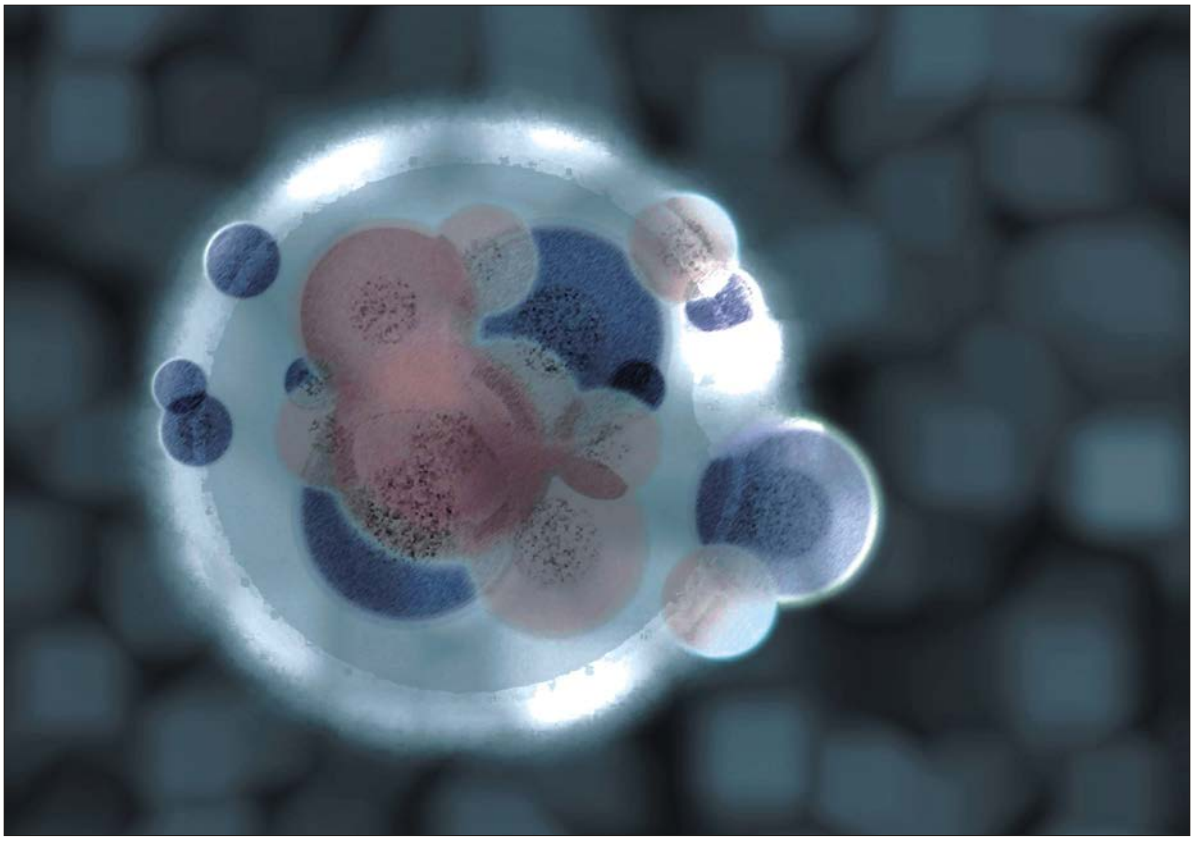

Journal of Biological Sciences

ISSN 1727-3048

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Journal of Biological Sciences 5 (4): 506-510, 2005
ISSN 1727-3048

Forage Value of Browses and its Implication to Traditional Management of Goats in Kgatleng District of Botswana

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Abstract: Browse species were analysed to determine their forage value to goats in Kgatleng district of Botswana. The plants were analysed for Crude Protein (CP), Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), ash, dry matter and condensed tannins. Most of the plants have CP content around 8% in the dry season. Ash ranged from 3.25-9.58% and the tannin content of 1.03-2.98%. Goats under traditional management depend mostly on browses especially in the dry season. There is no supplementary feed provided by the majority of the farmers. This study recommends the provision of supplementary feeds in the dry season for grazing goats.

Key words: Browse, nutrient composition, goats, Botswana

INTRODUCTION

Traditionally in Botswana goats are kept under the extensive management system, that is where the animals are left to graze freely on the range. Indigenous browsable species play an important role in the survival of goats under traditional management. Browsable trees are highly nutritious and contribute substantially to the diet of livestock in the communal areas[1].

Goats are able to select the most nutritious plants and parts of plants and they obtain reasonably balanced diet throughout the year. They have an advantage of having mobile lower lips so they are able to avoid the thorns and browse on the leaves. Therefore it is rare to see traditionally (extensively) raised goat in poor conditions unless carrying capacity is exceeded. On the whole, animals feeding under extensive management system are limited by the quality of nutrients available from indigenous grass and shrub species.

During the critical dry periods, when grasses and forbs are dormant browse species supply green materials for grazing animals, thus being the main source of nutrients for non- supplemented herbivores. Additionally they are abundant and of a consistently higher quality than herbaceous plants during drought. Indigenous multipurpose species are known to farmers and are well adapted to the environment. They are important feed resources in traditional extensive systems in Botswana. Grass biomass and quality is low during the dry season; crude protein content dropping to as low as 30 g kg^{-1} of dry matter[2]. Many of the tree browse species have evolved in semi-arid regions alongside herbivorous animals and are often used as a buffer to overcome feed gaps that arise from seasonal fluctuations in other feed sources. During the rainy season or in times of drought, trees provide green forage rich in proteins and minerals, whereas most of the grasses in the tropics are deficient in minerals. Browse are better sources of protein than grass[3]. Shrubs and trees often retain high levels of nutrient during the dry season increasing with the first flush of new growth before the rains. In a study carried out[3] the protein content of browse species was less than that of lucerne but above 8% CP, below which it could be considered deficient[4]. In addition browse has relatively high total mineral content (ash). Calcium is not usually deficient in arid regions, range forages often contain high level of Ca in relation to P[4]. Ca:P ratio was quite high, ranging from 8:1 for *terminalia serecia* to 10:1 for *E. stumper* and *C. apiculatum*[3]. However, goats are known to be tolerant to high Ca:P ratios.

Goats ate a broad variable range of plants[5]. A broadly similar pattern was also seen in the driest time with browse predominating. The study also showed that in the dry summer of 1978 mostly grass was eaten. The principal reason being that trees had been over grazed and the browse line on the trees was above the reach of most goats. Browse was still the most preferred plant category.

Chemical composition of the plant species is of great importance in the intake and nutrient availability of the

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feedstuff. CP and NDF contents indicate the quality of the biomass; in general the quality increases as the CP content increases and/or NDF content decreases[6]. A lower level of cell wall content can result in higher intake of leafy material from browse, the cell wall (NDF) concentration in the diet having a high negative association with intake by ruminants. Plants with high NDF concentration occupy a large volume in the rumen, so limiting gut fill.

The dry matter intake of goats is a factor of primary importance, since it reflects the capacity for voluntary feed intake and voluntary feed intake is a basic limiting factor in feed utilization. Most browse species have the advantage of maintaining their greenness and nutritive value through out the dry season when grasses dry up and deteriorate both in quality and quantity. Tree fodder is generally richer in protein and minerals and is used as a dry season supplement to poor quality natural pasture and/or fibrous crop residues[7]. Therefore there is need to quantify the nutritive value of shrubs and trees consumed by goats, so that program of browse management for production can be developed.

MATERIALS AND METHODS

Study site: The study was carried out in the Kgatleng district of Botswana in a small village called Radiajana which is a rural village in south eastern Botswana at an altitude of 1000 m. Rainfall during the period of study (March 2001 to September 2001) was as follows; March, 56 mm; April, 30.7 mm; May, 79 mm; June, 10 mm; July, 0 mm and September, 0 mm. The vegetation of Kgatleng district is Acacia/Combretum tree Savanna. This is a continuation of the southern, central and Northern Kgalagadi tree bush Savanna, but on a heavier soil and higher precipitation belt than the adjacent Kgalagadi sands to the west. Among the common tree and shrub species are *Acacia tortillis, Acacia eurobescence, Acacia nilotica, Terminalia serecia* and *Combretum* species. The potential stocking rate for Kgatleng District is 3.1 ha Lsu^{-1}.

The study was carried out in two sites. Site one was in the Northern part of the village while site two was in the south. The two sites were about one and half kilometers apart. The vegetation in site one was dominated by the *Acacia* species. Other species studied were *Dichrostachys cineria, Boscia foetida, Grewia flava* and *Boscia albitrunca.*

Site two had more plant species and these include a number of *Acacia* species, *Terminalia serecia, Dichrostachys ceneria, Maytenus senegalensis, Boscia foetida, Combretum hereroens, Boscia albitrunca, Grewia flava, Peltophorum africanum* and *Ziziphus mucronata.*

Data collection: Free range goats in the two sites were observed to document which tree fodder plants were browsed and the plants were sampled for chemical composition. Hand clipped samples of browsable tree species were collected in the months of March to September 2001. This was followed by laboratory analysis for determination of Crude Protein (CP), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), Acid Detergent Lignin (ADL), Dry Matter content (DM), Organic Matter (OM), ash, micro- and macro- nutrients and condensed tannins.

Nutrient composition: The DM content was measured by drying the samples at 60°C for 72 h and ash was determined by difference after igniting the samples in a muffle furnace at 550°C for 6 h. NDF and ADF were determined[8]. CP was determined using the Kjeldahl equipment[9].Tannin extraction was done by Makkar[10].

RESULTS

Table 1-4 showed the DM content in percentage and the chemical composition of all browse species sampled in Kgatleng rangelands. The results were shown as averages for the two sites, since they were in the same village. The results were for the months of March, May, July and September in the year 2001. March and May constituted the wet season with the rainfall of 56 and 79 mm, respectively. July and September had rainfall of 0 mm each thus representing the dry season.

Table 5 shows the monthly trend of CP percentage with the highest value obtained in March for *Ziziphus mucronata* with 19.96%, followed by *Boscia albitunca* and *Acacia tortilis* in May with 19.73% each. NDF fiber was lowest in the wet season, with range of 27.34 to 36.60% in March and May, respectively. The highest values were in July and September with 69.7% for *Acacia robusta* and 63.68% for *Boscia foetida* (Table 6). Table 7 compared the percentage condensed tannins across the months of the wet season and the dry season. *Acacia nilotica* had the highest level in September at the value of 2.93%. The lowest value was 0.12% for *Peltoforum afrcanum* in March.

Ash content in the Table 1 and 2, was highest in May at the 8.78% for *Terminalia serecia* followed by *Ziziphus mucronata* with 8.546%. The lowest ash content was in

Table 1: Nutritive value of browse species collected from Kgatleng rangelands in March 2001

Species	DM	ADF	NDF	Ash	CP
Acacia erobescence	50.9	48.81±0.45	55.85±0.50	5.70±0.02	17.9±0.16
Acacia nilotca	52.00	31.64±1.08	55.04±0.71	5.36±0.08	16.52±0.21
Acacia robnsta	54.70	30.03±0.63	66.40±0.92	6.25±0.00	16.37±0.13
Acacia tortilis	50.20	27.41±0.46	45.87±0.45	7.00±0.001	16.61±0.02
Boscia albibtrunca	61.40	26.33±0.44	54.95±0.60	7.26±0.06	19.73±0.09
Boscia foetida	46.60	37.08±0.54	62.36±120	6.36±1.08	17.40±0.02
Combretum hereroense	54.30	31.64±1.08	30.31±0.05	6.23±0.02	17.24±0.01
Dichrostachys cinerea	59.89	31.05±0.37	55.55±0.80	3.18±0.02	17.40±0.02
Grewia flava	57.40	30.19±1.47	62.86±1.69	3.98±0.06	17.40±0.00
Maytenus senegalensis	41.10	43.19±0.36	45.26±0.30	4.86±0.06	12.13±0.21
Peltoforum africanum	44.10	37.22±1.11	27.34±0.55	5.40±0.15	9.98±0.23
Terminalia serecia	60.70	50.19±0.10	64.33±1.05	4.20±0.12	10.81±0.17
Ziziphus mncronata	48.50	22.25±0.00	52.51±4.20	8.54±0.06	9.96±0.01

Table 2: Nutritive value of browse species collected from Kgatleng rangelands in May 2001

Species	DM	ADF	NDF	Ash	CP
A. eurobescence	45.91	38.14±1.26	56.57±0.80	5.08±0.27	17.35±0.00
A. nilotca	52.56	60.15±0.93	51.86±0.50	4.83±0.02	17.24±0.01
A. robusta	29.12	58.70±1.81	45.37±0.02	5.88±0.03	17.79±0.16
A. tortilis	50.80	35.84±0.80	42.20±0.80	4.88±0.13	19.73±0.09
B. albitrunca	29.12	35.06±0.59	52.44±0.00	6.48±0.43	17.40±0.00
B. foetida	63.44	40.84±0.80	57.00±0.20	5.68±0.02	16.37±0.13
C. hereroenes	60.23	42.38±0.02	43.11±0.01	4.98±0.57	9.97±0.001
D. ceneria	43.15	33.05±0.10	51.48±5.00	6.05±0.00	18.70±0.04
G. flava	61.54	30.32±0.26	40.62±2.13	6.24±0.02	16.61±0.02
M. senegalensis	64.83	44.11±1.09	47.94±1.74	3.86±0.06	9.98±0.23
P. africanum	48.49	40.91±1.66	36.60±0.60	4.10±0.15	10.81±0.17
T. serecia	64.33	43.95±2.50	44.40±1.20	8.78±0.02	12.13±0.21
Ziziphus mncronata	48.50	22.25±0.00	52.51±4.20	8.54±0.06	9.96±0.01

Table 3: Nutritive value of browse plants collected from Kgatleng rangelands in July 2001

Species	DM	ADF	NDF	Ash	CP
A. eurobescence	60.72	34.98±2.14	43.70±0.10	7.80±0.00	14.32±0.00
A. nilotca	67.86	62.04±0.04	56.44±0.00	6.65±0.01	10.10±0.21
A. robusta	63.05	62.06±1.80	52.02±0.01	6.00±0.00	14.51±0.01
A. tortilis	73.81	46.38±0.70	51.42±0.57	4.58±0.02	11.51±0.06
B. albitrunca	59.67	30.56±0.30	42.40±0.40	8.85±0.80	10.04±0.06
B. foetida	57.13	45.47±0.49	63.68±0.66	5.34±0.01	14.03±0.00
D. ceneria	73.82	33.70±0.86	55.38±0.96	6.54±0.01	13.37±0.04
G. flava	61.15	41.40±0.36	41.60±1.00	7.78±0.02	14.06±0.16
M. senegalensis	55.04	38.06±1.44	36.10±1.30	5.25±0.45	11.31±0.00
P. africanum	49.19	47.44±0.00	45.81±0.19	4.88±0.08	8.22±0.02
T. serecia	70.92	42.95±2.33	41.96±36.10	9.58±0.02	10.10±0.21

Table 4: Nutritive value of browse species collected from Kgatleng rangelands in September 2001

Species	DM	ADF	NDF	Ash	CP
A. eurobescence	49.69	43.26±0.23	64.21±0.00	8.15±0.00	14.74±0.01
A. nilotica	59.08	36.88±0.03	53.11±0.11	4.62±0.020	9.68±0.06
A. robusta	45.47	33.72±1.79	69.75±0.10	6.48±0.02	12.01±0.02
A. tortilis	35.59	33.84±0.18	54.50±0.01	4.40±0.00	10.12±0.13
B. albitrunca	54.72	28.71±0.81	62.45±0.41	8.93±0.08	9.84±0.00
B. foetida	36.34	43.17±0.84	65.18±0.13	5.38±0.03	7.75±0.11
D. ceneria	47.63	35.07±1.37	62.23±0.23	6.73±0.07	13.70±0.12
G. flava	34.05	30.77±0.97	47.10±0.13	6.33±0.02	13.11±0.88
M. senegalensis	36.22	47.19±0.36	52.38±0.30	4.62±0.00	6.86±0.08
P. africanum	46.51	41.23±0.20	44.87±1.06	4.93±0.02	7.80±0.00
T. serecia	60.00	36.91±0.02	52.22±0.03	7.64±0.02	9.94±0.01

May for *Dichrostachys cineria* at the value of 3.18% and *Maytenus senegalensis* had 3.86% in May. Table 3-4 showed the values of ash content in July with 9.58% for *Terminalia serecia* followed by 8.93% for *Boscia albitrunca* in September. The lowest record was for *Acacia tortilis* at 4.58 in July and 4.62 for *Maytenus senegalensis* in September. It is observed that the highest ash content was recorded in the dry season.

Table 5: Monthly trend of percentage crude protein content

Species	March	May	July	September
A. eurobescence	17.79±0.16	17.35±0.00	14.32±0.00	14.74±0.01
A. nilotica	16.52±0.21	17.24±0.01	10.10±0.21	9.68±0.06
A. robusta	16.37±0.13	17.79±0.16	14.51±0.01	12.01±0.02
A. tortilis	16.61±0.02	19.73±0.09	11.51±0.06	10.12±0.13
B. albitrunca	19.73±0.09	17.40±0.00	10.04±0.06	9.84±0.00
B. foetida	17.40±0.02	16.37±0.13	14.03±0.00	7.75±0.11
C. hereroense	17.24±0.01	9.97±0.001	-	-
D. ceneria	17.40±0.02	18.70±0.04	13.37±0.04	13.70±0.12
G. flava	17.40±0.00	16.61±0.02	14.06±0.16	23.11±8.88
M. senegalensis	12.13±0.21	9.98±0.23	11.31±0.00	6.86±0.08
P. africanum	9.98±0.23	10.81±0.17	8.22±0.02	7.80±0.00
T. serecia	10.81±0.17	12.13±0.21	10.10±0.21	9.94±0.01
Z. mucronata	19.96±0.01	16.52±0.21	-	-

Table 6: Monthly trends of neutral detergent fiber

Species	March	May	July	September
A. eurobescence	55.85±0.50	56.57±0.80	43.70±0.10	64.21±0.00
A. nilotica	55.04±0.71	51.86±0.50	56.44±0.00	53.11±0.11
A. robusta	66.40±0.92	45.37±0.02	52.02±0.01	69.75±0.10
A. tortilis	45.87±0.45	42.20±0.80	51.42±0.57	54.50±0.01
B. albitrunca	54.94±0.60	52.44±0.00	59.40±0.40	62.45±0.41
B. foetida	62.36±2.12	57.00±0.20	63.68±0.66	65.18±0.13
B. hereroense	30.31±0.05	43.11±0.01	-	-
D. ceneria	55.55±0.80	51.48±5.00	55.38±0.96	62.23±0.23
G. flava	62.86±1.69	40.62±2.13	41.60±1.00	47.10±0.13
M. senegalensis	45.26±0.30	47.94±1.74	36.10±1.30	52.38±0.30
P. africanum	27.34±0.55	36.60±0.60	45.81±0.19	44.87±1.06
T. serecia	64.33±1.05	44.40± .20	41.96±36.10	52.22±0.03
Z. mucronata	52.51±4.20	52.51±4.20	-	-

Table 7: Monthly trends of percentage tannin contents in browses consumed by free grazing Tswana goats in Kgatleng district of Botswana

Species	March	May	July	September
A. erobescence	0.54	0.22	0.44	0.44
A. nilotica	2.29	2.35	2.73	2.93
A. robusta	1.42	1.66	1.97	2.01
B. albitrunca	0.20	0.35	0.33	0.36
B. foetida	0.15	0.16	0.16	0.17
C. hereroense	0.14	0.13	-	-
D. cineria	0.32	0.56	0.62	0.62
G. flava	1.38	1.46	1.52	1.50
M. senegalensis	1.31	1.44	1.30	1.38
P. africanum	0.12	0.13	0.14	0.14
T. serecia	0.16	0.18	0.17	0.19
A. *tortilis*	1.71	2.0	2.3	2.3
Z. mucronata	1.27	1.32	-	-

DISCUSSION

Botswana has a well-defined short rainy season and a prolonged dry season, which last for at least eight months of the year. It is during the dry season and drought period that browses are very important in grazing livestock nutrition. In this study it was found that goats under extensive management were not given any supplementary feeds. They were fed almost entirely on the browse plants and grasses in the rangelands. The parts consumed were leaves, pods and twigs and all these constituted the browse.

Availability of browse: All the species had leaves and twigs throughout the season except for *Ziziphus mucronata* and *Combretum hereroense*, which dropped leaves and the twigs were woody in July and September. These were the months that had no rainfall at all. About thirteen tree fodder plants browsed by goats were studied and they had leaves all the times for goats to eat at different heights from the ground.

Nutritional quality of the browse plants: The DM slightly increased as the dry season advanced. The highest determined DM content was for *T. serecia* in July, 70%. However most of the plants had the dry matter content of 45-60%. This showed that most of the browse plants can still retain up to 50% moisture in the dry season. Water intake of goats is positively correlated to the dry matter intake[3]. It has been observed in this study that though CP content decreased in the dry season to the minimum of 8.86% for *Maytenus senegalensis*, most of the plant species were above 8% which is the threshold value for CP requirement to prevent deficiency for goats[4]. The trend as observed in this study in Table 5, is similar to[1] in which *Acacia tortilis* had CP of 129.5 g kg^{-1} (12.95%) in the wet season and 106.90 g kg^{-1} (10,69%) in the dry season. *Acacia tortilis* is the most abundant species in Botswana rangelands thus readily available and accessible to grazing ruminants. In another study[11] it was found that *Dichrostachys cinerea* and *Acacia nilotica* were good sources of protein at the values of 128.5 and 95.3 g kg^{-1}, respective. In this study *Dichrostachys cinerea* had 96.8 g kg^{-1} CP content in the

dry season (September) and the highest amount was obtained in the wet season.

Proanthocyanidins were oxidatively depolymerised in butanol-HCL into anthocyanidins, which was used to classify tannins[10]. The range of 0.12 to 2.93% tannin content was obtained which is in line with previous findings[12]. They reported the tannin content of browse seeds at the range of 2-5% of dry matter. The low content of tannins may be beneficial to goats due to their effect in reducing rumen degradation of forage protein, which can be out weighed by increasing protein availability in the small intestines. The tannin content of the browse leaves and twigs increased slightly towards the dry season. High level of tannins would reduce intake and protein and dry matter digestibility[13]. The anti-nutritive factors may complex with proteins and thus reducing or completely preventing their availability[14].

The fibre content generally increased from the wet to the dry season (Table 1-4). Acid detergent fibre ranged from 27.34% (*Peltoforum africanum* in March) to 69.70% (*Acacia robusta* in September). There was a lot of variation in the ADF and NDF across the species and between the seasons. The variation between species could be attributed to levels of maturity of plants. As plants mature, structural carbohydrates increase while crude protein declines[8]. NDF concentration in the diet has a negative association with feed intake by ruminants[6]. Most of the browse species had NDF around 50%. This indicated that the species were of moderate quality and would be consumed voluntarily by goats. ADF is another factor used to predict digestibility in browses. The range of ADF was 26.33-62.06% (*B. albitrunca* in March and *A. robusta* and *A. nilotica* in July). The results of this study showed that browseable plant species are nutritious and contribute substantially to the diet of goats under kept under traditional management.

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