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Effects of Selected Legume Species and Forage Sorghum Hay Grown in Limpopo Province on Voluntary Intake and Relative Palatability Indices of Pedi Goats

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ABSTRACT

Available feeds for goats during the dry season are limiting in proteins and other nutrients and do not support good intake and growth. The study was conducted to determine intake and relative palatability indices of different legume species, when offered as supplements to Pedi goats fed a low quality of forage sorghum hay. The legume species included cowpea, lablab and mucuna hays. The experimental design was a completely randomized design, with feeds as treatments and individual animals as replicates. Pedi goats ate higher ($p<0.05$) amounts of mucuna than lablab, sorghum and cowpea hays. Pedi goats ate more ($p<0.05$) of lablab than sorghum and cowpea hays. Mucuna and lablab hays were highly preferred by Pedi goats than sorghum and cowpea hays. However, Pedi goats had similar ($p>0.05$) palatability indices for mucuna and lablab hays. Palatability indices were positively and significantly ($p<0.05$) predicted from dry matter intakes of goats ($r^2 = 0.98$). However, intake and palatability indices of the forages were poorly ($p>0.05$) predicted from their nutrient composition and tannin contents. Some forages high in condensed tannins, for example mucuna, gave higher intake and palatability indices. It is concluded that mucuna and lablab supplementations gave higher intake and palatability indices. These legumes can be utilised as protein supplements to goats feeding on low quality roughages.

Key words: Legume species, goats, intake, relative palatability, polyphenolics, rumen escape

INTRODUCTION

Tropical carbon-4 plants such as sorghum tend to accumulate large amounts of low quality dry matter. Thus, diets based on such grasses are limiting in readily degradable nutrients and must be supplemented with feeds rich in those limiting nutrients (Hove *et al*., 2001). Forage legumes can be utilized for such a purpose. A major problem in evaluating the intake of leguminous forages lies in the reasons for which an animal may refuse the food (Provenza *et al*., 2000). One such reason might be low palatability, which may be defined as the low pleasing or satisfying aspect of a feed. Phenolics, alkaloids, tannins and aromatic compounds are some of the chemical compounds known to reduce palatability and intake, irrespective of the nutritional value of the feed (Ngwa *et al*., 2003; Sandoval-Castro *et al*., 2005). However, flavour (taste and odour) can also be considered as the most important food que. The addition of aromatic extracts to straw pellets increased the preference for pellets on goat feeding prefences (De Rosa *et al*., 2002).

Legumes are high in nitrogen contents and hence have the potential to increase productivity of goats feeding on low quality roughages. However, a number of these legumes have high levels

of polyphenolic compounds, especially tannins (Waghorn, 2008). The effects of such compounds on palatability of tropical legumes have not been extensively studied. Elsewhere, tannins have been found to reduce palatability of leaves of *Acacia* species when fed to goats (Ngwa *et al*., 2003). Relationships between tannin contents and relative palatability indices are useful in predicting the feeding value of such legumes (Villalba *et al*., 2002).

Therefore, the objectives of this study were, (1) to determine relative palatability indices of Pedi goats offered forage sorghum hay (*Sorghum sudanense*), cowpea (*Vigna unguiculata*), lablab (*Lablab purpureus*) and mucuna (*Mucuna pruriens*) hays and (2) to determine associations between nutrient composition, intake and palatabiIity indices of goats offered forage sorghum hay, cowpea, lablab and mucuna hays grown in Limpopo province.

MATERIALS AND METHODS

This experiment was carried out at the University of Limpopo Experimental Farm in June, 2009. The ambient temperatures in winter (May to July) ranged between 5 and 28°C. Mean annual rainfall ranged between 446.8 and 468.44 mm. The vegetation varied from a dense, short bushveld to a rather tree savanna of mostly *Acacia* species called the mixed Bushveld. The herbaceous layer is dominated by grasses such as *Digitaria eriantha, Schmidtia pappophoroides* and various *Aristida* and *Eragrostis* species (Acocks and Momberg, 1988; Low and Rebelo, 1996).

Feeds: Forage sorghum, cowpea, lablab and mucuna were grown in the summer of 2009 in large plots of 50×50 m under irrigation at the University of Limpopo Experimental Farm. The legumes were harvested at the flowering stage while forage sorghum was cut at early grain filling stage. The forages were harvested using a mower and dried under the shade to minimize nutrient losses. After drying, the forages were chopped into 13 mm lengths, packed and then stored until feeding time.

Animals, housing and feeding: Pedi goats aged five months and weighing 18±2 kg^{-1} were used. The goats were housed in a roofed and half-walled shed. Four feeds, (forage sorghum, cowpea, lablab and mucuna) were used. The experimental design was a completely randomized design with feeds as treatments and individual animals as replicates. Each animal was provided with a feeding trough having four separate compartments to accommodate test feeds. The order of placement of feeds in the troughs was randomized every day to avoid habit reflex. The experiment was conducted for a total of 17 days, consisting of a 10-day period of adaptation to confinement feeding and diets followed by seven days of data collection. The goats were fed *ad libitum*, allowing a 15% refusal of each diet as suggested by Kaitho *et al*. (1996). Water and a mineral mixture (Table 1) were provided *ad libitum*. Daily samples of feed offered to the animals were pooled over the collection period and dried for chemical analysis. The feeds offered and feed refusals were weighed and recorded for each animal on a daily basis.

Chemical analysis: Dry matter (DM), organic matter (OM) and crude protein of feeds were determined using the methods of the AOAC (1990). The neutral detergent fibre (NDF), acid detergent fibre (ADF), of the meal samples were measured by the method of Van Soest (1994). Total polyphenols contents and extracted hydrolysable tannins were determined using the method used by Waterman and Mole (1994). Extracted condensed tannins were determined using the method of Porter *et al*. (1986).

Table 1: Nutritional composition of the mineral block offered to the experimental animals

Nutrient	Quantity
Calcium	48.0 g kg^{-1} max
Phosphorus	10.0 g kg^{-1} max
Sulphur	6.0 mg kg^{-1}
Magnesium	10 mg kg^{-1}
Manganese	100 mg kg^{-1}
Copper	25 mg kg^{-1}
Cobalt	0.30 mg kg^{-1}
Iron	208 mg kg^{-1}
Sodium	2.5 mg kg^{-1}
Zinc	100 mg kg^{-1}
Selenium	0.5 mg kg^{-1}
Vitamin A	12750 I.E kg^{-1}

Source: Kanhym feed company

Measurements, calculations and statistical analysis: A modification of the methods described by Ben Salem *et al.* (2005) and Kaitho *et al.* (1997) was adapted for the calculations. The intake of forage sorghum hay was used as the basis of comparing the intake and palatability of the other feeds. All calculations were done on dry matter basis.

Data on chemical composition and tannins contents were subjected to analysis of variance (SAS, 2008). Treatment means were compared using a Least Significant Difference (LSD) test at the 5% level of probability. General Linear Model procedures (GLM) of SAS (2008) were used to compare effects of feed type on feed intake and palatability indices of goats. Linear regression analysis was used to establish associations between chemical characteristics, palatability indices and intake.

RESULTS

Results of the nutrient composition of cowpea, lablab, mucuna and forage sorghum hays are presented in Table 2. All the legume species had higher ($p<0.05$) protein contents (18% and above) than sorghum hay (13%). Protein contents of the legumes ranged from 18%for mucuna hay to 22% for cowpea hay. Mucuna hay had the highest ($p<0.05$) condensed (0.40 = Condensed tannins as percentage DM luecocyanidin equivalent) and hydrolysable tannin contents (284.3 mg g^{-1}) than sorghum (111.1 mg g^{-1}), lablab (113.3 mg g^{-1}) and cowpea (81.3.3 mg g^{-1}). However, cowpea hay had lowest (0.05 mg g^{-1}) total polyphenolics, condensed tannins (0.03 = Condensed tannins as percentage DM luecocyanidin equivalent) and hydrolysable tannin ($p<0.05$) contents (81.3) than sorghum, lablab and mucuna hays. Lablab hay had higher ($p<0.05$) total polyphenolics (1.24 mg g^{-1}) than mucuna (0.35 mg g^{-1}), cowpea (0.05 mg g^{-1}) and sorghum (0.17) hays.

The effects of forage species on intake and palatability indices of goats are presented in Table 3. Mucuna hay was the most consumed by Pedi goats while cowpea hay was the least. Pedi goats ate similar ($p>0.05$) amounts of sorghum (58.9 g/goat/day) and cowpea (47.2 g/goat/day) hays. However, they ate higher ($p<0.05$) amounts of mucuna (398.4 g/goat/day) than lablab (278.3 g/goat/day), sorghum (58.9 g/goat/day) and cowpea (47.2 g/goat/day) hays. Similarly, Pedi goats ate more ($p<0.05$) of lablab (278.3 g/goat/day) than sorghum (58.9 g/goat/day) and cowpea (47.2 g/goat/day) hays. Pedi goats had the highest palatability indices for mucuna hay (3.6) and the lowest for cowpea hay (0.7). Pedi goats had similar ($p>0.05$) palatability indices for mucuna

Table 2: Nutrient composition of forage hays

	Treatment				
Variable	Cowpea	Lablab	Mucuna	Sorghum	SE
Dry matter (%)	90.00	93.00	94.00	94.00	2.10
Organic matter (%)	83.00^{c}	87.00^{b}	90.00^{a}	90.00^{a}	1.50
Crude protein (%)	22.00^{a}	19.00^{b}	18.00^{c}	13.00^{d}	0.00
Neutral detergent fibre (%)	38.00^{bc}	34.00^{c}	40.00^{b}	64.00^{a}	1.82
Acid detergent fibre (%)	32.00^{bc}	31.00^{c}	36.00^{b}	52.00^{a}	2.35
Condensed tannins*	0.03^{d}	0.05^{c}	0.40^{a}	0.06^{b}	0.00
Hydrolysable tannins (mg g^{-1})	81.30^{d}	113.30^{b}	284.30^{a}	111.10^{c}	1.30
Total polyphenols (mg g^{-1})	0.05^{d}	1.24^{a}	0.35^{b}	0.17^{c}	0.00

Means with different superscripts in the same row are significantly different ($p<0.05$), SE: Standard error, *: Condensed tannins as percentage DM luecocyanidin equivalent

Table 3: Dry matter intake of forage hays and palatability indices of male castrated Pedi goats

	Treatment				
Variable	Cowpea	Lablab	Mucuna	Sorghum	SE
Intake (g/goat/day)	47.2^{c}	278.3^{b}	398.4^{a}	58.9^{c}	51.693
Palatability indices	0.7^{c}	3.0^{ab}	3.6^{a}	1.0^{bc}	1.653

Means with different superscripts in the same row are significantly different ($p<0.05$), SE: Standard error

Table 4: Prediction of intake (DMI) and palatability indices (Pi) of Pedi goats offered cowpea, lablab, mucuna and forage sorghum hays from intake, crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), condensed tannins (CT), hydrolysable tannins (HT) and total polyphenol (TP) contents

Factor	Formulae	Y-variable	r^{2}	P
DM (%)	Y = -5908.55240+66.14566	DMI	0.36	0.398
OM (%)	Y = -1553.48664+20.03995	DMI	0.15	0.610
CP (%)	Y = 110.62316+4.69389	DMI	0.013	0.888
NDF (%)	Y = 398.09952+-4.96686	DMI	0.20	0.548
ADF (%)	Y = 614.85667+-10.22333	DMI	0.21	0.539
CT*	Y = 89.55260+776.40725	DMI	0.63	0.209
HT (mg/g)	Y = -29.97147+1.53503	DMI	0.66	0.187
TP (mg/g)	Y = 121.60061+163.48458	DMI	0.26	0.488
DMI (g/goat/day)	Y = 0.44902+0.00831	Pi	0.98	0.009
DM (%)	Y = -51.52009+0.58076	Pi	0.40	0.369
OM (%)	Y = -13.11807+0.17406	Pi	0.16	0.595
CP (%)	Y = 1.61875+0.02517	Pi	0.01	0.928
AF (%)	Y = 3.69585+-0.3978	Pi	0.19	0.568
ADF (%)	Y = 5.65111+-0.08722	Pi	0.22	0.531
CT*	Y = 1.27041+5.80932	Pi	0.51	0.284
HT (mg g^{-1})	Y = 0.29837+0.01197	Pi	0.58	0.237
TP (mg g^{-1})	Y = 1.33260+1.63795	Pi	0.37	0.389

r^{2}: Regression co-efficient, P: Probability, *: CT as percentage DM luecocyanidin equivalent

(3.6) and lablab (3.0) hays. However, palatability indices for mucuna (3.6) and lablab hays (3.0) were higher ($p<0.05$) than those for cowpea hay (0.7). Goats had similar ($p>0.05$) palatability indices for lablab (3.0) and sorghum (1.0) hays. Series of linear regression equations that predict

dry matter intake and palatability indices of goats from nutrient composition and dry matter intake of the three legumes and sorghum hay fed to Pedi goats are given in Table 4. Palatability indices were positively and significantly ($p<0.05$) predicted from dry matter intakes of goats ($r^2 = 0.98$). However, there were poor and non-significant ($p>0.05$) relationships between nutrient contents of the forages and their intake and palatability indices by goats.

DISCUSSION

Legume hays had higher protein contents and lower fibre contents than sorghum hay. However, the preference rankings for the evaluated forages produced the following order: mucuna>lablab>sorghum>cowpea, respectively. The high intake and palatability indices of mucuna and lablab hays by goats suggest that these legumes can be utilised as protein supplements to goats feeding on low quality roughages.

Legumes, mucuna hay in particular, had markedly higher polyphenolic compounds. Polyphenolic compounds especially tannins, tend to reduce intake, digestibility and palatability of a feed (Makkar *et al*., 1993). However, in the present study, mucuna hay had the highest amounts of both condensed tannins and hydrolysable tannins but it was consumed in larger amounts than the other forages. Nunez-Hernandez *et al*. (1989) reported similar results where *Juniperus monosperma*, a diet high in phenolic/tannin compounds, fed to Angora goats resulted in a higher dry matter intake than an alfalfa diet low in phenolic/tannin compounds. In contrast, Villalba *et al*. (2002) found that tannins enhanced intake of feed high in energy at lower doses and they depressed its ingestion at higher doses. At higher doses tannins reduce intake as a result of astringency. Astringency, the sensation caused by the formation of complexes between tannins and salivary glycoproteins, may increase salivation and decrease palatability. It has been suggested that, depending on the chemical structure and concentration, condensed tannins can also have beneficial effects on the nutrition and health of ruminants (Min *et al*., 2003). Rumen escape, urea recycling and microbial efficiency are mechanisms by which tannins in forage legumes may increase the efficiency of protein utilization by ruminants (Reed *et al*., 1990).

Palatability indices were positively and significantly predicted from dry matter intakes of goats. Ikhimioya (2008) reported similar results where relative palatability indices were positively and significantly correlated with daily intake. This is in line with the assertions made by Marten (1970) and Arnold (1970) that palatability influences voluntary intake.

There were poor relationships between nutrient composition and intake and palatability indices for goats. Forages high in protein, for example cowpea, gave lower palatability indices and intake values. These findings are similar to those of Kaitho *et al*. (1997) who observed poor relationships between palatability indices of goats and chemical constituents of forages. However, Alonso-Diaz *et al*. (2008) reported negative correlations between dry matter intakes by goats fed *Lysiloma latisiliquum*, *Acacia pennatula*, *Piscidia piscipula* and *Brosimum alicastrum* and condensed tannins and total tannins. Phenolics, alkaloids, tannins and aromatic compounds tend to alter palatability and intake, irrespective of the nutritional value of the feed (Ngwa *et al*., 2003). Ikhimioya (2008) also reported poor relationships between relative palatability indices in goats and fibre contents of leaves of *Afzelia africana*, *Bambusa vulgaris*, *Chromolaena odorata*, *Mangifera indica* and *Newbouldia laevis*. This is consistent with the results of Hadjigeorgiou *et al*. (2003) who reported, for sheep and goats, poor relationships between forage preference rankings with their fibre characteristics. In contrast, Alonso-Diaz *et al*. (2009) reported that neutral detergent fibre was

a better predictor of intake than polyphenolic compounds. The probable reason is that neutral detergent fibre is digestible compared to acid detergent fibre which is not digestible.

CONCLUSIONS

The results of this study suggest that cowpea, lablab and mucuna legumes are a valuable source of protein for Pedi goats. Lablab and mucuna legumes had higher intake and palatability indices, suggesting that these legumes can be utilised as protein supplements to goats feeding on low quality roughages. There were poor relationships between nutrient composition and intake and palatability, hence nutrient content is an unreliable predictor of intake and palatability. Some forages high in condensed tannins, for example, mucuna, gave higher intake and palatability indices. The reasons for this are not clear and hence, there is need to do more studies on the subject.

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