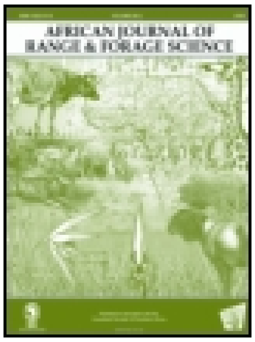

Taylor & Francis
Taylor & Francis Group

African Journal of Range & Forage Science

ISSN: 1022-0119 (Print) 1727-9380 (Online) Journal homepage: http://www.tandfonline.com/loi/tarf20

Effect of Acacia tortilis pods on intake, digestibility and nutritive quality of goat diets in southwestern Eritrea

Mengistu R Araya , Robinson K Ngugi , Nashon K R Musimba & Dickson M Nyariki

To cite this article: Mengistu R Araya , Robinson K Ngugi , Nashon K R Musimba & Dickson M Nyariki (2003) Effect of Acacia tortilis pods on intake, digestibility and nutritive quality of goat diets in southwestern Eritrea, African Journal of Range & Forage Science, 20:1, 59-62, DOI: 10.2989/10220110309485799

To link to this article: http://dx.doi.org/10.2989/10220110309485799

Published online: 12 Nov 2009.

African Journal of Range & Forage Science 2003, 20(1): 59–62
Printed in South Africa — All rights reserved

AFRICAN JOURNAL OF RANGE & FORAGE SCIENCE
ISSN 1022–0119

Effect of *Acacia tortilis* pods on intake, digestibility and nutritive quality of goat diets in southwestern Eritrea

Mengistu R Araya[1], Robinson K Ngugi[2], Nashon KR Musimba[2] and Dickson M Nyariki[2]

[1] *Ministry of Agriculture, Research and Extension Department, PO Box 4627, Asmara, Eritrea*
[2] *University of Nairobi, Department of Range Management, PO Box 29053, Nairobi, Kenya*

Received 13 May 2002, accepted 8 January 2003

Fresh *Acacia tortilis* pods were mixed with low quality native grass hay to form the following five rations: 100% hay (T_1), 25% pods and 75% hay (T_2), 50% pods and 50% hay (T_3), 75% pods and 25% hay (T_4) and 100% pods (T_5) on 'as fed' weight basis. Fifteen male *Barka* goats, approximately one year old and 10–15kg body weight, were randomly assigned to the five rations and fed in individual pens. Chemical composition, dry matter intake (DMI), *in vitro* dry and organic matter digestibility and body weight changes of the animals were evaluated. The average crude protein content of the pods was about 47% higher than the 7% minimum required for normal rumen function, while that of the hay was about 13% below. Percent ash, neutral detergent fibre (NDF), acid detergent fibre (ADF), hemi-cellulose (HC), cellulose (CL) and acid detergent lignin (ADL) contents were higher in the hay than in the pods. The pods were, however, generally higher in Ca, P, Mg and Na than the hay. Average DMI (g d^{-1} and g kg^{-1} LBW), percent in vitro dry and organic matter digestibility and body weight gains (total kg and gd^{-1}) increased with an increase in *A. tortilis* pods, up to 75% level and then begun to decline. However, despite the decrease, T_5 still had significantly ($P < 0.05$) higher feed digestibility and body weight gains than T_2 and T_3. Thus, supplementing low quality range herbage with *Acacia* pods can considerably improve the nutritive value of range livestock diets, particularly during the dry season when other types of fodder are of extremely low quality.

Keywords: *Acacia* pods, *Barka* goat diet, range forage, pastoralists, semi-arid Eritrea

Introduction

Trees and shrubs of the genus *Acacia* Mill. are probably the most dominant woody species in the dry tropics of sub-Saharan Africa (Le Houerou 1980, NRC 1979). There are about 135 species of *Acacia* in Africa today, many of them widely spread throughout the arid and semi-arid tropics of western, eastern and southern Africa, either as pure stands or in mixtures with allied woody species (Pellew 1980). Species of the genus provide high quality animal fodder, timber, fuelwood, charcoal, gums and other products as well as contributing to soil stabilisation and improvement through nitrogen fixation. Their particular value in arid zones lies in their extreme resistance to heat, drought, salinity and alkalinity, drifting sand, grazing and repeated cutting (Le Houerou 1980).

Pastoralists in Africa have long recognised the importance of *Acacia* trees and shrubs as a source of fodder (browse and pods) in the dry season. They have over the years developed appropriate techniques of harvesting the fodder, including pollarding (e.g. *Acacia nilotica*), lopping (e.g. *A. seyal)* and use of long hooked poles to manually shake down the pods of species such as *Acacia tortilis*. Fallen leaves, flowers and pods constitute an important source of forage for domestic and wild herbivores (Coughenour *et al.* 1985, Du Toit 1990, Dunham 1991, Halevy and Orshan 1973, Mwalyosi 1987, 1990, Pellew 1983a, 1983b, Vesey-Fitzgerald 1973). Some species such as *A. tortilis* (Forssk.) and *A. brevispica* flower profusely, producing large quantities of highly nutritious seedpods, which can be stored for use as dry season supplement (Kayongo and Field 1983).

Chemical analyses show that *Acacia* seedpods are potential sources of protein, minerals and moderate levels of carbohydrates for livestock (Du Toit 1990, Dunham 1991). Seeds alone have a high crude protein (up to 38%) and lower fibre than empty pods, and carbohydrate content varies across species. (Gwynne 1969, Tanner *et al.* 1990). *A. tortilis* subsp*. raddiana* fodder shows satisfactory levels of digestible protein (12%) and energy (6.1mJ kg^{-1} of dry matter), and high mineral content. Although there is a considerable wealth of information on the chemical composition of browse and pods (Coughenour *et al*. 1985, Du Toit 1990, Dunham 1991, Kayongo and Field 1983, Halevy and Orshan 1973), few studies have been conducted to evaluate the ability of fodder from trees and shrubs to meet the nutritional requirements of different kinds of livestock under different grazing regimes in tropical Africa. This study was, therefore, designed to determine the influence of increasing levels of *A. tortilis* pods on intake, digestibility and nutritive quality of diets of growing *Barka* goats in south-western lowlands of Eritrea.

Materials and methods

The study was conducted at Shambuko Agricultural Research Station in Gash Setit Province, Eritrea. Hand-harvested *A. tortilis* pods and native grass hay were both chaffed and mixed to form the following five rations: 100% hay (T_1), 25% pods plus 75% hay (T_2), 50% pods plus 50% hay (T_3), 75% pods plus 25% hay (T_4) and 100% pods (T_5) on 'as fed' weight basis. The browse consisted predominantly of ripe pods before dehiscence, while the hay comprised cut and sun-dried mixture of native grass species. Fifteen local male *Barka* goats, of about the same age (one year) and body weight (10–15kg), were randomly assigned to the five treatments (3 goats/treatment) and fed in individual pens in a completely randomised single factor experimental design.

The study lasted 90 days comprising 14-days pre-treatment adjustment during which all animals were fed grass hay twice a day and 76-days data collection period during which animals were fed their respective rations. All animals were treated against internal and external parasites before the beginning of the study. In the course of the study, the bucks were weighed every week, in the morning, following an over-night fast. Feeding was done twice a day, at 08h00 and 16h00 at 105% *ad libitum*, to ensure that animals voluntarily ate all that they needed. The amount fed each day was adjusted on the basis of the previous day's voluntary intake, to an amount that would result in about 5% orts (feed refuse). Feed offered each day was sampled. Each animal's samples were composited and stored for chemical analysis later. Orts were measured before the subsequent feeding. Daily feed intake was calculated as the difference between the amount of feed offered and the amount refused. The bucks had free access to clean water and a commercial mineral lick block throughout the experimental period.

In vitro *digestibility*

In vitro dry and organic matter digestibility of the diets was determined using standard procedures (Tilley and Terry 1963). Inoculum was obtained from a rumen-fistulated steer, three to four hours after feeding, filtered through a thick 100% polyester wool cloth and immediately stored in a thermos flask. The donor steer was feeding on local grass hay, similar to the one used in the study. All diet substrate samples to be incubated were mixed in the same proportions as in the experimental diets. Incubations were carried out in duplicate. One blank tube per eight tubes was included. *In vitro* dry matter disappearance (%) was calculated using the following formula:

$$IVDMD = 100(S - R - B)/S$$

where S = sample weight, R = residual weight and B = blank inoculum weight

Data were analysed by the analysis of variance (ANOVA) procedures for completely randomised experimental design using Statistical Package for Social Sciences (SPSS). Where treatment effects were significant, comparisons among individual means were made using Fisher's least significance difference (LSD) procedure.

Chemical composition

For chemical analyses, feed samples were oven-dried at 50°C and then ground through a 1mm screen of a Wiley mill. Dry matter (DM), organic matter (OM), crude protein (CP) and total ash contents were determined according to the AOAC (1980) procedures, while neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL), and acid insoluble ash (AIA) were determined according to the procedures of Goering and Van Soest (1970). Hemicellulose (HC) was calculated as the difference between NDF and ADF, and cellulose (CL) as the difference between ADF and ADL. Mg and Ca contents were determined by atomic absorption spectrophotometer method; K and Na by flame emission photometry procedures and P by the colorimetric method (AOAC 1980).

Results and discussion

Table 1 presents the average percent chemical composition of the native grass hay, whole *A. tortilis* pods, hulls and seeds. Results show that the hay and pods were very high in DM content, which was mainly attributed to the fact that both were harvested during the dry season. The 6.2% average CP content of the hay was below the 7–8% minimum recommended for normal rumen function (Leng 1990). *Acacia* pods, on the other hand, had approximately two times more CP than the hay. Thus, access of free ranging livestock to *Acacia* pods, as is common in most of Eastern Africa's rangelands, can potentially improve the diet quality of animals, particularly during the dry season.

Average AIA, NDF, ADF, HC, CL and ADL (%) contents were slightly higher in the hay than in the pods. Ca, P, Mg and Na content was considerably higher in the pods lower than in the hay. According to NRC (1985), small ruminants require 0.21–0.51% Ca, 0.16–0.37% P, 0.04–0.08% Mg and 0.04–0.1% Na. Therefore, on the basis of chemical composition analysis results, the hay used in this study could have met the Ca and Mg requirements of the goats. However,

Table 1: Average percent chemical composition of grass hay, whole *A. tortilis* pods, seeds and hulls (DM = dry matter, OM = organic matter, AIA = acid insoluble ash, CP = crude protein, NDF = neutral detergent fibre, ADF = acid detergent fibre, ADL = acid detergent lignin, CL = cellulose, HCL = hemi-cellulose, Ca = calcium, P = phosphorus, K = potassium, Mg = magnesium, Na = sodium, T = trace)

Item	DM	OM	AIA	CP	NDF	ADF	ADL	CL	HCL	Ca	P	K	Mg	Na
Grass hay	90.5	89.1	10.90	6.2	60.1	35.2	5.5	29.7	25.6	0.25	0.2	1.8	0.1	T
Pods	91.1	93.4	6.64	13.3	28.4	24.7	5.7	19.0	3.7	5.6	1.5	9.7	1.1	0.09
Hulls	90.2	92.8	7.18	8.9	31.1	27.1	6.8	20.3	4.1	5.6	1.0	10.4	0.7	0.10
Seeds	91.7	95.0	5.00	26.3	23.1	20.5	3.4	17.1	2.6	5.3	2.4	7.6	1.6	0.11

under normal grazing conditions, this might not have been possible due to inadequate DM intakes associated with the low quality of the hay.

Intake, digestibility and body weight changes

Average dry matter intake (g d^{-1} and g kg^{-1} BLW), percent *in vitro* dry and organic matter digestibility and body weight gains (total kg and g d^{-1}) increased with an increase in amount of *A. tortilis* pods in the rations, up to 75% level and then started to decline (Table 2). However, T_5 animals still showed significantly ($P < 0.05$) higher average organic matter digestibility and weight gains than T_2 and T_3 animals. On the other hand, T_1 animals actually lost weight, which was mainly attributed to the nutritional stress experienced by the animals as a result of relatively low intake and digestibility of the hay. According to the results of this study, 75% pods supplementation level should be the maximum. Such levels might, however, not be attainable under normal grazing conditions, particularly during the dry season, when the pods like other forages are scarce.

The greatest cause of poor livestock performance, particularly in the tropics, is limited feed intake and digestibility of feed: intake being almost synonymous with energy intake and digestibility with availability of nutrients to the animal. When feed availability is not a limiting factor, intake increases up to a certain point, above which digestibility becomes the limiting factor (Jamieson and Hodgeson 1979). The increase in dry matter intake, digestibility and body weight gains with an increase in the amount of *Acacia* pods, observed in this study, could be attributed to the stimulating effect of high nitrogen (protein) and energy on the rumen microbial fermentative capacity, resulting in increased rumen turnover rate. Church and Santos (1981) observed a steady increase in digestibility with an increase in supplemental nitrogen up to a certain point and then it levelled off. On the other hand, the decline in digestibility observed in T_5 could be attributed to lack of sufficient energy in the diet to utilise the available protein. Polyphenolic compounds, such as tannins, which are sometimes fairly high in *Acacia* browse (Mueller-Harvey *et al*. 1988, Woodward and Reed 1989, Tanner *et al*. 1990) could also have contributed to the drop in digestibility in T_5. Although the problem of polyphenolic compounds was outside the scope of this study, other studies have shown that these compounds can complex with the rumen micro-organisms, resulting in substantial reduction in feed digestion rate (Reed 1986, Woodward and Reed 1989, Tanner *et al*. 1990).

High rumen digestibility increases the rate of feed disappearance from the rumen through nutrient absorption and increased rate of passage of feed particles (Church 1983). This, in turn, results in increased feed intake and live weight gains. However, diets with high CP content without readily fermentable energy give low body weight gains, suggesting lack of adequate energy for nitrogen metabolism and assimilation by ruminants. Optimum nitrogen and energy levels in the rumen result in rapid proliferation of the rumen microorganisms, which, in turn, results in a rapid breakdown of the ingesta, and hence faster digestion rates. The lower weight gains of animals on either pure hay or pods observed in this study may be attributed to dietary nitrogen and energy deficiencies, respectively. High nitrogen diets require readily available energy sources that match the rate of nitrogen metabolism and assimilation at the tissue level. If this requirement is not met, much of the absorbed nitrogen is lost through the urine, which reduces the amount of energy available for weight gain, as nitrogen excretion requires energy. This phenomenon could possibly account for the low weight gains exhibited by T_5 animals. In a similar study, Andrews *et al*. (1972) observed that increasing levels of energy in high protein diets resulted in higher live weight gains than when energy was limited.

Conclusion

Although this study was conducted under 'artificial' conditions, i.e. forages were chopped and mixed in predetermined proportions before feeding, and animals were confined in crates, the results still have important practical applications. Our results show that *Acacia tortilis* pods are highly acceptable to goats and when grass is limited on the range, the pods can be an acceptable substitute for grass in goat diets. The same would be expected of other small ruminants like sheep. However, in case of large ruminants, such as cattle, pastoralists would face the problem of inadequate quantities of pods. Furthermore, consumption of pods considerably improves the quality of goat diets as well as their growth rate. These results suggest that resource-poor pastoralists and agro-pastoralists, particularly in Africa, can use *Acacia* pods as a strategic dry season supplementary feed to improve the nutritional value of the inherently low quality natural forages. This would alleviate the feed quality constraint generally imposed on livestock production systems in the arid and semi-arid areas where conventional supplements such as oil-seed cakes are rarely used because they are too

Table 2: Dry matter intake (g d^{-1}), *in vitro* dry and organic matter digestibility (%) and average daily body weight gains (g d^{-1}). (Treatment means in the same row with different letter superscripts differ significantly ($P < 0.05$))

Item	*A. tortilis* pods level in diet (%)				
	T_1	T_2	T_3	T_4	T_5
Total intake (g d^1, DM)	395.3^a	587.8^c	669.0^d	776.3^e	446.1^b
Intake (g kg^1 BLW)	22.0^a	30.4^c	35.8^d	38.8^e	23.9^b
IVOMD (%)	37.4^a	48.6^b	53.0^b	61.6^c	57.6^c
IVDMD (%)	46.3^a	48.3^a	55.7^b	63.6^c	54.6^b
Total Weight gain (kg)	-1.7^a	2.8^b	3.4^b	5.50^c	4.9^c
Daily weight gain (g)	-19.9^a	32.7^b	40.6^b	65.5^c	58.5^c

expensive and not readily available. Feeding of *Acacia tortilis* pods alone should, however, be discouraged, as they do not provide adequate energy. At least 25% of the ration should be made up of a high-energy feed. Because farmers often harvest, dry and store *Acacia* pods for use during critical periods, further research should be conducted to determine how long the material could be stored before it becomes unfit for the various kinds and/or classes of range livestock.

Acknowledgements — We thank the Swedish International Development Cooperation Agency (SIDA) for financial support of this study through the Pastoral Information Network Programme (PINEP) of the Department of Range Management, University of Nairobi.

References

Andrews, RP, Escuder-Volente J, Curran MK and Holmes W 1972. The influence of supplements of energy and protein on the intake and performance of cattle fed on cereal straw. ***Animal Production*** 15: 167–176.

Association of Official Agricultural Chemists 1980. Methods of Analysis. (11th edn) Washington DC, USA.

Church DC 1983. Digestive Physiology and Nutrition of Ruminants. (4th edn) O and B Books, Oregon, USA.

Church DC and Santos A 1981. Effect of graded levels of soya beans meal and of NPN-molasses supplement on consumption and digestibility of wheat straw. ***Journal of Animal Science*** 53: 1609–1615.

Coughenour MB, Ellis JE, Swift DM, Coppock DL, Galvin K, McCabe JT and Hart TC 1985. Energy extraction and use in nomadic pastoral ecosystem. ***Science*** 203: 619–625.

Du Toit JT 1990. Giraffe feeding on *Acacia* flowers: predation or pollination? ***African Journal of Ecology*** 29: 63–68.

Dunham KV 1991. Phenology of *Acacia albida* trees in Zambezi riverine woodlands. ***African Journal of Ecology*** 29: 118–129.

Goering HK and Van Soest PJ 1970. Forage fibre analyses (apparatus, reagents, procedures and some applications). Agriculture handbook No. 379. United States Department of Agriculture, Washington DC, USA.

Gwynne MD 1969. The nutritive value of *Acacia* pods in relation to *Acacia* seed distribution by ungulates. ***East African Wildlife Journal*** 7: 176–178.

Halevy G and Orshan G 1973. Ecological studies on *Acacia* species in the Negev and Sinai: II. Phenology of *A. raddiana*, *A. tortilis* and *A. gerrardii* spp. Negevensis. ***Israel Journal of Botany*** 22: 120–138.

Jamieson WS and Hodgeson J 1979. The effects of daily herbage allowance and sward characteristics on the ingestive behaviour and forage intake of calves under strip-grazing management. ***Grass and Forage Science*** 3: 261–271.

Kayongo H and Field CR 1983. Feed quality and utilisation by cattle grazing natural pasture in range areas of northern Kenya. Integrated project in arid lands. Technical Report A5: 230–245.

Le Houerou HN 1980. Browse in Northern Africa. In: Browse in Africa. The current state of knowledge. Papers presented at the international symposium on browse in Africa, Addis Ababa, 8–12 April 1980. ILCA, Addis Ababa, Ethiopia. pp 55–82.

Leng RA 1990. Factors affecting the utilisation of poor quality forages by ruminants particularly under tropical conditions. ***Nutrition Research Review*** 3: 277–303.

Mueller-Harvey I, McAllan AB, Theodorou MK and Beever DE 1988. Phenolics in fibrous crop residues and plants, and their effects on the digestion and utilization of carbohydrates and proteins in ruminants. In: JD Reed, BS Capper and PJH Neate (eds) Plant breeding and nutritive value of crop residues. Proceedings of a workshop held at ILCA, Addis Ababa, Ethiopia, 7–10 December 1987. ILCA, Addis Ababa, Ethiopia. pp 97–132.

Mwalyosi RBB 1987. Ecological changes in Lake Manyara National Park. ***African Journal of Ecology*** 19: 201–204.

Mwalyosi RBB 1990. The dynamic ecology of *Acacia tortilis* woodland in Lake Manyara National Park, Tanzania. ***African Journal of Ecology*** 28: 289–299.

National Research Council 1979. Tropical Legumes: Resources for the Future. United States National Academy of Science, Washington DC, USA.

National Research Council 1985. Ruminant Nitrogen Usage. National Academy Press, Washington DC, USA.

Pellew AR 1980. The production and consumption of *Acacia* browse and its potential for animal protein production. In: HN Le Houerou (ed) Browse in Africa. International Livestock Centre for Agriculture, Addis Ababa, Ethiopia.

Pellew RA 1983a. The giraffe and its food resources in the Serengeti. I. Composition, biomass and production of available browse. ***African Journal of Ecology***. 21: 241–267.

Pellew RA 1983b. The impacts of elephant, giraffe and fire upon *Acacia tortilis* woodlands of the Serengeti. ***African Journal of Ecology.*** 21: 41–74.

Reed JD 1986. Relationships among soluble phenolics, insoluble proanthocyanidins and fibre in East African browse species. ***Journal of Range Management*** 39: 5–7.

Tanner JC, Reed JD and Owen E 1990. The nutritive value of fruits (pods with seeds) from four *Acacia* species compared with extracted noug (*Goizotia abbyssinica*) meal as supplements to maize stover for Ethiopian highland sheep. ***Animal Production*** 51: 127–133.

Tilley JMA and Terry RA 1963. A two-stage technique for i*n vitro* digestibility of forage crops. ***Journal of the British Grassland Society*** 18: 104–118.

Vesey-Fitzgerald DF 1973. Animal impact on vegetation and plant succession in Lake Manyara National Park, Tanzania. ***Oikos*** 24: 314–325.

Woodward A and Reed JD 1989. The influence of polyphenolics on the nutritive value of browse: a summary of research conducted at ILCA. ***ILCA Bulletin*** 35: 2–11.