

The Evaluation of Nutritive Value of Three Tropical Browse Species for Sheep Using *in Vitro* and *in Vivo* Digestibility

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ABSTRACT : *In vitro* and *in vivo* experiments were carried out to evaluate the nutritive value of three tropical browse species as assessed by DM and CP digestibility, and NDF and ADF degradability with incubation times (T) of 6, 12, 24 and 48h. During the *in vivo* digestibility experiment three male castrated sheep (age 16 - 25 months) with a mean liveweight of 11.5 ± 0.9 kg were placed in individual metabolism stalls and were allocated to one of the three browse species in a 3×3 Latin square design. The browse species were all leguminous and consisted of: *Acacia sieberina* (*A. sieberina*), *Ficus polita* (*F. polita*), and *Ficus sycomorus* (*F. sycomorus*). The mean DM and CP contents of *F. polita* were higher than for *A. sieberina* and *F. sycomorus* ($p < 0.05$). In contrast the NDF and ADF contents of *F. sycomorus* were higher compared to the other species examined ($p < 0.05$). The *in vitro* DM and CP digestibility, and NDF and ADF degradability observed at different stages of incubation were higher in *F. polita* followed by *A. sieberina* and *F. sycomorus*. The DM and CP digestibility at 48 h incubation were 72.92, 74.84 and 53.52% and 77.38, 77.68 and 63.64% for *A. sieberina*, *F. polita* and *F. sycomorus*, respectively. This shows that *F. polita* contains more soluble materials which ruminant can benefit from and hence has more feeding value. The fermentation of *F. sycomorus* was slower for all the nutrients evaluated due to the presence of more fibre. Similarly, higher *in vivo* digestibility coefficient of DM, CP, NDF, ADF and hemicellulose were observed for *F. polita* reflecting its higher values of CP, ether extract (EE) and hemicellulose associated with lower values of NDF and ADF. Higher DMI and daily gain were recorded in sheep during feeding of *F. polita* compared to the other species evaluated. The digestibility of all the nutrients examined were higher in the *in vivo* than in the *in vitro* trial except for CP and DM. Sheep showed no visual signs of toxicity throughout the study periods. These results showed *A. sieberina*, *F. polita* and *F. sycomorus* can sustain sheep on a maintenance diet and could as well be used as a supplementary feed to low producing animals during the tropical dry season. Further research is needed to ascertain the viability of using these browse species on a long-term basis. (*Asian-Aust. J. Anim. Sci.* 2001. Vol. 14, No. 4 : 496-500)

Key Words : Browse Species, Sheep, *in Vivo* and *in Vitro* Digestibility and Degradability

INTRODUCTION

An inadequate yearly supply of good quality forage is common in tropical African regions where native pastures and browse from trees are the main forages for livestock (Yahaya et al., 2000). In tropical Africa, considerable quantities of crop residues and agro-industrial by-products are generated every year, however, because of lack of knowledge they are lost or under utilized (Aregheore, 2000). Livestock reared in these regions may have problems in meeting their maintenance needs on hay alone (Yahaya et al., 1999) and depend on browse trees to balance their diet in terms of protein, vitamins and minerals (LeHouderou,

1980).

The tropical browse plant species are palatable and have been found to offer considerable potential while being productive (Yahaya et al., 2000). Traditional herdmen and other pastoral groups habitually cut down branches from various trees species (*Acacia*, *Adansonia* etc.) making leaves and pods available to livestock during the dry season when there is no other forage is available (Yahaya et al., 2000). These leguminous trees produce leaves and pods which are rich in protein, minerals and vitamins (ILCA, 1988). Unfortunately, because some tree forages contain secondary compounds which may be toxic when fed *ad libitum* (Dmello, 1992; Fall-Toure et al., 1998), little has been done to evaluate their nutritive value. Digestibility may be directly estimated *in vivo* or determined by using *in vitro* procedures, which are cheaper and more convenient.

This paper compares *in vitro* digestibility and degradability and *in vivo* digestibility of three browse trees as the sole feed for sheep in the tropics and assesses whether or not these feeds could be used to sustain small ruminants as a sole diet or as supplementary feed.

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MATERIALS AND METHODS

Experimental diets

The three experimental browse species were all leguminous and consisted of: *Acacia sieberina* (*A. sieberina*), *Ficus polita* (*F. polita*), and *Ficus sycomorus* (*F. sycomorus*). A total of seven kilograms (mature branches thicker than 15 mm with leaves from each species to ensure uniform fodder composition) were harvested from seven different plants within (the 15 km² area) Nigeria about 20 km from the experimental livestock farm. The cut fresh materials for each specie was dried (32-34°C) for 24 h and thoroughly mixed individually. Throughout the study, material was always harvested and dried for 24 h. before feeding to individual sheep. Representative samples from the dry *A. sieberina*, *F. polita*, and *F. sycomorus* was milled through a 3.5 mm screen and stored for used in the analysis.

In vitro procedures

A total of 96 milled samples of 2 from *A. sieberina*, *F. polita*, and *F. sycomorus* were each incubated for 6, 12, 24 and 48h times (T) with rumen liquor+pepsin solution (Pepsin Wako Pure Chemical Industries Ltd. Tokyo) to determine DM and CP digestibility (total 48 samples). Similarly, 2 samples each from the same browse species were incubated for the same time (T) with rumen liquor only to determine NDF and ADF degradability (48 samples).

Stage 1. For each browse species duplicates of 0.5g of ground leave plus pods for DM, CP, NDF and ADF were placed into centrifuge glass tubes with a 4:1 ratio (40:10 ml) of buffer solution and strained rumen liquor obtained from two fistulated cows (McDougall, 1948; Tilley and Terry, 1963). The tubes were maintained at 38°C throughout the incubation time. At the end of incubation the tubes were centrifuged for 20 minutes at 3000 rpm and the supernatant discarded (Tilley and Terry, 1963). To determining ADF and NDF degradability 50 ml of acid detergent and neutral detergent solutions (ADS and NDS) respectively, were added to the residues according to the experimental design. The residues were kept in boiling water (100°C) for 1 h before filtering, oven drying and ashing (550°C). Finally the ADF and NDF contents of each browse species after each incubation time (T) were calculated from the weight of the residues.

Stage 2. To determine DM and CP digestibility, stage 1 was followed by pepsin digestion. Fifty ml of pepsin was added to the residues in each tube followed by incubation at 38°C for time T according to the design. The tubes were shaken at regular intervals and centrifuged at the end of the each incubation time. The supernatant was discarded and the

insoluble residues washed, transferred to aluminum vessels and were dried at 105°C to a constant weight. The dry weight of the residues was used to calculate the digestibility for each incubation time (T) and browse species.

In vivo digestibility

To estimate in vivo digestibility of the three browse species, three male castrated sheep (age 16-25 months) with a mean liveweight of 11.5±0.9 kg were placed in individual metabolism stalls, and were randomly allocated to one of the browse species in a 3×3 Latin square design.

Each digestion trial consisted of two weeks for adaptation and a subsequent 7 days for collection of faces and urine. The experimental feeds were offered *ad lib* twice a day at 7:30 and 17:30 h after the lefts over from previous day were weighed and sub-sampled. The liveweight of the animals was measured weekly before the morning feeding. Food and water was withheld for the night before the liveweight measurement of animals.

Chemical analyses

Dry matter (DM), organic matter (OM), crude protein (CP), NDF, ADF, Ca and P contents were determined on feed, faces and urine samples from sheep fed each browse species, as described by Van Soest et al. (1991) and AOAC (1990). The hemicellulose contents were calculated by subtracting ADF from NDF (table 1).

Statistical analysis

The *in vitro* data were analyzed using ANOVA appropriate to a randomized block design, while the data obtained from the *in vivo* trial were subjected to Latin square design ANOVA, with means differences determined using Fishers Least Significant Test (Steel and Torrie, 1980).

Table 1. Mean chemical composition (%) of the treated browse species

Chemical Composition	Acacia sieberina	Ficus polita	Ficus sycomorus	SE
DM	32.2 ^b	44.1 ^a	34.3 ^b	1.7
OM ¹	93.4	89.1	87.6	1.7
CP	16.2 ^a	19.3 ^a	9.6 ^b	2.9
EE	3.1 ^a	4.2 ^a	2.2 ^b	0.6
NDF	54.4 ^b	52.3 ^c	55.6 ^a	1.0
ADF	36.4	31.1	36.9	1.9
Hemicellulose	18.1	21.2	18.7	1.0
Ca	2.4	0.5	0.2	0.7
P	0.1	0.2	0.1	0.1

¹ 100% Dry matter basis.

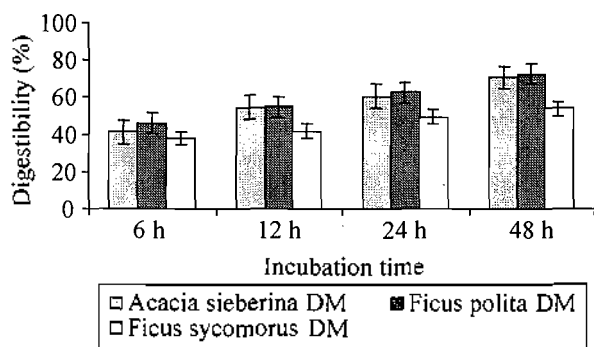


Figure 1. *In vitro* DM digestibility of experimental browse species

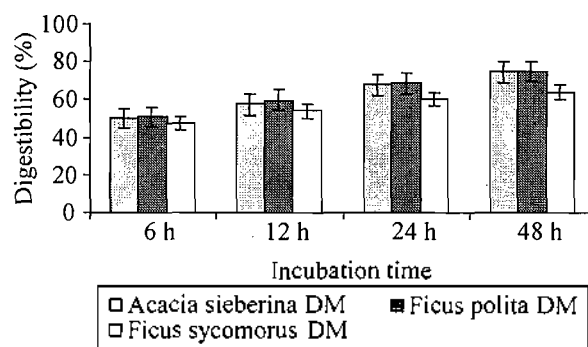


Figure 2. *In vitro* CP digestibility of experimental browse species

and Torrie, 1980).

RESULTS AND DISCUSSION

Chemical compositions of the treatment browse species are shown in table 1. The DM, and CP contents of *F. polita*, was higher than those of *A. sieberina* and *F. sycomorus* ($p < 0.05$). While the NDF and ADF content in *F. sycomorus* and *A. sieberina* and were higher than that for the *F. polita*, the hemicellulose contents in *F. polita* was higher than those of *A. sieberina* and *F. sycomorus* ($p < 0.05$). The DM CP and OM contents of all the browse species evaluated were similar to those obtained in *Acacia albida*, *Ziziphus spinochrist*, and *Sterculia satigera* (Yahaya et al., 2000) and ILCA, (1988). The NDF obtained from the browse species, except that of ADF are higher in the present study than the 40% and 30% obtained from *Robinia pseudoacacia* (Black Locust Leaf) meal by Ayers et al. (1996).

In vitro (DM and CP) digestibility and degradability (NDF and ADF) in the browse species

The estimate of the *in vitro* DM and CP digestibility, NDF and ADF changes with different

incubation times are shown in figures 1, 2, 3 and 4. The digestibility of DM and CP were higher in the *F. polita* than *A. sieberina* and *F. sycomorus*. This showed that among the species evaluated *F. polita* contain more soluble nutrients which ruminant can benefit from. The DM and CP digestibility at 48 h incubation were 72.92, 74.84 and 53.52% and 77.38, 77.68 and 63.64% respectively, for *A. sieberina*, *F. polita* and *F. sycomorus* (figures 1 and 2). Similarly, lower degradability was observed in the *F. sycomorus*, reflecting its higher value of ADF (table 1). The *in vitro* degradability for NDF were 54.49, 62.04 and 50.83% and for ADF were 47.15, 47.89 and 40.44% respectively, in *A. sieberina*, *F. polita* and *F. sycomorus* (figures 3 and 4). These results indicate that the *F. sycomorus* fermentation was slower due to the presence of more fibrous materials. Generally the feeding value of the forages and the extent of forage degradation in the rumen is constrained by the amount of fiber content (NDF) (Von Keyserlingk et al., 1996, Van Straalen et al., 1990 and Aregheore, 2000). Forages containing high cell wall content show restricted voluntary intake due to their slow degradability and accumulation of fiber in the rumen. The higher digestibility and degradability observed in the *F. polita* may be linked to its higher CP contents

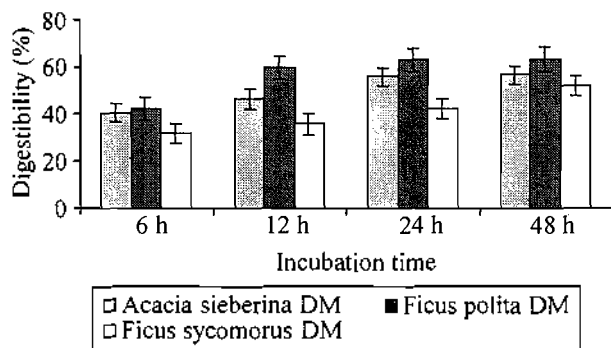


Figure 3. *In vitro* NDF digradability of experimental browse species

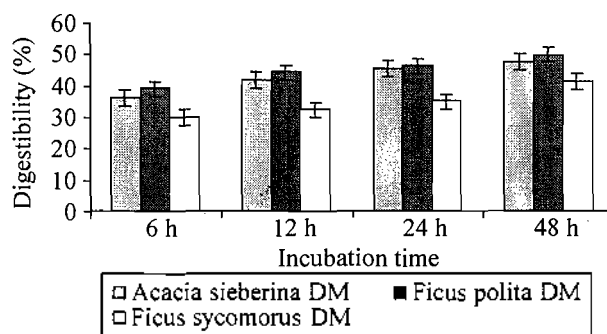


Figure 4. *In vitro* ADF degradability of experimental browse species

which provides more N for microbial utilization (Yahaya et al., 2000; Abdulrazak et al., 1997).

In vivo digestibility

In vivo DM digestibility (DMD), DM intake (DMI) and daily gain in sheep are shown in table 2. Higher ($p < 0.05$) digestibility coefficients of DM, CP, NDF, ADF and hemicellulose were observed in the compared to those of *A. sieberina* and *F. sycomorus*. This may be linked to the higher values of CP, EE and hemicellulose in *F. polita*, associated with its lower values of NDF and ADF in *Ficus polita*. Similarly the amount of cell wall (ADF), minerals in the forage, and the physiological status of the animals have been shown to decrease DMI and DMD of browse species (Mandibaya and Chihora, 1999; Yahaya et al., 2000). In the present study, higher dry matter intake (DMI) and daily gain were recorded in *F. polita*, followed by *A. sieberina* and *F. sycomorus*. The *A. sieberina* has slightly lower NDF and ADF contents, but higher CP and EE contents compared to *F. sycomorus*. The lower DMI and DMD observed in *F. sycomorus* may be linked to low CP content and CP digestibility. The mean DMI was comparable to 347 and 320 DM day⁻¹ obtained when Menz rams were fed *Acacia nicotica*, Welw. and *Acacia sieberina*, D.C., respectively in Ethiopia (Tanner et al., 1990), but lower to 735g DM/d and 916 g DM/d respectively by Smith, (1988) and Yahaya et al. (2000). Tree fodder as a supplement or sole diet has been reported to alleviate nitrogen deficiency, thereby improving the rate of degradation of the basal diet and the fractional outflow rate of liquid matter from the rumen and hence feed intake (Goodchild and McMeniman, 1994; Mandibaya and Chihora, 1999). The daily gain from *Ficus polita* was higher than that of other species evaluated ($p < 0.05$). The mean daily gain of (155 g) for the three forages was 20 g higher than that reported by Ayers et al. (1996) when goats were fed *Robinia pseudoacacia*, Del. in Oregon. In southern

Nigeria, 56g of daily gain was obtained when sheep were fed *Acacia areura*, Del. (Adu, 1982).

Mean DMD among the three species was slightly lower than the value of 74% DMD reported by Yahaya et al. (2000) when goats were fed *Acacia albida*, Del., in Nigeria. However, the mean NDF and ADF digestibility were found to be slightly higher than those of 54% and 52% reported by Ayers et al. (1996) when goats were fed *Robinia pseudoacacia*, Del. in Origen.

The differences in daily gain in sheep fed different browse species may be attributed to the low DMI influenced by low CP and high cell wall contents (ADF). A low rate of degradation of cell walls may lead to lower forage digestibility and subsequently lower daily gain (Chesson, 1993). In the current study no sign of toxicity was observed in any animals. Similarly, no toxic symptoms have been observed when goats and steers were offered leguminous tree forages in Harare, Zimbabwe (Florence et al., 1998; Mandibaya and Chihora, 1999; Yahaya et al., 2000).

The results from the *in vitro* and *in vivo* experiments indicated that the *Fi. polita* species has the highest potential digestible and degradable materials in all the nutrients examined and therefore has high nutritive value. The *F. sycomorus* has the lowest potential digestible and degradable materials, followed by *A. sieberina* and hence has lower nutritive value compared to *F. polita*. Potentially both species examined can provide feed for small ruminants during the long tropical dry season.

CONCLUSION

The result of this study revealed that both browse species examined can sustain sheep on a maintenance requirement feed level and could as well be used as supplementary feed for small ruminants animals grazing on poor quality forages during the long tropical dry season, or for low producing animals. Further research is needed to ascertain the viability of using these browse species on a long-term basis.

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Table 2. *In vivo* mean digestibility, dry matter intake (DMI) and daily gain of rams fed three browse species.

Parameters	Acacia seiberina	Ficus polita	Ficus sycomorus	SEM
DM	56.1 ^b	59.2 ^a	53.6 ^c	1.61
CP	62.9 ^b	67.4 ^a	60.1 ^c	2.12
NDF	58.8 ^b	60.1 ^a	58.4 ^b	0.51
ADF	55.7 ^b	57.9 ^a	55.2 ^b	0.85
Hemicellulose	61.0 ^b	64.4 ^a	59.3 ^b	1.50
DMI(g/day)	396.0 ^b	442.0 ^a	354.0 ^c	25.09
Daily gain (g/day)	158.0 ^b	175.0 ^a	132.0 ^c	12.52

^{a,b,c} Means with different superscript are significantly different ($p < 0.05$).

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