ^{a,b}	2.19	*
Organic matter	76.86 ^a	75.79 ^{a,b}	74.21 ^b	74.64 ^{a,b}	2.04	*
Protein	78.30	78.76	76.92	77.16	1.94	NS
Fat	84.13	84.36	83.49	82.70	2.45	NS
Ash	46.25	49.75	48.62	47.41	7.22	NS
NDF	63.70	62.84	61.60	60.25	3.18	NS
ADF	35.71 ^a	33.96 ^a	27.56 ^b	22.19 ^c	3.73	***
Energy	74.55 ^a	73.46 ^{a,b}	71.76 ^b	72.11 ^b	2.02	*
N retained/N intake (%)	37.39 ^a	41.47 ^b	34.73 ^a	35.91 ^a	3.61	**
N retained/N digested (%)	48.15 ^{a,b}	53.38 ^a	45.28 ^b	46.53 ^b	5.05	*

[†]Concentrate 1-4: 30% of the total protein in the diet supplied by lupine seeds, faba beans, bitter vetch seeds and vetch seeds, respectively.

RSD: Residual Standard Deviation; NS: not significant; * $P<0.05$; ** $P<0.01$; *** $P<0.001$; ^{a,b,c}: Values affected by different letters are different ($P<0.05$).

The leguminous seeds are considered a good protein source for human and for domestic animals (Sandberg, 2002). In this study four different leguminous seeds were used as alternative

source of meat meals for lactating goat diets. They are considered excellent protein sources with a high nutritional value. On the other hand, their tannin and cyanogenetic glycoside contents may become important factors limiting their nutritional utilization (Piccioni, 1970).

A noteworthy result is that the intake of dry matter was equal to or even exceeded $90 \text{ g/kg}^{0.75}$ per day. Taking into account the specific metabolizable energy requirements for maintenance and that 86% of digestible energy is metabolizable one (Aguilera *et al.*, 1990), it was possible to calculate the intake level achieved by each experimental group. This was equal to: 2.73, 2.75, 2.67 and 2.68 times the metabolizable energy requirements for maintenance. Masson (1981a,b) fed lactating goats of Alpine breed at the beginning (Masson, 1981a) or in the middle of the lactation (Masson, 1981b) with a diet in which the soya-bean meal was substituted by beans, pea seeds or lupine seeds, obtaining numerically higher but statistically not different intakes. The most important determinants of digestibility of the diets by goats are those related to their chemical composition (Giger *et al.*, 1986; Sanz Sampelayo *et al.*, 1998). The four diets here considered resulted isonitrogenous and isoenergetic. However some differences were detected in respect to the apparent digestibility of the different nutrients. The dry matter and organic matter digestibility was highest for the lupine seeds diets and lowest for the bitter vetch seeds and vetch seeds ones. In this sense, it is necessary to take into account that another important factor determining the digestive utilization in the ruminant is the particular rumen fermentation process. This process is specially determined by the fibre and protein composition of the diet. Giger *et al.* (1986) derived an equation in goats to estimate the organic matter digestibility in function of the content of NDF, ADF, ADL and protein of the diet. Substituting in this equation the values corresponding to the composition of the diets here used, it is obtained a maximum organic matter digestibility for the lupine seed diet and minimum values for those with bitter vetch seeds and vetch seeds. Since organic matter digestibility is the digestibility coefficient more related to the energy one, the digestibility of the energy resulted in logic, higher for lupine seed diet than for bitter vetch seed and vetch seed diets.

In the same way it was derived different N balance values what probably, would be due to the amino acid composition of the different protein sources. In this case, the maximum values were those for the faba bean seeds diet and the minimum ones those for the bitter vetch seed and vetch seed diets.

Conclusion

From these results it is deduced the good acceptance and nutritional utilization of the four designed diets. The lupine and faba bean seeds stood out with regard to the energy and protein utilization respectively.

References

- Aguilera, J.F., Prieto, C. and Fonollá, J. (1990). Protein and energy metabolism of lactating Granadina goats. *Br. J.Nutr.*, 63: 165-175.
- Giger, S., Sauvart, D., Hervieu, J. and Dorleans, M. (1986). Étude de la prévision de la digestibilité des rations mixtes distribuées à las chèvres laitières par ses caractéristiques analytiques. *Ann. Zootech.*, 35: 137-160.
- Goering, H.K. and van Soest, P.J. (1970). *Forage fiber analyses (Apparatus, Reagents, Procedures and some Applications)*. Agricultural Handbook No. 379. ARS. USDA. Washington, D.C.
- Masson, C. (1981a). Utilisation des graines protéagineuses dans l'alimentation de la chèvre en début de lactation. *Ann. Zootech.*, 30: 435-442.
- Masson, C. (1981b). Utilisation des graines protéagineuses dans l'alimentation de la chèvre laitières. In: *Nutrition et systèmes d'alimentation de la chèvre. ITOVIC. INRA Symposium International*. Tours, France.
- National Research Council (1981). Nutrient requirements of goats. Angora, dairy and meat goat in temperate tropical countries. In: *Nutrient requirements of domestic animals*. Number 15, Washington DC, USA, National Academic Press.
- Piccioni, M. (1970). *Diccionario de alimentación animal*. Editorial Acribia, Zaragoza, Spain.
- Sandberg, A.S. (2002). Bioavailability of mineral in legumes. *Br. J. Nutr.*, 88: S281-S285.
- Sanz Sampelayo, M.R., Pérez, L., Boza, J. and Amigo, L. (1998). Forage of different physical forms in

the diets of lactating Granadina goats: Nutrient digestibility and milk production and composition. *J. Dairy Sci.*, 81: 492-498.

Statgraphics (1991). *User manual*. Statistical Graphics System by Statistical Graphics Corporation. Rock-Wille, Maryland, USA.