Relative Palatability to Sheep of Some Browse Species, their *In sacco* Degradability and *In vitro* Gas Production Characteristics

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ABSTRACT : A study was conducted to estimate the nutritive value of some selected acacia forages using palatability index, *in sacco* degradability and *in vitro* gas production characteristics. Ten wethers (mean wt. 18±3.5 kg) were offered *Acacia tortilis, Acacia nilotica, Acacia mellifera, Acacia brevispica, Acacia senegal* and *Leucaena leucocephala* (control) using a cafeteria system to determine the species preference by the animals. The acacia species were rich in nitrogen and showed variable palatability pattern. Significant ($p<0.05$) differences in relative palatability index (RPI) were detected among the species with the following ranking: brevispica > leucaena > mellifera > tortilis > senegal > nilotica. *Acacia nilotica* appeared to be of low relative palatability with RPI of 24% and this was attributed to relatively high phenolic concentrations. The DM potential degradability (B) and rate of degradation (c) of the species were significantly ($p<0.05$) different, ranging from 40.1 to 59.1% and 0.0285 to 0.0794/h respectively. Acacia species had moderate levels of rumen undegradable protein, much higher than that in leucaena. *In vitro* gas production results indicated the effect of polyphenolic compounds on the fermentation rate, with lower gas production recorded from *A. nilotica and tortilis*. Based on RPI, *A. brevispica* and *mellifera* were superior to the rest and comparable to *L. leucocephala*. Long-term feeding trials are required with the superior species when used as protein supplements to poor quality diets. ***(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 11 : 1580-1584)***

Key Words : Acacia Sp., *In situ* Degradability, *In vitro* Digestion, Palatability, Sheep

INTRODUCTION

Studies on the use of multipurpose tree legume forages (MPTS) as livestock feed is increasingly becoming important particularly in the tropics where the natural pasture and crop residues are of low quality (Abdulrazak, 1995; Topps, 1992). The MPTS also play a significant role as supplementary feed for low quality diets offered to livestock. In previous studies with cattle, we reported improvements in intake, digestion and live weight gains when *Leucaena leucocephala* and *Gliricidia sepium* forages were offered as supplements to low quality diets (Abdulrazak et al., 1996). In marginal areas of Kenya, acacia tree forages are important browse for small ruminant due to their abundance and ability to grow in the severe and dry condition (Le Houerou, 1980). They also have multiple uses ranging from improvement of soil fertility, provision of firewood and timber in addition to provision of livestock fodder (Topps, 1992). However, a draw back to use of acacia browse is accessibility by foraging animals due to the spiny nature of the branches of some species. Additionally, a wide range of secondary compounds such as tannins have been reported (Reed, 1986; Abdulrazak et al., 2000; Abdulla et al., 1994). Therefore the need to screening trees in respect to their nutritive values and palatability before incorporating into farming system had been advocated (Ben Salem et al., 1994). Chemical composition and palatability trials have been conducted to establish the preference by livestock of browse species (Larbi et al., 1998; Kaitho et al., 1997 and Ben Salem et al., 1994). Similarly *in vitro* gas production and *in sacco* degradability (Khazaal and Ørskov, 1994; Apori et al., 1998 and Abdulrazak et al., 2000) have been used with promising results as simple tools of screening browse species. Palatability has been found to affect the choice of a particular forage regardless of the composition of the nutrient content (Martens, 1978). A wide variability in nutritive value and palatability of tropical tree forages has been reported (Kaitho et al., 1997), of these however, information on acacia species relative to well researched species such as *Leucaena leucocephala and Gliricidia sepium* is scanty. The objective of this study was to estimate the nutritive value of some selected acacia forages using palatability index, *in sacco* degradability and *in vitro* gas production characteristics using leucaena as a control, and recommend promising species for further studies.

MATERIALS AND METHODS

Site

The acacia leaves and petioles (*tortilis, senegal, brevispica, mellifera* and *nilotica)* were harvested from Egerton University Chemeron field station situated in the northern part of Baringo district, Kenya, in the Lower Midland agro-ecological zone (LM5). The area is at an altitude of 1,080 m above sea level, with an annual mean temperature of 23°C and annual rainfall of 700 to 950 mm.

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Forages were harvested during the rainy season from at least 12 individual trees or shrub of each species. Harvested forage was then dried under the shade for 48 h and stored till later use in the study.

Palatability study

A cafeteria feeding approach described by Larbi et al. (1993) was used. The relative palatability of the browse species was determined using ten wethers 18±3.5 kg with *Leucaena leucocephala* as a control. The study was conducted in a split plot design with two pens as replications, collection days as main plots and the tree species as subplots. Tree forages were weighed and placed in bin troughs randomly arranged in each of two pens. The two groups of sheep were introduced into the separate pens from 08:00 to 12:00 h each day before they were taken back to their individual pens to feed on the urea treated straw. The refusals were weighed to determine the amount consumed. The position of the troughs were altered each day to prevent development of a "habit reflex". After an adaptation period of 10 days the amount of forage dry matter offered, refused and subsequently intake was recorded for 5 days during collection period. The intake data was used to determine the relative palatability of the tree forage species. A relative palatability index (RPI) was calculated for each species by dividing the amount consumed by that of the highest value, and multiplied by 100. Water and mineral lick (contained Ca 17.1%, P 7.2%, NaCl 26%, Mn 0.4%, Zn 0.5%, Iodine 0.05%, Cu 0.2%, Fe 0.3%, Co 0.005%, Mg 2.5% and Se 0.0012%) were on offer at all times.

In vitro gas production

Samples were incubated *in vitro* with rumen fluid in calibrated glass syringes following the procedure of Menke and Steingass (1988). Rumen liquor was obtained from three sheep fed with 800 g DM timothy hay and 200 g DM concentrates, twice daily and had free access to water and mineral mix. About 200±5 mg of 1 mm milled samples were weighed into 100 ml calibrated glass syringes in duplicate. About 30±1.0 ml of rumen-buffer mixture was added into each syringe and then all the syringes were incubated in a water bath maintained at 39±0.1°C. The syringes were gently shaken every hour during the first 8 h of incubation. Readings were recorded after 3, 6, 12, 24, 48 and 72 h. The mean gas volume readings were fitted to the exponential equation $p=a+b\ (1-e^{-ct})$ (Ørskov and McDonald, 1979), (where p=gas production at time t; $a+b$=the potential gas production, c=the rate of gas production and a, b and c are constants) using Neway' computer program (X.B.Chen, Rowett Research Institute, Aberdeen).

In sacco degradability

To determine the *in sacco* degradation characteristics of the samples, 4 g of dry sample milled through a 2.5 mm screen were placed in nylon bags (140 × 75 mm, pore size 40 to 60 um). The bags were incubated in the rumen of three ruminally-cannulated steers. The animals were offered Rhodes grass *ad libitum* plus 2 kg DM of mixed concentrate twice a day at 08:00 and 17:00 h. Animals had free excess to water and mineral/vitamin licks. Nylon bags were withdrawn at 3, 6, 12, 24, 48, 72 and 96 h after insertion. 0 h measurement was obtained by soaking the two bags of each sample in warm water (37°C) for 1 h. The 0 h measurement and incubated bags were then washed with running cold water until the rinse out was clear, and dried for 48 h at 60°C. The DM degradation data were fitted to the exponential equation $p=a+b\ (1-e^{-ct})$ (Ørskov and McDonald, 1979) to determine the degradation characteristics.

Chemical analysis

Dry matter (DM), ash and nitrogen (N) content were measured according to the official methods of the Association of Official Analytical Chemists (AOAC, 1990). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined according to the methods of Van Soest et al. (1991). The extraction of phenolics was done using 70% aqueous acetone. Total extractable phenols (TEPH) were determined using Folin Ciocalteu according to Julkunen-Titto (1985). The concentration of TEPH was calculated using the regression equation of the tannic acid standard. Total extractable tannins (TET) were estimated indirectly after being absorbed to insoluble polyvinylypolyrrolidone (PVP). Concentration of TET was calculated by subtracting the TEPH remaining after PVP treatment from TEPH. The total condensed tannins were measured and calculated as leucocyanidin equivalent, following the method of Porter et al. (1986).

Statistical analyses

Analysis of variance (ANOVA) was carried out on all the data using the General linear model (GLM) of Statistica for windows (Statistica, 1993). Significance between means was tested using the least significant difference (LSD).

RESULTS AND DISCUSSION

The CP content ranged between 17 and 22% with highest amount in *A. senegal*. *A. nilotica* had lowest CP but higher concentration of extractable phenolics, while *A. mellifera* tended to have the lowest concentration of phenolics (table 1). The wide variation in CP, fibre and anti-nutritional compounds of the forages is consistent with

Table 1. Chemical composition of selected acacia species and *L. leucocephala* leaves

Species	Ash	CP	NDF	ADF	ADL	TEPH	TET	CT
	% of Dry matter							
A. tortilis	8.6	18.0	51.1	43.7	8.5	5.4	1.1	3.8
A. nilotica	5.5	17.1	29.8	15.1	8.1	14.7	6.5	2.0
A. mellifera	10.2	19.9	50.7	33.5	7.4	1.8	0.8	0.7
A. brevispica	7.7	20.5	36.1	39.3	6.5	3.9	2.2	1.5
A. senegal	10.6	22.0	42.4	22.1	6.1	6.4	4.1	1.4
L. leucocephala	14.2	21.0	56.3	22.4	6.8	3.1	1.8	0.5
SEM	1.21	0.76	1.81	2.39	0.64	1.88	0.89	0.48

SEM: standard error of the mean.

CP: crude protein; NDF: neutral detergent fiber; ADF: acid detergent fiber; ADL: acid detergent lignin; TEPH: total extractable phenolics; TET: total extractable tannins; CT condensed tannins as leucocyanidin equivalent.

previous reports of browse from other plants of the tropics (Apori et al., 1998; Larbi et al., 1998 and Topps, 1992). The high CP content and lower fibre fraction make the tree species suitable diet supplement to low quality forages. However, the antinutritional factors in acacia species have resulted into low intakes (Ben Salem et al., 1997). Furthermore, for better management and use of tree in livestock feeding system, information on their palatability, in addition to chemical composition is necessary. In this trial a cafeteria approach was used to elucidate that point.

Table 2 presents the relative palatability index of forages, which differed widely with the following ranking: *brevispica>leucaena>mellifera>tortilis>senegal>nilotica. A. nilotica* seems to be of low palatability. The exact reason for this although is not known, but may probably is due to its higher content of phenolic compounds. It was also observed that *A. nilotica* leaves had strong smell than the other tree species even after sun drying. Other studies (Reed, 1995) have indicated that secondary compounds such as tannins may reduce intake of forage legumes by decreasing palatability or through suppression of digestion. In our study we observed that although *A. senegal* had similar concentration of condensed tannin to that of *A. brevispica*, they exhibited a different palatability pattern. It must be noted that the total extractable phenolics were relatively higher in *A. senegal* than *A. brevispica*. Thus, the low palatability index suggests that other factors in addition to condensed tannins could be responsible for the palatability in animals fed tree forages. This study focused on just a few species of acacia leaves that were available at the time of experiment, during the wet season and only using sheep. Livestock prefer dry fruits (pods and seeds) which are mainly available after the rainy season, therefore pods were not included in this study. It is worth noting that recently, sheep have been introduced in some marginal areas in addition to dominating traditional goat keeping. This study could therefore shade some light on the nutritive value of acacia forage for sheep. Other studies have reported differences between sheep and goats on palatability of browse species in Ethiopia (Kaitho et al., 1997) and that of dromedaries and sheep in Tunisia (Ben Salem et al., 1994). A further study is suggested to screen more species and including other plant parts during different season.

Table 2. Palatability index and preference ranking of selected acacia species and *L. leucocephala*

	Plant parts	Palatability index (%)	Preference ranking
Acacia brevispica	Leaves and petioles	100	1
Leucaena leucocephala	Leaves and petioles	93	2
Acacia mellifera	Leaves and petioles	76	3
Acacia tortilis	Leaves and petioles	58	4
Acacia senegal	Leaves and petioles	57	5
Acacia nilotica	Leaves and petioles	24	6
SEM		3.68	
LSD ($p<0.05$)	-	7.36	-

Dry matter and nitrogen degradability of forages is presented in table 3. A significant ($p<0.05$) difference in disappearance after 24 and 48 h was recorded. Acacia species had moderate levels of rumen by pass protein (100 – (a+b), which were much higher than that of *L. leucocephala*. The results tend to suggest that acacia foliage could also supply by pass protein to the host animal. However, it should be emphasised that the intestinal digestibility of the undegradable dietary protein is variable in tree forages (Mgheni et al., 1994) and it is not necessarily available in the intestine. On the other hand the results also indicate the need for degradable nitrogen. During the dry season pods are readily available and could supply cheap source of soluble N to meet the nutritional requirements of rumen microbes when animals are offered such diets. Supplementing barley straw diets with *A. brevispica* leaves resulted into better intake when soluble N such as urea was

Table 3. *In sacco* degradability of selected acacia species and *L. leucocephala* leaves

	Total degradability (%)		Degradability parameters (%)			
	24 h	48 h	*A*	*B*	*A+B*	*c (%/h)*
Dry matter degradability						
A. tortilis	45.9	67.0	22.2	55.6	77.8	0.0285
A. nilotica	73.3	80.3	36.8	44.9	81.7	0.0698
A. mellifera	71.4	77.6	25.1	54.7	79.7	0.0794
A. brevispica	61.5	77.8	22.9	59.1	82.0	0.0472
A. senegal	56.7	68.2	34.7	40.1	74.8	0.0346
L.leucocephala	73.9	84.1	35.4	53.9	80.9	0.0479
SEM	3.09	1.99	1.93	2.06	1.39	0.0054
LSD (p<0.05)	6.73	4.34	4.21	4.49	3.03	0.0118
Nitrogen Degradability						
A. tortilis	47.6	48.3	37.9	16.4	54.4	0.0293
A. nilotica	46.1	48.7	30.2	22.2	51.3	0.0416
A. mellifera	44.2	47.2	29.5	21.4	50.1	0.0406
A. brevispica	47.9	54.7	17.7	39.0	56.7	0.0578
A. senegal	32.7	35.9	16.3	23.9	40.2	0.0314
L. leucocephala	61.9	66.8	35.2	36.1	71.3	0.0436
SEM	2.59	2.80	2.46	2.64	2.79	0.0029
LSD (p<0.05)	5.58	6.10	5.36	5.75	6.08	0.0063

A,B,c are constants in the equation (Ørskov and McDonald, 1979), SEM: standard error of the means.

Table 4. *In vitro* gas production (ml/200 mg DM) of selected acacia species and *L. leucocephala* leaves

	In vitro gas production				
	24 h	48 h	a+b (ml)	*c (%/h)*	OMD 48 (%)
A. tortilis	24.7	32.5	37.5	0.0435	49.6
A. nilotica	22.2	29.5	43.2	0.0221	46.8
A. mellifera	32.0	37.2	42.4	0.0529	54.1
A. brevispica	30.0	36.4	39.7	0.0615	53.3
A. senegal	28.3	32.2	36.7	0.0552	49.4
L. leucocephala	26.1	30.7	18.3	0.0589	48.0
SEM	0.96	0.91	1.07	0.0039	0.85
LSD (p<0.05)	2.09	1.98	2.33	0.0085	1.85

a, b, c are constants in the equation (Ørskov and McDonald, 1979).

SEM: standard error of the means.

OMD48: *In vitro* organic matter digestibility calculated from the equation: OMD (%)=18.53+0. 9239 Gas production+0.0540 Crude protein (Menke and Steingass, 1988).

added and subsequently improved the animal performance (Abdulrazak, unpublished data). The potential (a+b) and rate (*c*) ranged between 77 to 82% and 0.0285 to 0.0794/h, respectively. *A. tortilis* had the lowest rate of degradation probably due to relatively higher condensed tannins concentration.

Differences in gas production were recorded among the species (table 4). *A. mellifera* and *A. brevispica* had the highest gas production after 24 and 48 h respectively. *A. nilotica* had relatively higher ($p<0.05$) concentration of phenolic compounds, and exhibit a lower gas production after 24 h of incubation. The calculated organic matter digestibility (OMD) ranged from 46.8 to 54.1% with *A. mellifera* and *A. brevispica* having more than 50% and lowest values recorded in *A. nilotica,* indicating the potential to supply metabolisable energy. The OMD values were moderate, but comparable to in vitro values reported from some browse in the tropics (Ben Salem et al., 1994).

In conclusion, native acacia species such as *A. brevispica* and *A. mellifera* were of high nutritive value and comparable to exotic *Leucaena leucocephala.* The relatively low palatability in some species was attributed to factors including odour and phenolic concentrations. A long-term intake and digestion study with the promising species is needed to elucidate these findings.

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