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Nutrient Composition and Tannin Contents of Forage Sorghum, Cowpea, Lablab and Mucuna Hays Grown in Limpopo Province of South Africa

T. Gwanzura, J.W. Ng'ambi and D. Norris
Department of Animal Production, University of Limpopo, P/Bag X1106, Sovenga, 0727, South Africa

Corresponding Author: T. Gwanzura, Department of Animal Production, University of Limpopo, P/Bag X1106, Sovenga, 0727, South Africa

ABSTRACT

The nutrient composition and tannin contents of forage sorghum (*Sorghum sudanese*), cowpea (*Vigna unguiculata*), lablab (*Lablab purpureus*) and mucuna (*Mucuna pruriens*) were determined by chemical methods. The experimental design was a completely randomised design with four treatments: forage sorghum, cowpea, lablab and mucuna hays. All the legume species had higher ($p<0.05$) protein contents than sorghum hay, ranging from 18-22%. Within the legume species, cowpea hay had higher ($p<0.05$) protein content than lablab and mucuna hays. Similarly, lablab hay had higher ($p<0.05$) protein content than mucuna hay. Sorghum hay had higher ($p<0.05$) NDF and ADF values than the legume species. Mucuna hay had higher ($p<0.05$) concentrations of both condensed tannins and hydrolysable tannins than cowpea, lablab and sorghum hays, while lablab hay had the highest ($p<0.05$) concentrations of total polyphenols. Among the legume species, mucuna hay had higher ($p<0.05$) NDF and ADF values than lablab hay, while those of cowpea and lablab hays were similar ($p>0.05$). Legumes have the potential of being utilised as protein supplements for ruminants on low quality roughages. However, tannins in legumes may have both negative and positive effects on diet intake, digestibility and palatability. There is, therefore, need to evaluate these legumes when used as protein supplements for ruminants on a basal diet of sorghum hay.

Key words: Legume species, nutrient composition, protein, condensed tannins, hydrolysable tannins, total polyphenols

INTRODUCTION

Sorghum, a C_4 species, is widely grown in Limpopo province where rainfall is erratic and drought is common. C4 grasses accumulate large amounts of low quality dry matter (Akin, 1989). Low sorghum stover crude protein values of 6.4 and 3.3% were reported by Mosimanyana and Kiflewahid (1987) and Savadogo *et al.* (2000), respectively. Jilani *et al.* (2001) also reported a low crude protein value of 5%. However, higher values have been reported elsewhere (Kanani *et al.*, 2006). Legume species such as mucuna (*Mucuna pruriens*), lablab (*Lablab purpureus*) and cowpeas (*Vigna unguiculata*) have high nitrogen contents and low fibre contents. Crude protein values of 17.9, 16.8 and 19.1% for lablab, mucuna and cowpeas, respectively, have been reported (Murphy *et al.*, 1999; Mupangwa *et al.*, 2002; Hess *et al.*, 2008). These legumes have, therefore, the potential to improve productivity of ruminants fed low quality

roughages. However, a number of these forages contain tannins which may reduce their feeding values when fed to ruminant animals (Reed, 1995). Tannins may, also, interfere with the concept of high protein and low fibre contents as indicators of high feeding values (Woodward and Reed, 1989). Extensive and conclusive evaluation of different tannin contents and other polyphenols of forage sorghum, cowpea, lablab and mucuna are not available. Such data would be very helpful in establishing relationships between forage tannin contents and their feeding values when fed to ruminants. The objective of this study was, therefore, to determine nutrient composition and tannin contents of forage sorghum, cowpea, lablab and mucuna hays grown in Limpopo province.

MATERIALS AND METHODS

This experiment was done at the University of Limpopo in 2009. Forage sorghum, cowpea, lablab and mucuna hays were grown in summer of 2009 at the University of Limpopo Experimental Farm. The forages were harvested using a sickle and dried under the shade to minimize nutrient losses (Minson, 1990). After drying, the forages were passed through a hammer mill (12.7 mm sieve). Samples for nutrient analysis were ground to pass a 1 mm sieve. Samples for tannin analysis were further ground to pass through a 0.2 mm sieve. Ground samples were stored individually in airtight containers until nutrient analysis. Duplicate samples of each treatment were analysed and the average was taken as the final result.

The experimental design was a completely randomised design with four treatments, each having four replications. The treatments were as follows:

Sorghum : Forage sorghum hay
Lablab : Lablab hay
Cowpea : Cowpea hay
Mucuna : Mucuna hay

Chemical contents analysed were organic matter, crude protein, acid detergent fibre, neutral detergent fibre, condensed tannins, hydrolysable tannins and total phenolics.

Chemical analysis: Dry Matter (DM) and Organic Matter (OM) of samples were determined according to the procedures of AOAC (2000). Acid Detergent Fibre (ADF) and Neutral Detergent Fibre (NDF) were measured by the method of Van Soest *et al.* (1991) and nitrogen content by the Kjeldahl method AOAC (2000). Samples were also analysed for total polyphenolic contents and extracted hydrolysable tannins according to the procedures of Hagerman and Butler (1991) and Waterman and Mole (1994). Extracted condensed tannins were determined using the method described by Porter *et al.* (1985). Four samples per replicate were used.

Statistical analysis: All data on DM, OM, Crude Protein (CP), ADF, NDF, Condensed Tannins (CT), Hydrolysable Tannins (HT) and Total Phenolics (TP) of were subjected to GLM procedures of SAS (2008) to detect treatment effects. Treatment means were compared using a Least Significant Difference (LSD) test at the 5% level of probability.

RESULTS

Results of the nutrient composition of cowpea, lablab, mucuna and forage sorghum hays are presented in Table 1. All the legume species had higher ($p<0.05$) protein contents (18% and above)

Table 1: Nutrient composition of forage hays

	Treatment				
Variable (%)	Cowpea	Lablab	Mucuna	Sorghum	SE
Dry matter	90	93	94	94	2.10
Organic matter	83^{c}	87^{b}	90^{a}	90^{a}	1.50
Crude protein	22^{a}	19^{b}	18^{c}	13^{d}	0.00
Neutral detergent fibre	38^{bc}	34^{c}	40^{b}	64^{a}	1.82
Acid detergent fibre	32^{bc}	31^{c}	36^{b}	52^{a}	2.35
Condensed tannins*	0.03^{d}	0.05^{c}	0.40^{a}	0.06^{b}	0.00
Hydrolysable tannins (mg g^{-1})	81.3^{d}	113.3^{b}	284.3^{a}	111.1^{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 at $p<0.05$, SE: Standard error, *Condensed tannins were determined as percentage of DM luecocyanidin equivalent, Four samples per replicate were used

than sorghum hay (13%). Protein contents of the legumes ranged from 18% for mucuna hay to 22% for cowpea hay. Among the legume species, cowpea hay had higher ($p<0.05$) protein content (22%) than lablab (19%) and mucuna hays (18%). Similarly, lablab hay had higher ($p<0.05$) protein content (19%) than mucuna hay (18%). Sorghum hay had higher ($p<0.05$) NDF (64%) and ADF (52%) values than the legume species. Among the legume species, mucuna hay had higher ($p<0.05$) NDF (40%) and ADF (36%) values than lablab hay (34, 31%), while those of cowpea (38, 32%) and lablab hays were similar ($p>0.05$). 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 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 mg g^{-1}) 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 mg g^{-1}) hays.

All the legume species had higher ($p<0.05$) protein contents than sorghum hay. Among the legume species, cowpea hay had higher ($p<0.05$) protein content than lablab and mucuna hays. Similarly, lablab hay had higher ($p<0.05$) protein content than mucuna hay. Sorghum hay had higher ($p<0.05$) NDF and ADF values than the legume species. Among the legume species, mucuna hay had higher ($p<0.05$) NDF and ADF values than lablab hay, while those of cowpea and lablab hays were similar ($p>0.05$). Compared to other hays, mucuna hay had higher ($p<0.05$) concentrations of both condensed tannins and hydrolysable tannins. Lablab hay had the highest ($p<0.05$) concentrations of total polyphenols followed by mucuna, sorghum and cowpea hays.

DISCUSSION

Forage sorghum hay contained higher NDF and ADF values than the legume species. Black *et al.* (1980) observed similar results in sorghum. The authors observed high values of neutral detergent fibre and acid detergent fibre of 69 and 36%, respectively at bloom stage of development. C4 grass leaves develop a lignified midrib to provide mechanical support which contributes to the high fibre concentration in grass leaf blades. In stems, structural changes occur as it matures resulting in a thick cuticle and lignified epidermis and a solid ring of thick-walled, lignified vascular, sclerenchyma and parenchyma cells in the ring (Wilson, 1993). C4

grasses, such as sorghum, have fewer mesophyll cells and a high proportion of lignified vascular tissues than C3 plants. Since mesophyll cells are comparatively unlignified and highly digestible, their proportion influences quality of the grass (Akin, 1989).

Legume hays had higher CP contents than sorghum hay. Cowpea hay had higher crude protein contents than those of lablab and mucuna. Similar results were reported by Jilani *et al.* (2001), where cowpea had the highest crude protein contents when four summer forage legumes were compared. Forage sorghum with a value of 13% had the least crude protein content. Bressani (1985) and Nielsen *et al.* (1997) observed high crude protein contents of cowpea, ranging from 22-30% in the leaves and grain. The crude protein value of lablab, 19%, was similar to those reported by Mosimanyana and Kiflewahid (1987), Abule *et al.* (1995), Ahmad *et al.* (2000) and Murphy (1998). Aganga and Kgwatalala (2005) reported a medium crude protein value of lablab of 16.4%. However, Murphy *et al.* (1999) and Odunsi (2003) reported higher lablab CP values ranging from 21.4-30.3 and 23%, respectively. In contrast, Makembe and Ndlovu (1996) reported a lower whole plant lablab CP value of 12.2%. In the present study, mucuna had a crude protein value of 18%. Lower mucuna CP values of 16.8 and 16% have been reported by Mupangwa *et al.* (2002) and Chikagwa-Malunga *et al.* (2009), respectively. Higher crude protein values for mucuna have been reported. For example, Adjorlolo *et al.* (2001) reported a crude protein level of 20%. The high CP values in the legumes used in the present study may indicate that these forages can be used as protein supplements for goats feeding on low quality roughages.

Mucuna hay had the highest concentrations of both condensed tannins and hydrolysable tannins. This is similar to the findings of Chikagwa-Malunga *et al.* (2009), who reported high concentrations of total tannins in whole plants at 123 days after planting. Lablab hay had the highest concentrations of total polyphenols. Mokoboki (2007) also reported high values of total polyphenols and extracted condensed tannins in lablab hay. In a study to determine fibre-bound condensed tannins in fodder trees and forages used in ruminant feeding, *Acacia robusta* and lablab had similar amounts of fibre-bound tannins (Phale and Madibela, 2006). Cowpea hay had the least contents of condensed tannins, hydrolysable tannins and total polyphenols. Tannins act as chemical defence mechanisms in plants against pathogens, herbivores and hostile environmental conditions; thus, they can exert detrimental effects in multitude of ways (Clausen *et al.*, 1990). Tannins depress food intake, complex with dietary proteins and other dietary components, resulting in a drain on the nitrogen supply to the animal (Fahey and Jung, 1989). Tannins are strongly astringent and the astringency is the major cause of reduced intake (Reed, 1995). Tannins may also bind to proteins in the mouth, reducing the palatability of the feed and hence potentially decreasing intake. When tannins complex with proteins in the animal's gut, they are believed to be responsible not only for growth depression but also for low protein digestibility and increased faecal nitrogen concentrations (Barry *et al.*, 1984; Fahey and Jung, 1989). However, tannins in forage legumes may also have positive effects on feeding values (Mueller-Harvey and McAllan, 1992; Reed, 1995). The neutral pH of the rumen facilitates the formation of tannin-protein complexes (Hagerman and Butler, 1991). These effects can be beneficial to ruminants as inhibition of protein degradation protects protein from microbial enzymes. The neutral pH may also reduce the occurrence of bloat and thus, potentially, increasing the availability of protein for digestion in the lower gut upon appropriate change in pH (McArthur *et al.*, 1992).

CONCLUSIONS

Cowpea, lablab and mucuna hays had high protein contents. This means that the legumes have the potential of being utilised as protein supplements for ruminants on low quality roughages. Mucuna hay had higher concentrations of both condensed tannins and hydrolysable tannins than cowpea, lablab and sorghum hays, while lablab hay had the highest concentrations of total polyphenols. These tannins may have both negative and positive effects on diet intake, digestibility and palatability. There is, therefore, need to evaluate these legumes when used as protein supplements for Pedi goats on a basal diet of sorghum hay.

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