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ORIGINAL ARTICLE

Evaluation of nutritive value and palatability by goats and sheep of selected browse foliages from semiarid area of Kenya

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ABSTRACT

The feeding value of five browse foliages (*Acacia brevispica, Acacia mellifera, Berchemia discolor, Zizyphus mucronata* and *Maerua angolensis*) grown in semiarid area of Kenya were evaluated. Their chemical composition including polyphenolics and *in vitro* gas production characteristics were determined. The biological activity of the polyphenolics was assessed as the increases in gas production profiles and *in vitro* true dry matter (DM) and organic matter (OM) digestibility after *in vitro* incubation with or without addition of polyethylene glycol (PEG) as a tannin binding reagent. The intake and palatability ranking of the browse foliages by goats and sheep were also investigated. The browse foliages had variable crude protein content (149.5–248.6 g/kg DM) and variable content of neutral detergent fiber (205.1–424.0 g/kg DM). The content of total extractable tannins was generally low (2.4–34.8 g/kg DM). At 24 h of incubation, *Z. mucronata* produced the highest gas volume, while after 48 h of incubation, *B. discolor* produced the highest gas volume. *M. angolensis* had the least gas production potential within the browse foliages. Addition of PEG increased gas production except in *A. mellifera* and *M. angolensis*. However, PEG addition did not have any significant effect on *in vitro* true DM and OM digestibility except in *B. discolor*, which decreased. The rank order of preference (highest to least) for goats was *A. brevispica, Z. mucronata, B. discolor, A. mellifera* and *M. angolensis* while the rank order of preference for sheep was *A. brevispica, B. discolor, A. mellifera, Z. mucronata* and *M. angolensis*. The goats had higher intakes of all the browse foliages than sheep. The result of this study highlights the higher feeding value of the browse species as supplemental feed with low quality basal diet with both of animal species except *M. angolensis*.

Key words: *browse foliages, goats, nutritional value, palatability, sheep.*

INTRODUCTION

The nutrition of livestock, especially domesticated ruminants, in arid and semiarid regions in the tropics has been a problem for farmers because of lack of basal feeds (Hernandez *et al*. 1998). When available even in limited quantities, the fibrous feeds such as cereal crop residues and poor quality mature grasses cannot maintain animals during much of the year. The leaves of shrubs and trees provide supplements of protein and energy when grasses are mature and are of low nutritional value, and provide a reserve of feed that can be utilized in times of drought (Wilson 1969). The browse foliages are often regarded as important supplemental

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feed resources for the grazing ruminants and therefore the browses have been incorporated into the feeding regimen to improve the nutritional status of the animals (Lusigi *et al*. 1984).

The importance of browse foliages for livestock feeding is determined by their availability, palatability and nutritive value. Grazing ruminants, goats and sheep are particularly known to consume a wide range of browse foliages and are reported to select those that meet their nutritional needs and avoid those that can be toxic (Ngwa *et al*. 2003). Feed selection by animals depends on the palatability of the feeds. Palatability is a complex phenomenon being determined by both plant and animal factors (Marten 1978). Browse foliages have been reported to contain tannins with varying concentrations (Abdulrazak *et al*. 2000; Osuga *et al*. 2006, 2007). The tannins in the foliages exhibit antinutritional effects or positive nutritional merits. When in high concentration in the browse foliages, the tannins reduce ruminal and postruminal digestion of protein (Min *et al*. 2003). However, when the tannins concentrations are low, they have been shown to prevent extensive proteolysis in the rumen and increase in intestinal absorption of amino acids (Barry *et al*. 1986; Min *et al*. 2003). Additionally, tannins affect palatability and preference of browse foliages by ruminants when offered (Krueger *et al*. 1974; Garcia 1989; Ngwa *et al*. 2003).

In the less productive rangelands in the arid and semiarid zone of Kenya, information available on the nutritional value of indigenous browse foliages and their preference for livestock is still very scant. The comparative assessment in goats and sheep for their palatability on tanniniferous foliage is also scant. Therefore, the objective of this study was to evaluate the potential nutritional value, intake and preference of five browse foliages common in the semiarid area of Kenya offered to goats and sheep. Part of this study had been presented at the 12th AAAP Animal Science Congress in 2006. Nutritive value of one browse species assessed in this study had been described in a previous paper as reference foliage to compare the nutritive values of browse species harvested at another area in dry season (Osuga *et al*. 2006).

MATERIALS AND METHODS

The research protocol regarding animal use followed the guidelines recommended in the *Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching* (Federation of Animal Science Societies 1999).

Browse foliages

Leaves from five browse species (*Acacia brevispica, Acacia mellifera, Berchemia discolor, Zizyphus mucronata* and *Maerua angolensis*) that grow in semiarid zone of Kenya were tested in this study. The browse forages were selected based on local farmers' knowledge of the species consumed by animals in Kenya. All the samples were harvested from Egerton University's Chemeron Field Station in Marigat Division, Baringo District, Kenya. The area is located at an altitude of 1066 m above sea level with an average annual rainfall and temperature of 700 mm and 24°C, respectively.

Chemical analysis

Dry matter (DM), organic matter (OM) and crude protein (CP) contents were measured according to standard methods (AOAC 1984). 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). Acid detergent insoluble CP (ADICP) was determined as described by Licitra *et al*. (1996). The extraction of phenolics was done using 70% aqueous acetone. The concentration of total extractable phenolics (TEPH) was determined using Folin Ciocalteu and tannic acid standard as outlined by Makkar (2000). The total extractable tannins (TET) were estimated indirectly after being absorbed to insoluble polyvinyl polypyrrolidone (PVP). The concentration of TET was calculated by subtracting the TEPH remaining after PVP treatment from the TEPH.

In vitro study

Animals

Three mature sheep fitted with permanent rumen fistula were used. The animals were fed on diet made up of 800 g DM timothy hay and 200 g DM concentrate twice daily at 09.00 and 16.00 hours in equal sized meals. The animals had free access to water and mineral licks. The animals provided the rumen liquor for the *in vitro* gas production and tannin bioassay experiments. The rumen liquor was withdrawn at 06.00 hours, mixed, strained through four layers of cheesecloth and kept at 39°C under a CO_2 atmosphere.

In vitro *gas production*

About 200 mg of sample (milled through a 1.0 mm sieve) were incubated *in vitro* with rumen fluid in calibrated glass syringes in triplicate following the procedure of Menke and Steingass (1988). The syringes were pre-warmed at 39°C before addition of 30 mL of rumen liquor-buffer mixture (ratio 1:2) into each syringe and incubation in a water bath maintained at 39°C. Blanks with buffered rumen fluid only were also included. The gas production readings were recorded after 3, 6, 12, 24, 48, 72 and 96 h of incubation. The gas production parameters were estimated by fitting the mean gas volumes to the exponential equation (Blümmel & Ørskov 1993):

$$G = a + b(1 - e^{-ct}),$$

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where G is the gas production (mL/200 mg DM) at time t, a is the gas production from the immediately soluble fraction (mL), b is the gas production from the insoluble but degradable fraction (mL), $a + b$ is the potential gas production (mL), c is the rate constant of gas production from insoluble fraction (per h).

Tannin bioassay

Incubation was carried out as described by Makkar *et al.* (1995). About 500 mg DM of the feed samples were incubated with 1.0 g polyethylene glycol (PEG, molecular weight = 6000; +PEG) or without PEG (–PEG). The syringes were pre-warmed at 39°C for 1 h before the addition of 40 mL rumen liquor-buffer mixture (1:3) into the syringes and incubation in triplicate in a water bath maintained at 39°C. Blanks were also included in the incubation for both –PEG and +PEG. The gas production readings were recorded after 2, 4, 6, 8, 12, 16 and 24 h of incubation.

In vitro *true DM and OM degradability*

After termination of the incubation at 24 h, the syringe contents were quantitatively transferred into a 500 mL beaker by rinsing the syringes with about 70 mL of neutral detergent solution and refluxed for 1 h. Residual DM and ash were then determined (Blümmel & Becker 1997). *In vitro* true DM digestibility (IVTDMD) and true OM digestibility (IVTOMD) were then calculated.

Palatability evaluation

Study site

The study was conducted at Egerton University's Tatton Farm in Njoro, Kenya. The area is situated at an altitude of 2250 m above sea level. The area has a mean annual temperature and rainfall of 21°C and 900 mm, respectively.

Animals, housing and feeding

Five Small East African goats (24.0 kg) and five Corriedale sheep (19.5 kg) of similar age (about 1 year old) were used in this study. All the animals were housed in a roofed shed in well ventilated individual pens (1.5 × 2.5 m) for the duration of the experiment. Each pen had water and a feed trough. The feed troughs were divided into five partitions enough for the five test foliages. Water and mineral salt licks were provided *ad libitum* throughout the experimental period. Prior to the beginning of the experiment, the animals grazed on natural pasture without any supplementation.

After an adaptation period of the animals to the pens and the foliages for 10 days, a five-day trial was conducted as outlined by Rogosic *et al.* (2006). Each day, the animals were given maize bran (100 g as fed) at 08.00 and at 08.30 hours, and the weighed browse foliages were placed in each of the five partitions of the feed trough. Additional browse material was added as necessary every 30 min until 14.00 hours. The feed refusals were collected and weighed, and the intakes of browse foliages during the 6 h measurement were determined. Each day, the positions of the foliages in the feed trough partitions were rotated. After collection of the browse foliage refusals at 14.00 hours, the animals were offered chopped rhodesgrass (*Chloris gayana* Kunth) hay *ad libitum*.

Statistical analysis

In vitro gas production data was fitted to the asymptote exponential model using the Neway computer program (Macaulay Land Use Research Institute 2000). Analysis of variance was carried out on *in vitro* gas production profiles, tannin bioassay estimates, *in vitro* degradability and intake data using StatView for Windows (SAS 1999). Significance between means was tested using Fisher's least significance difference.

RESULTS AND DISCUSSION

Chemical composition

Table 1 indicates variations in the foliage chemical components analyzed. The OM content ranged from 932.3 g/kg DM in *A. mellifera* to 970.6 g/kg DM in *A. brevispica*. The CP content range was from 149.5 g/kg DM in *A. mellifera* to 248.6 g/kg DM in *M. angolensis*. *Z. mucronata, A. mellifera* and *A. brevispica* had the highest NDF, ADF and ADL contents, respectively. *M. angolensis* had numerically the lowest fiber contents among the species. The unavailable CP fraction associated with the cell wall (ADICP) ranged from 9.7 g/kg DM in *M. angolensis* to 22.3 g/kg DM in

Table 1 Chemical composition of the browse foliages

Species	DM (g/kg)	OM (g/kg DM)	CP (g/kg DM)	NDF (g/kg DM)	ADF (g/kg DM)	ADL (g/kg DM)	ADICP (g/kg DM)	TEPH (g/kg DM)	TET (g/kg DM)
Acacia brevispica	893.1	970.6	236.3	417.9	255.4	126.6	20.2	70.0	31.9
Acacia mellifera	899.3	932.3	149.5	395.4	322.2	94.8	21.4	37.9	16.9
Berchemia discolor	884.4	961.0	216.3	423.0	202.6	81.0	18.3	72.2	34.8
Maerua angolensis	862.8	933.8	248.6	205.1	119.5	59.1	9.7	15.1	2.4
Zizyphus mucronata	877.1	960.4	192.8	424.0	226.7	106.6	22.3	53.8	20.2

ADF, acid detergent fiber; ADICP, acid detergent insoluble crude protein; ADL, acid detergent lignin; CP, crude protein; DM, dry matter; NDF, neutral detergent fiber; OM, organic matter; TEPH, total extractable phenolics; TET, total extractable tannins.

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Z. mucronata. The TEPH and TET contents ranged from 15.1 to 72.2 g/kg DM and 2.4–34.8 g/kg DM, respectively.

The chemical composition of these Kenyan browse foliages is likely to have an impact on the consumption by the goats and sheep (Bryant *et al*. 1991). The five studied browse foliages are generally considered of intermediate to high nutritional quality because they contain over 80 g/kg DM of CP and less than 500 g/kg DM of NDF (Leng 1990). The high CP content of the browse foliages (149.5–248.6 g/kg DM) justifies the use of the browse foliages to supplement poor quality natural pastures and crop residues such as straw and stover (Osuga *et al*. 2006). The low to moderate fiber content of browse foliages would positively influence the voluntary intake and digestibility of the foliages (Bakshi & Wadhwa 2004). The fiber of browse foliages has also been shown to be more digestible than that of mature grasses and crop residues (El Hassan *et al*. 2000). Hence, when used as supplements, the foliages may improve the digestibility of low nutritional quality basal forages by providing easily fermentable non-structural carbohydrates (Kim *et al*. 1999), rumen degradable nitrogen and highly colonized fiber to inoculate rumen bacteria into the less digestible fiber (Leng 1990). The tannins present in the browse foliages were generally low: in fact lower than the nutritional critical level of 40 mg/g DM (Barry *et al*. 1986). However, the nutritional significance of the tannins depends on the biological activity of the tannins.

In vitro gas production

The *in vitro* gas production characteristics of the browse foliages are summarized in Table 2. There were significant ($P < 0.05$) differences in gas production and ruminal fermentation parameters among the browse foliages. After 6 and 12 h of incubation, *Z. mucronata, A. brevispica* and *A. mellifera* produced the highest ($P < 0.05$) gas volume. At 24 h of incubation, *Z. mucronata* produced the highest ($P < 0.05$) gas volume. After 48 h of incubation, *B. discolor* produced the highest gas up to 96 h of incubation. *M. angolensis* produced the least gas volume from 12 to 96 h of incubation. The potential gas production was highest ($P < 0.05$) in *B. discolor* and lowest in *M. angolensis*. The rate of gas production was highest in *A. mellifera* and lowest in *M. angolensis*.

The significant differences ($P < 0.05$) among the browse foliages for their *in vitro* gas production and fermentation characteristics are in agreement with previous studies on similar foliages from Kenya (Abdulrazak *et al*. 2000; Osuga *et al*. 2006, 2007). Gas is produced by the fermentation of OM in the feed (Blümmel & Fernandez-Rivera 2002). Therefore the differences in gas production among the various species could be due to the amount of substrate fermented in *in vitro*. Besides volatile fatty acids (VFAs), the released energy and ammonia produced from protein degradation is thought to be used by the rumen microbes (Blümmel & Fernandez-Rivera 2002) with high efficiency for microbial protein synthesis (AFRC 1993).

In the current study, all the browse foliages had generally high gas production potential except *M. angolensis*. The high extent of gas production in *B. discolor, Z. mucronata, A. brevispica* and *A. mellifera* may be due to higher OM availability than in *M. angolensis*, with the OM fermented to form VFAs and therefore high gas volumes being produced. The high CP and non-structural carbohydrate contents of *M. angolensis* may have resulted in the substrate yielding more microbial biomass production and polysaccharides storage in the cell (Kim *et al*. 1999) than those of the other foliages and hence, may have resulted in less gas production. Blümmel and Becker (1997) had also reported an inverse relationship between gas production and microbial yield.

Table 2 *In vitro* gas production and gas production parameters of the browse foliages

Species	3 h (mL/200 mg DM)	6 h (mL/200 mg DM)	12 h (mL/200 mg DM)	24 h (mL/200 mg DM)	48 h (mL/200 mg DM)	72 h (mL/200 mg DM)	96 h (mL/200 mg DM)	$a + b$ (mL)	c (%/h)
Acacia brevispica	5.3^{b}	10.8^{a}	21.1^{a}	27.5^{c}	33.6^{d}	39.3^{c}	43.1^{c}	41.5^{c}	4.4^{c}
Acacia mellifera	5.0^{b}	10.2^{a}	22.9^{a}	31.2^{b}	37.2^{c}	39.9^{c}	41.6^{c}	40.3^{c}	6.8^{a}
Berchemia discolor	4.2^{c}	7.8^{c}	18.5^{b}	32.0^{b}	46.0^{a}	48.5^{a}	50.2^{a}	51.4^{a}	4.4^{c}
Maerua angolensis	5.2^{b}	8.8^{b}	16.9^{b}	23.2^{d}	31.6^{e}	35.0^{d}	37.8^{d}	37.8^{d}	3.9^{d}
Zizyphus mucronata	6.2^{a}	11.0^{a}	21.8^{a}	34.8^{a}	42.0^{b}	44.3^{b}	45.4^{b}	45.2^{b}	5.9^{b}
SEM	0.3	0.4	0.8	1.3	1.8	1.5	1.4	1.6	0.4

^{a,b,c,d,e}Means with different superscripts in a column differ significantly ($P < 0.05$). a, b and c are constants in the equation (Blümmel & Ørskov 1993): Gas production = $a + b(1 - e^{-ct})$. DM, dry matter; SEM, standard error of the means.

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Tannin bioassay, true DM and OM degradability

The effect of PEG addition on gas production, IVTDMD and IVTOMD are presented in Table 3. The increase in gas production was highest ($P < 0.05$) in *B. discolor* (24.1%) and lowest ($P < 0.05$) in *A. mellifera* (1.1%) but only significant ($P < 0.05$) in *A. brevispica*, *B. discolor* and *Z. mucronata*. Both IVTDMD and IVTOMD were highest ($P < 0.05$) in *M. angolensis* and lowest ($P < 0.05$) in *A. mellifera*. However, a significant ($P < 0.05$) decrease in IVTDMD and IVTOMD due to PEG addition was only noted in *B. discolor*.

Due to the need for development of methods aimed at correctly quantifying the biological activity of tannins present in browse foliages (Schofield *et al.* 2001), there has been renewed interest in the use of tannin binding agents such as PEG for neutralizing their negative effects on animals. PEG has high affinity to bind to tannins, thus preventing the formation of potentially indigestible tannin-protein complexes (Jones & Mangan 1977). Therefore, the extent of PEG binding to the tannins is a measure of the total amount of tannins in the sample (Jones *et al.* 2000) and their ability to affect the degradation of feed in the rumen (Ammar *et al.* 2004). The increase in gas production due to inclusion of PEG in the incubation represents the quantitative effect of tannins (Makkar *et al.* 1995). In the current study, there were differences in gas production response due to PEG addition between the browse species. *B. discolor* showed the highest increase in gas production although all the browse species had lower levels of tannins than the critical level, leading to antinutritional effects (Barry *et al.* 1986). This shows that the tannins in *B. discolor* are of the highest biological antinutritive activity among the browse foliages evaluated. In another study (Osuga *et al.* 2007), the tannins in *B. discolor* were found to have a high prevalence of prodelphinidin flavonoids, which are of high molecular weight and therefore interact more strongly with enzymes and other proteins than other tannins of low molecular weight (Kawamoto *et al.* 1996). However, the increase in gas production was significant in *A. brevispica*, *B. discolor* and *Z. mucronata*, which would indicate the use of PEG when feeding such species would be advantageous to improve microbial activity and digestibility of the feeds. In another study, the species also showed significant increases in gas production due to PEG addition, mainly due to high tannins and prevalence of prodelphinidins in the tannins present in the browse foliages (Osuga *et al.* 2006, 2007).

The browse foliages had relatively high IVTDMD and IVTOMD, which demonstrates the high nutritive value of the browse foliages when used in ruminant feeding. The addition of PEG did not have a significant ($P \geq 0.05$) effect on the IVTDMD and IVTOMD of the browse foliages except in *B. discolor*, that had a significant decrease in both IVTDMD and IVTOMD due to PEG addition. This may probably be due to the PEG-tannin complexes, which are insoluble in neutral detergent solution and thus contributing to the weight increment of the undegraded residue (Makkar *et al.* 1995).

Palatability evaluation

The intakes of the browse foliages during observation are presented in Table 4. There were marked differences in intake of the browse foliages by goats and sheep. Both animals preferred *A. brevispica* over all the other browse species. The preference of the browse

Table 3 Effect of polyethylene glycol addition on gas production and *in vitro* true digestibility

Species	Gas production (24 h)			IVTDMD			IVTDMD		
	−PEG (mL/500 mg DM)	+PEG (mL/500 mg DM)	Incr† (%)	−PEG (%)	+PEG (%)	S	−PEG (%)	+PEG (%)	S
Acacia brevispica	60.4^{b}	66.6^{c}	10.3*	74.7^{c}	75.7^{c}	ns	74.4^{c}	75.2^{c}	ns
Acacia mellifera	65.0^{ab}	65.7^{c}	1.1^{ns}	65.7^{d}	66.2^{e}	ns	70.5^{d}	71.4^{d}	ns
Berchemia discolor	66.4^{a}	82.4^{a}	24.1**	74.7^{c}	71.6^{d}	*	74.5^{c}	71.2^{d}	*
Maerua angolensis	49.3^{c}	51.4^{d}	4.3^{ns}	85.8^{a}	84.0^{a}	ns	85.3^{a}	83.5^{a}	ns
Zizyphus mucronata	66.6^{a}	73.5^{b}	10.4*	79.2^{b}	79.6^{b}	ns	78.9^{b}	79.2^{b}	ns
SEM	2.0	3.1		1.8	1.7		1.4	1.4	

*$P < 0.05$; **$P < 0.01$. a,b,c,d,e Means with different superscripts in a column differ significantly ($P < 0.05$). †% increase = 100 × (+PEG gas volume (mL) − −PEG gas volume (mL))/−PEG gas volume (mL). DM, dry matter; Incr, Increase; IVTDMD, *In vitro* true dry matter degradability; IVTOMD, *In vitro* true organic matter degradability; ns, not significant ($P \geq 0.05$); PEG, polyethylene glycol; S, significance; SEM, standard error of the means.

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Table 4 Intakes of the browse foliages offered to goats and sheep

Species	Animals	
	Goats (g DM/$BW_{0.75}$/6 h)	Sheep (g DM/$BW_{0.75}$/6 h)
Acacia brevispica	15.1^{a}	12.8^{a}
Acacia mellifera	6.4^{b}	5.9^{bc}
Berchemia discolor	10.4^{ab}	9.2^{ab}
Maerua angolensis	1.6^{c}	1.9^{c}
Zizyphus mucronata	13.0^{a}	4.7^{bc}
SEM	12.9	11.1

^{a,b,c}Means with different superscripts in a column differ significantly ($P < 0.05$). BW, body weight; DM, dry matter; SEM, standard error of the means.

species for goats in ranking order from the greatest to the least was *A. brevispica, Z. mucronata, B. discolor, A. mellifera* and *M. angolensis*. The ranking order of the browse species by sheep was *A. brevispica, B. discolor, A. mellifera, Z. mucronata* and *M. angolensis*. Although the study did not aim to compare the intake between goats and sheep, the goats consumed numerically more of all the browse species except *M. angolensis*, which had similar consumption by goats and sheep.

Differences in palatability for the browse foliages used in this study were reflected in the differences in the DM intake of the tested foliages. Several factors may be behind these observations including plant and animal factors. The intake of forages is influenced by plant species, form of presentation, stage of maturity, methods of processing and chemical constituents of the fodder (Kalio *et al*. 2006). The level of antinutritional factors such as tannins may also affect the palatability of forages and hence preference by the animals. In this study, the highest DM intake was recorded for *A. brevispica* for both goats and sheep and least for *M. angolensis*. In the study conducted under similar conditions, Abdulrazak *et al*. (2001) also found *A. brevispica* to be more preferred by sheep than *Leucaena leucocephala* and other *Acacia* species. Despite *A. brevispica* having moderate tannin levels as *B. discolor* and higher than the rest of the species, high preference of *A. brevispica* was observed in the study. Marten (1978) reported that the relative palatability of any feed depends on the nature of the positive associative effect with the feeds on offer. It is therefore possible that the effect of tannins present in *A. brevispica* and *B. discolor* could have been masked by the ingestion of the other feeds. It has also been shown that the tannins in *A. brevispica* are not as biologically active as in other species (especially *B. discolor*) (Table 3).

The differences in intake of the browse foliages by the goats and sheep may also be partly due to the differences in DM contents of the foliages (Kaitho *et al*. 1996). *M. angolensis* had the lowest DM content, which may have resulted in its low preference. The foliage moisture might have influenced on the smell of the foliages. During feeding, *M. angolensis* had some smell that may have been due to high moisture content of the forage. This suggests that taste, smell or tactile feel of feed may relate the palatability or preference by animal (Ngwa *et al*. 2003). Since *M. angolensis* had high CP and low fiber content and high IVTDMD, the low preference by the animals might also be due to some specific metabolites that modulate animal satiety that may require further investigation. However, these differences in preference may alter depending on the adaptation of animals or large variation of their nutritional status through the year. This is because some browse species that are least preferred during periods when fodder availability is high could be relished during periods when available feeds are scarce. Therefore, having a variety of browse species in farming systems will ensure year-round availability of fodder for increased animal productivity.

The ranking order of preference for *A. brevispica* and *M. angolensis* was similar for goats and sheep (Table 4). The goats ate more of the browse foliages than the sheep did. Previous studies have also shown that goats often eat more of some browse species than do sheep (Kaitho *et al*. 1997; Rogosic *et al*. 2006). Howe *et al*. (1988) noted that goats may have mechanisms that attenuate the antinutritional effects of cell wall lignifications in their diets. However, when offered moderate- or good-quality forages, the goats and sheep do not differ in DM and OM digestibility, although the fiber digestibility of low quality forages is greater in goats than in sheep (Schmid *et al*. 1983; Doyle *et al*. 1984). Gordon and Illius (1992) also reported that goats appear to digest more extensively plants containing antinutritional substances (ANS), such as tannins, than sheep. These differences in utilization of ANS-containing browses may partly be a function of differential ruminal metabolism of ANS (Kronberg & Walker 1993) or biotransformation of the components post-absorption through the intestine. The goats are also known to secrete proline-rich protein in saliva, which has high affinity for tannins, hence, reducing astringency (Foley & McArthur 1994).

The influence of spinescent growth in some browse species on the feeding behavior of mammalian

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browsers has been reported (Ortega-Reyes & Provenza 1992). In this study, *A. brevispica* and *A. mellifera* have some spines but the spines did not appear to deter feeding. This suggests that the spines may have little influence in the preference of browse foliages.

From the results of chemical composition and *in vitro* rumen degradability, the browse foliages have nutritional potential as supplements to low-quality basal forages such as cereal crop residues and hay in the semiarid regions of Kenya. Though *M. angolensis* was least preferred, presence of variety of species may be important during periods of scarcity and severe feed shortages.

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