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Nutritive value of some selected indigenous livestock browse species in the drylands of Southern Province, Zambia

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Abstract

Indigenous browse is an important source of quality nutrition of grazing animals in the dry season in arid and semi-arid regions. This study investigated the nutritive values of four important browse species in dry region of southern Zambia. Samples of fresh leaves were collected during the dry season (September to November). The frequency and the density of the browse trees in the grazing area was measured. Crude protein were similar for Julbernadia globiflora and Brachystegia spiciformis (11.70±0.14 and 11.42±0.31 respectively) but were higher than for Dichrostachys cinerea and Piliostigma thonningii (p<0.05). Crude fibre was found to be lowest in Dichrostachys cinerea with 18.16±0.16% which also contained the highest amount of tannins with 4.10±0.06% (p<0.05). Piliostigma thonningii had the highest levels of calcium of 1.76±0.03% and Dichrostachys cinerea had the least amount with 1.35±0.18% (p<0.05).The leaves of Brachystegia spiciformis had the highest digestibility of 67.95±0.85%, followed by Dichrostachys cinerea with 66.03±1.95%, Julbernadia globiflora with 49.47±1.06%, and Piliostigma thonningii with 24.82±2.62% (p<0.05). Overall, the browse species assessed are abundant and have a good potential to supply nutritious and fairly digestible feeds suitable for ruminant feeding in the dry season.

Key words: Crude fibre, in vitro dry matter digestibility, tannins

I. Introduction

Ruminant production in Zambia and in most parts of Africa is constrained by the poor quality of feed consumed by the animals especially in the dry season. The alternating relatively long-dry and short-rainy seasons has a major influence on the productivity and quality of rangeland. Sustainability of these production systems has been facing a lot of challenges in especially with reference to availability of adequate animal feed resources (Chibinga et al, 2012). This is because these animals depend on fibrous crop-residues and natural pasture which are usually in short supply and of low nutritive value especially in the dry season and during periods of drought. Inadequate nutrition in the dry season often results in reduced productive and reproductive performance of livestock which culminate in substantial economic losses to the farmers (Simbaya, 1998). Herders are facing new challenges to secure their livelihoods, and, in this context, fodder trees and shrubs are emerging as key resources, allowing herds to subsist up to the end of the dry season (Gautier et al, 2005; Ouédraogo-Koné *et al., 2006).*

Browse, or the available parts of the tree or shrub plant such as leaves, twigs, flowers, fruits or pods is an important fodder resource for ruminant livestock in semi arid rangelands (Ndambe et al 2014). Browse species are higher in protein and some mineral and they also offer a very stable feed reserve compared to grass (Chileshe 2002**).** Browse trees are also in general deep-rooted, resistant to drought, have a long life, act as windbreaks, have low demands on maintenance and can conserve soil moisture (Humphreys, 1994*).* It can also be noted that browse presents an inexpensive locally produced protein source for ruminants that can correct the nitrogen shortfall in herbaceous vegetation in the dry season (Le Houeron 1978: Van 2006).

Information on vegetation of grazing lands is critical to our understanding of livestock production and our ability to manage both animal and plant resources to optimize the productivity of grazing lands. To most effectively manage vegetation and grazing animals for livestock production

with care to avoid overuse and destruction of natural resources, we need information concerning nutrition. Measurements or estimations of vegetation characteristics, such as weight, cover, density, and nutritional value and of foraging behaviour are vital to achieve this knowledge. (Ben Salem et al. 2005).

For most of the fodder trees and shrubs identified in dry tropical Africa, knowledge of browse production and chemical composition is still insufficient. Overcoming this constraint would ensure maximization of the use of this fodder by livestock. It is therefore important to measure the chemical composition of the browse trees and to carry out *in-vitro* digestibility studies in order to determine the level of usefulness and effectiveness of the selected browse species as feed for animals in extreme weather conditions

This study was conducted to determine the nutritive value of selected browse species in order add the existing pool of knowledge and provide a baseline for further research on the same browse species in Zambia and in other similar environments.

II. Materials and Methods

Study Site

The study was conducted in grazing lands of Choma District (Mochipapa area) in Southern Province, Zambia. Choma is situated at 16.82^{o} South latitude, 26.98^{o} East longitude and 1325 meters elevation above sea level. It covers an area of about 7, 296 square kilometers of land. It is found on high ground with typical climate of southern Zambia of temperatures of between 14^{o}C and 28^{o}C. The rainfall pattern is from October-November to March-April with mean annual rainfall about 800mm of which 369mm falls between January and February. Agriculture is the main economic activity with approximately 180 commercial farmers, 150 emergent farmers and approximately 23, 206 small scale farmers who are involved in production of cash crops or rearing of livestock (Choma municipal council, 2013).

Vegetative field sampling was done at plot levels. 10 x 10 meters fifty (50) plots were established at 1 km intervals along a transect to quantify species density and frequecy. The density was estimated as described by Cook and Stubbendiek (1986). Species Frequency was measured as applied by Abercombie *et al* (1980) based on percentage of occurrence of individual plant species in relation to the total number of observation points.

Nutritional Analysis

The chemical composition of the leaves collected was determined by use of proximate analysis were the following parameters were analyzed: Dry matter (DM %) using Official Methods of Analysis, AOAC (1990); crude protein (CP %) using the Kjeldahl method; Ether Extract (EE %) using AOAC official methods 920.39; Crude fibre (CF %) using AOAC official methods 962.09; Neutral Detergent fibre (NDF %), Acid detergent fibre (ADF %), Lignin (%), Cellulose (%), Hemicellulose (%), total tannins, Ash (%) and key minerals such as Calcium (Ca %) using permanganate method; and Phosphorus (P%) using Vanodo-molybdate method.

In vitro dry matter digestibility (IVDMD) of the leaves was determined following the methods of Tilley and Terry (1963), by incubating in a thermostatically controlled water circulating bath.
The data was subjected to Analysis of Variance (ANOVA) using Minitab reference manual version 16.

III. Results and Discussion

Distribution of the browse species

The frequency of the browses species in the grazing area was found to highest in *Julbernardia globiflora* (63%) and lowest in *Dichrostachys cinerea* (16%). Only *Julbernardia globiflora* and *Brachystegia spiciformis* had frequency above 50%. The density of the browse species was highest in *Julbernardia globiflora* (1760 trees per hectare) and lowest in *Dichrostachys cinerea* (33 tress per

hectare). The dominance of *Julbernardia globiflora* and *Brachystegia spiciformis* in the grazing area could be due to ecological preference. These browse species are usually dominant in drier areas of deciduous woodland where there is less competition with other trees species which are not suitable to long dry seasons. FAO (1998) indicated that Miombo woodland in Zambia is dominated by trees species such as *Brachystegia, Julbernardia* and *Isoberlinia*. The implication is that there is more fodder availability from the species *Julbernadia globiflora* and *Brachystegia spiciformis* as they were both dominant and have better quality browse with the Crude Protein in these two species being higher than 10% compared to the other two species whose CP is lower than 10%.

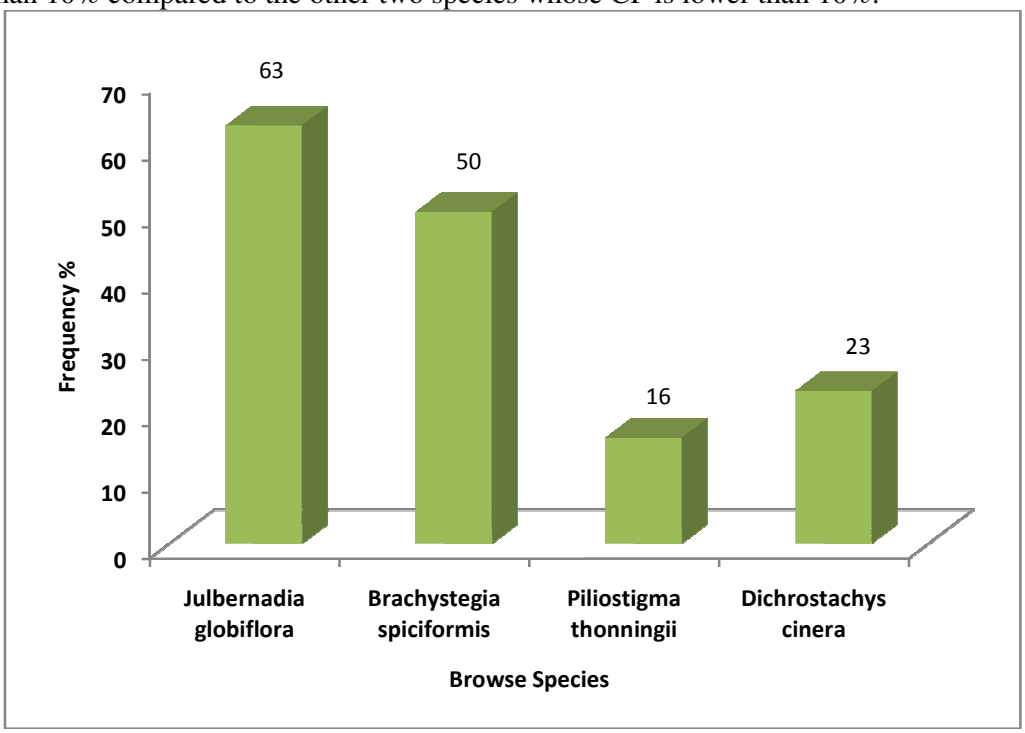

Figure 1. *Mean f*requency of occurrence (%) if the browse species

Table 1. Density of the species

	Species	Density (trees/ha)
1	*Julbernardia globiflora*	1760
2	*Brachystegia spiciformis*	396
3	*Dichrostachys cinerea*	66
4	*Piliostigma thonningii*	33

Chemical Composition

Crude Protein

The crude protein content ranged from 7.63% in *Dichrostachy cinera* to 11.70% in *Julbernadium globiflora.* According to APRU (1980), mature cattle require 7.8% CP for maintenance and 10% for growing beef cattle. (Kearl 1982) indicated a range of 11-13% CP to be adequate for maintenance and growth requirements of goats and sheep. All the species except *Dichrostachy cinera* had CP content higher than the required amounts for maintenance and growth. Boitumelu (2000) indicated that browse may be used alone or as supplements to other feeds because that have higher protein content as compared to mature grasses with a protein content of 3-10% or hay with Crude protein of less than 5%.

Mineral Composition

The contents of macro-mineral (Ca and P) in selected browse species from Choma rangelands are presented in the Table 2. The concentration of Calcium (Ca) among the browse species ranged from 1.35-1.76% with mean value of 1.53%. The highest value was noted in *Piliostigma thonningii* (1.76%) and the lowest in *Dichrostachy cinera* (1.35%). The concentration of Phosphorus (P) among the browse species ranged from 0.12-0.24% with mean value of 0.18 %. The highest value was noted in *Julbernadia globiflora* (0.24 %) and the lowest in *Brachyastegia spiciformis* (0.12%). According to National Research Council cited by Abdullah et al (2013), the recommended range on mineral nutrients for all classes of ruminants are 0.19-0.82% Ca and 0.12-0.48 % P. the Ca recorded in all the browse species exceeds the recommended range while the amount of P was within the recommended range. The results on P levels are in contrast to Inam-ur-Rahim (1999), Akhtar et al. (2007) and Sultan et al. (2009) who has observed P deficiency in various forages.

Table 2. Chemical composition (%) and in-vitro digestibility of browse tree leaves

Parameter	*Dichrostachys cinera*	*Julbernadia globiflora*	*Piliostigma thonningii*	*Brachystegia spiciformis*
Dry matter	93.36±0.12^{c}	94.52±0.18^{a}	93.25±0.04^{c}	93.77±0.01^{b}
Crude protein	7.63±0.77^{b}	11.70±0.14^{a}	8.58±0.07^{b}	11.42±0.31^{a}
Ether extract	2.92±0.68	5.05±1.48	5.05±0.92	4.88±0.53
Crude fibre	18.16±0.16^{d}	33.24±0.04^{a}	28.03±0.07^{b}	27.56±0.14^{c}
ADF	20.30±2.91^{a}	22.31±3.66^{a}	17.06±4.31^{b}	15.33±3.45^{b}
NDF	33.74±2.66	32.38±5.39	40.64±8.66	28.27±1.78
Lignin	18.19±2.68^{a}	14.94±1.69^{a}	12.93±3.34^{b}	9.42±2.47^{b}
Hemicellulose	17.48±4.65^{b}	17.43±1.84^{b}	23.58±4.36^{a}	12.93±2.64^{b}
Cellulose	2.11±1.68^{c}	7.37±1.97^{a}	4.14±1.24^{b}	5.91±2.87^{b}
Ash	6.66±0.20^{a}	4.63±0.10^{c}	5.93±0.09^{b}	4.43±0.11^{c}
Calcium	1.35±0.18^{b}	1.47±0.14^{ab}	1.76±0.03^{a}	1.53±0.06^{ab}
Phosphorus	0.15±0.03^{bc}	0.24±0.04^{a}	0.19±0.02^{ab}	0.12±0.01^{c}
IVDMD	66.03±1.95^{a}	49.47±1.06^{d}	24.82±2.62^{c}	67.95±0.85^{a}
Tannins	4.10±0.06^{a}	2.28±0.11^{b}	0.11±0.06^{c}	1.46±0.02^{b}

Figures with a different superscript are significantly different ($p<0.05$)

Digestibility

In-Vitro dry matter digestibility was found to be highest in *Brachystegia spiciformis* (67.95%) and lowest in *Piliostigma thonningii* (24.82%). This range is in agreement with Skarpe and Bergstrom (1986) working in Botswana with Kalahari woody species who found a range of 38 to 78%. Similar findings were reported by McKay and Frandsen (1969) and Walker (1980). Digestibility is a major determinant of nutritive value of a feedstuff (Holeck et al 1982). The higher the digestibility the better the nutrition level of feedstuff. Generally as the crude protein level increases, so does the digestibility of the leaves. Higher levels of CP result in increased ruminal ammonia N concentration which in turn enhances microbial activity and growth resulting in greater DM digestibility (Griswold et el 2003).

Crude fiber

The crude fiber content ranged from 18.16 % in *Dichrostachy cinera* to 33.24% in *Julbernadia globiflora.* The NDF content ranged from 28.27% in *Brachystegia spiciformis* to 40.64% in *Piliostigma thonningii* whilst that of ADF ranged from 15.33 in *Brachystegia spiciformis* to 22.31% in *Julbernadia globiflora*. The amount of NDF and ADF in browse plants, are the major determinants of forage quality. Both NDF and ADF have a negative correlation to the digestibility.

Tannins

The analysis of the anti-nutritional factors (tannins), indicated that *Dichrostachys cinerea* had the highest amount of tannins (4.10%) and the lowest was found in *Piliostigma thonningii* (0.11%). A concentration of tannin of 5% and above have been reported to cause rejection of browses by goats and wild browsers (Cooper and Owen-Smith 1985). In sheep and cattle, dietary tannin levels of 2% and 5% respectively have also been reported to have negative effects on digestibility (Mcleod 1974). Low intake and digestibility of browse may have some connection with the deleterious substances that it may contain such as cyanogenic glucosides, or tannins which may considerably reduce their nutritive value or even be toxic to animal. However, toxicity depends upon the concentration of the deleterious compound in the fodder and the rate at which the forage is eaten. An amount of the plant eaten quickly, say in one hour, could be fatal, whereas the same amount of plant material eaten slowly over, for example, a five hour period, would be harmless (Storrs, 1982). Tannins are not always harmful unless they are consumed in high levels (Yami 2011). On the range, the chances of animals getting poisoned are remote because they actually eat a combination of species and browse slowly, particularly when the plant is armed with defensive structures such as hairs and thorns.

IV. Conclusion

The browse species analysed in this study are abundant and have good levels of nutrients and they can be used as a good source of feeds for livestock in the dry season when the availability of quality feed is very low. Feeding trials using ruminants are should be done in order to fully ascertain the nutritional values of these browses.

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