Comparison of Indigenous Browses and Sunflower Seed Cake Supplementation on Intake and Growth Performance of Dual-purpose Goats Fed Buffel Grass (*Cenchrus ciliaris*) Hay*

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ABSTRACT : A study to compare the effects of supplementing *Delonix elata*, *Grewia similis*, *Tamarindus indica* and sunflower seed cake on intake and growth rate of dual-purpose goats fed low quality Buffel grass (*Cenchrus ciliaris*) hay was carried out. Twenty-eight male goats aged five to seven months (mean weight 12.93±3.94 kg) were randomly allocated to four dietary groups in a completely randomised design. The diets were hay plus *Grewia similis*, hay plus *Delonix elata*, hay plus *Tamarindus indica* and hay plus sunflower seed cake. All diets were supplemented with maize bran. The experimental period was 90 days. Voluntary dry matter intake of the supplements was higher for *Tamarindus indica* (275.5 g/day) and *Grewia similis* (201.8 g/day) and lowest for sunflower seed cake (81 g/day). Goats supplemented with *Grewia similis* had the highest hay intake (183.8 g/day) while those supplemented with sunflower seed cake had the lowest hay intake (98.9 g/day). Animals fed browse supplements gained significantly more weight ($p<0.001$) than those with sunflower seed cake. There were no significant differences in live weight change between goats fed the different browses. However, those fed *Tamarindus indica* gained an average of 20.79 g/d which was slightly higher than the gains for those on *Grewia similis* and *Delonix elata* while those fed sunflower seed cake lost weight. Correspondingly, goats supplemented with browse leaf meals had higher feed conversion ratios than those supplemented with sunflower seed cake and required 23.91 to 35.06 g DM of feed to produce one g of weight gain per day. In a separate study, the DM disappearance pattern indicated that *Grewia similis* and *Delonix elata* were highly degradable compared to *Tamarindus indica*. At 24 h of incubation, DM degradability was 627, 588 and 345 g/kg DM for *Grewia similis*, *Delonix elata* and *Tamarindus indica*, respectively. In another study *in vivo* DM digestibility ranged from 46.1% (for hay alone) to 56.2% (for hay plus *Grewia similis*). It was concluded that the addition of *Tamarindus indica*, *Grewia similis* and *Delonix elata* leaf meals to *Cenchrus ciliaris* hay resulted in increased total DM intake, *in vivo* digestibility and growth rate. Therefore, leaf meals of indigenous browses particularly *Tamarindus indica* and *Grewia similis* could be used as supplementary feeds for small ruminants grazing on poor quality roughages during the dry season rather than use of expensive, less effective and intermittently available sunflower seed cake. ***(Asian-Aust. J. Anim. Sci. 2005. Vol 18, No. 7 : 966-972)***

Key Words : Indigenous Browses, Goats, Intake, Digestibility, Growth

INTRODUCTION

In tropical Africa, feeding of ruminant livestock during the dry season is based on natural pastures, standing hay and crop residues. Most of these are of low nutritive value and livestock reared on these feed resources may have problems in meeting even their maintenance needs (Shayo, 1997). Since supplies of commercial concentrates and agro-industrial by-products are limited and expensive, other supplementary high protein feeds or minerals from locally available sources are imperative for ruminants. In this regard tropical trees and shrubs are important feeds for livestock and wild animals and can be used as alternative supplements to balance the diet of livestock in terms of protein, energy, vitamins and minerals. Leguminous trees produce leaves and pods that are palatable and rich in protein, minerals and vitamins that are deficient in natural pasture and crop residues. The supplementation of animals fed low quality roughage with tree legumes has been found to offer considerable improvement in animal performance while at the same time lowering the costs of production (Yahaya et al., 2000).

Although the role of trees and shrubs is recognised in different livestock production systems in the tropics, appreciable work in evaluating the nutritional value of these forage material has concentrated mainly on exogenous plants such as Leucaena, Grilicidia and Mulberry (Shayo, 1997). However, due to agronomic requirements and climatic differences in various locations of the tropics, Leucaena or Mulberry trees are not widely distributed in all areas. In the semi-arid regions of Tanzania indigenous tree legumes are more common. Furthermore, indigenous tree legumes are widely valued by farmers for their feeding value to animals and traditional herdsmen habitually cut down branches from various tree species, making leaves and pods available to livestock during the dry season when there is shortage of other forages (Komwihangilo et al., 2001). However, there is little documentation on values of

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indigenous browses as feed supplements to ruminant livestock during the dry season. Equally, little is known about their influence on various aspects of livestock production such as milk yield and growth rate. As an attempt to address some of the gaps, a study was conducted to compare the value of three leguminous browse trees, namely *Delonix elata*, *Grewia similis* and *Tamarindus indica* to sunflower seed cake as supplements to dual-purpose goats fed low quality *Cenchrus ciliaris* hay. It was hypothesised that indigenous browse leaf meals abundantly available are a potential protein supplement that may be used to replace more expensive seed cakes in feeding of goats under smallholder production systems.

MATERIALS AND METHODS

Location

Experiments were conducted at the Livestock Production Research Institute (LPRI), Mpwapwa, Tanzania (Latitude: 06°20'S Longitude: 36°30'E) between June 2000 and January 2001. The LPRI is in the semi-arid region characterized by a consecutive four months rainy period from November. The area receives an average of 660 mm of rain annually with 90% of the rain falling between December and April.

Feed preparation

Browse leaves were harvested from *Tamarindus indica* and *Delonix elata* trees and *Grewia similis* shrubs that were growing naturally around the LPRI farm. The harvesting was done during the dry season between July and August 2000. The leaves were separated from the stems of harvested branches but leaf stalks were included during harvesting. The harvested materials were dried under shade in barns for 15 days. After drying the leaf stalks were removed from the leaf meals. The dry leaves were then thoroughly mixed, put in polypropylene bags and kept in a moist free store until the time of feeding. Buffel grass (*Cenchrus ciliaris*) hay was harvested from the LPRI pasture farm in June 2000 using a forage harvester, baled and stored for later use. No artificial fertilizers had been applied to the pastures for five consecutive years. Sunflower seed cake and maize bran were purchased from local pressing and milling firms in Mpwapwa township. The maize bran referred to is actually a mixture of bran, maize polishing and traces of maize flour as the maize dehulling machines do not separate them. Farmers usually mix this stuff with oil cakes and mineral mix for use as supplements for livestock.

In sacco study

To determine the *in sacco* degradation characteristics of the browse trees, 3 g of dry samples milled through a 2.5 mm screen were put in nylon bags (140 mm×75 mm, 40-60 μm pore size (Huntington and Givens, 1995). The bags were incubated in the rumen of two rumen-fistulated steers for 0, 3, 8, 16, 24, 48, 72 and 96 h where each browse material was replicated two times. The animals were offered *Cenchrus ciliaris* hay plus 3 kg of concentrate (a mixture of maize bran (70%), sunflower seed cake (29%) and salt (1%)) twice a day at 0800 and 1600 h. For purposes of comparison of the studied plant materials no attempt was made to adjust rumen micro-flora in favour of any. The measurement for 0 h was obtained by soaking the two bags of each sample in warm water (37°C) for 1 h. After incubation, the bags were washed with running cold water until the rinse out was clear. The bags were then dried at 60°C for 48 h and weighed. The percentage dry matter disappearance at each incubation period was calculated and the data obtained were fitted to the exponential equation of Ørskov and McDonald, (1979): $P = a+b(1-e^{-ct})$, whereby P is the percentage of materials degraded after a given time, a is the measure of solubility (degradation at time zero), b is the potential degradability of the DM, c is the rate of degradation of b and t is time in hours.

In vivo study

A digestibility experiment was conducted to determine the *in vivo* digestibility of hay alone, hay plus *Grewia similis*, hay plus *Delonix elata* and hay plus *Tamarindus indica*. For each test feed, three entire male goats aged 9-10 months and average weight of 14.12 kg were used. The animals were fed according to their body weight requirements and feed was supplied to the animals twice daily. In the morning at 0900 h the animals were given leaf meal of the browses and at 1200 h they were given hay. The leftovers from each feeding, where applicable, were weighed before the next feeding. A preliminary period of 10 days was allowed before the start of the collection period which lasted for 14 days. During the collection period, faeces were collected each morning and weighed before the animals were given the ration of that day. Part of daily total faeces (20%) from each animal was preserved in a deep freezer for subsequent N-determination. Feed offered, refusals and faeces were dried at 105°C for 24 h to determine the dry matter content and the difference in the amount of dry matter of feed offered and of faeces was taken as the amount of dry matter digested *in vivo*.

Growth and intake study

Twenty-eight Blended (Malya) entire male goats aged five to seven months with 12.93±3.94 kg mean weight were used in the growth and intake study. All animals were treated against internal and external parasites before commencement of the study. These goats were a result of a three way crossing between Kamorai (55%), Boer (30%)

Table 1. Laboratory analysis of the chemical composition of feeds used in the study

Feed material	DM (g/kg)	Composition as g/kgDM					Total tannins (mg/g)
		Ash	CP	ADF	NDF	EE	
Delonix elata	890.0	99.0	225.0	265.0	456.0	39.0	44.02
Grewia similis	890.0	145.0	184.0	241.0	468.0	34.0	5.59
Tamarindus indica	892.0	94.0	130.0	351.0	463.0	34.0	63.62
Sunflower cake	922.0	62.0	248.0	288.0	396.0	225.0	NA
Maize bran	888.0	51.0	117.0	72.0	209.0	45.0	NA
Cenchrus ciliaris hay	933.0	57.0	18.0	509.0	786.0	NA	NA

DM = Dry matter, CP = Crude protein, ADF = Acid detergent fibre.
NDF = Neutral detergent fibre, EE = Ether extract, NA.= Not analysed.

and indigenous Tanzanian goats (15%). The animals were randomly allotted into four groups of seven animals each. Each group was allocated to one of the four experimental treatment diets in a completely randomised design. The basal diet for all treatments was *Cenchrus ciliaris* hay and the supplementary feeds were dried leaves of *Grewia similis* (T1), *Delonix elata* (T2), *Tamarindus indica* (T3) and sunflower seed cake (T4) was included as a control diet. For each treatment, hay and supplementary feed comprised 53% and 37%, respectively, of the ration. The hay:supplement ratios were adjusted according to requirement and weights of animals at respective weighing times. Maize bran was added to all treatments as an energy source and comprised 10% of the ration. Mineral licks and water were supplied *ad libitum*.

All animals were caged in wooden pens with slatted floors and individually fed with test diets. The animals were allowed six weeks to acclimatize to the stalls and feeds. The experimental period lasted for 90 days (October, 2000-January, 2001). Prior to the experimental period, initial body weights of all animals were measured. Subsequent weights were measured on day 26, 45, 61 and 91 (final weight) of the experiment. The animals were fed three times a day and feeding was done in such a way that tree leaves or sunflower seed cake as well as maize bran were supplied at 0830 h, prior to feeding of hay. The leftovers, where these were realised, of tree leaves, sunflower seed cake and maize bran were measured before the animals were provided with hay. The animals were given hay in two equal portions, one at 1200 h (with supplementary feeds finished by then) and another at 1800 h. Hay refusals for individual animal were collected and weighed the following morning (at 800 h) before the next feeding. Daily feed intakes and refusals were recorded separately for the supplementary feeds, hay and maize bran. Samples of feeds offered and refusals were ground to pass a 1-mm screen. Dry matter and nutrient content of both offered and leftover feeds were analysed by AOAC (1990) procedure. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined by Goering and Van Soest (1970) method. Total tannins were analysed based on methods of Makkar et al. (1993).

Dry matter intake (DMI) and feed conversion ratio (FCR) were calculated as follows:

DMI (g/day) = Amount offered (gDM)-Amount refused (gDM)

FCR = Amount consumed (g/day)/Liveweight gain (g/day)

Statistical analysis

The data on dry matter intake, *in vivo* digestibility and weight gain of the dual-purpose goats were subjected to analysis of variance (ANOVA) using the SAS (1999) software. Initial weights of the goats were used as a covariate in analysing the data on weight gain. The following model was adopted:

$$Y_{ij} = \mu+T_i+b(A_{ij}-\bar{A})+e_{ij}$$

Where
Y_{ij} = Record of the j^{th} animal assigned to i^{th} treatment.
μ = General effect (overall mean),
T_i = Effect of the i^{th} treatment,
A_{ij} = Body weight of the j^{th} animal in i^{th} treatment.
$\bar{A}$ = Overall mean of the body weights.
b = Regression of Y_{ij} on A_{ij} and
e_{ij} = Random element specific to each animal.

RESULTS

Chemical composition, degradability and *in vivo* digestibility of feeds used in the experiment

Chemical compositions of feeds used in the experiment are presented in Table 1. Hay had lower (18 g/kg DM) CP content while sunflower seed cake had higher (248 g/kg DM) CP content than the browses. Among the browse species, *Tamarindus indica* had the lowest (130 g/kg DM) CP content while *Delonix elata* had the highest (225 g/kg DM) level of CP. As expected, *Cenchrus ciliaris* hay had the highest values for both ADF and NDF. For the supplement feeds, the highest value for ADF content was found in *Tamarindus indica*, followed by that of sunflower seed cake. All the three browse species had more or less the same amounts of NDF which were higher than the value for sunflower seed cake. Total tannin concentration was highest (63.62 mg/g) for *Tamarindus indica*, followed by *Delonix elata* (44.02 mg/g) and least for *Grewia similes* (5.59 mg/g).

Table 2. Degradability characteristics of ground leaf material of the three browse species when placed in the rumen of steers from 3 to 96 h

Browse species	a (%)	b (%)	c
Grewia similis	17.8	60.1	0.057
Delonix elata	16.3	59.5	0.052
Tamarindus indica	15.4	69.4	0.013

Table 3. Mean *in vivo* digestibility coefficient (mean±SE) of hay and hay/ leaf mixture when fed to male goats

Diet	Digestibility coefficient
Hay only	0.461 ± 0.009^{a}
Hay plus *Tamarindus indica*	0.536 ± 0.010^{b}
Hay plus *Delonix elata*	0.545 ± 0.010^{b}
Hay plus *Grewia similis*	0.562 ± 0.007^{b}

Means with different superscript within a column differ significantly ($p<0.001$).
SE = Standard error of mean.

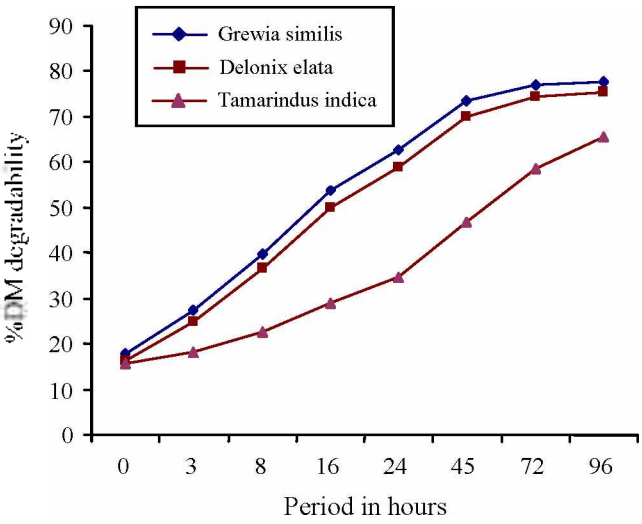

Figure 1. *In sacco* DM degradability pattern of the three browse species.

Table 2 shows the degradability characteristics of the three browse species. Kinetics analysis of DM degradation showed that a rapidly soluble fraction (a) value of *Grewia similis* was the highest and that of *Tamarindus indica* was the lowest. For a potentially degradable fraction (b) the highest value was observed in *Tamarindus indica*, followed by that of *Grewia similis*, and that of *Delonix elata* was the lowest. The pattern of DM disappearance over incubation time is shown in Figure 1. The DM disappearance pattern indicated that *Grewia similis* and *Delonix elata* were highly degradable compared to *Tamarindus indica*. For instance at 24 h of incubation, DM degradability was 627, 588 and 345 g/kg DM for *Grewia similis*, *Delonix elata* and *Tamarindus indica* respectively. At 48 h DM degradability increased to 733, 701 and 469 g/kg DM for *Grewia similis*, *Delonix elata* and *Tamarindus indica*, respectively.

In vivo DM digestibility of hay alone and hay plus the leaf meal of the browses is shown in Table 3. Goats fed on hay supplemented with leaf meal of browses had significantly ($p<0.001$) higher digestibility coefficients than those fed on hay alone. The difference for the values of digestibility coefficients between the goats that received hay only and those given hay plus leaf meal ranged from 75 to 101 g/kg. There were no differences in digestibility between the leaf meal supplements.

Feed intake and growth rate of goats

Table 4 shows the DM intake of the feeds and growth performance of the goats. The DM intake of the supplements differed significantly ($p<0.001$) among supplemented diets. The highest total DM intake was observed in goats which were supplemented with *Tamarindus indica* followed by those supplemented with *Grewia similis*. The goats supplemented with sunflower seed cake had the lowest total DM intake. The type of supplement had significant ($p<0.001$) effect on hay intake, the highest intake being observed in goats which were supplemented with *Grewia similis* followed by those supplemented with *Delonix elata* while those supplemented with sunflower seed cake showed the lowest intake of hay.

Live-weights of the animals did not differ significantly ($p>0.05$) between treatments at the start of the experiment (Table 4). Average daily gain of goats was significantly ($p<0.001$) influenced by the supplemental diets. Goats supplemented with *Tamarindus indica* and *Grewia similis* had the highest average daily gain while those supplemented with sunflower seed cake lost weight. There were no significant ($p>0.05$) differences in live weight change of goats fed the three browse supplements. Correspondingly, goats supplemented with *Tamarindus indica*, *Grewia similis* and *Delonix elata* had significantly ($p<0.001$) higher feed conversion ratio compared to those supplemented with sunflower seed cake and required only 23.91, 28.50 and 35.06 g DM of feed, respectively, to produce one g of weight gain per day.

DISCUSSION

Chemical composition, degradability and *in vivo* digestibility of feeds

In the present study CP contents of the browses were slightly lower than that of sunflower seed cake, but far higher than the minimum CP content of 80g/kg DM recommended by Van Soest (1982) for ruminants. The CP contents in the three browses were within the range reported for other browses such as *Leucaena leucocephala* (Richards et al., 1994), *Morus alba* (Shayo, 1997) and different native browse tree legumes of western Tanzania (Rubanza et al., 2003). The estimates of degradability characteristics of the browses indicate that *Tamarindus indica* had a greater

Table 4. Dry matter intake and growth performance (mean±SE) of 5-7 months old Malya male goats fed *Cenchrus ciliaris* hay with either sunflower seed cake or browse leaf meals

Parameter	Treatments			
	T1	T2	T3	T4
Number of animals	7	7	7	7
Intake				
Supplement intake (gDM/day)	201.76±1.06^{c}	126.95±1.15^{b}	275.52±1.48^{d}	80.98±0.54^{a}
Hay intake (gDM/day)	183.83±2.03^{d}	170.64±2.76^{c}	130.43±1.93^{b}	98.91±2.01^{a}
Total intake (gDM/day)[1]	432.50±3.43^{c}	339.43±4.06^{b}	447.76±3.20^{d}	221.73±2.77^{a}
Total intake/kgW$^{0.75}$	58.11±0.16^{c}	49.70±0.23^{b}	62.12±0.20^{d}	34.90±0.21^{a}
Growth performance				
Initial weight (kg)	13.87±1.58^{b}	12.43±1.59^{b}	13.40±1.70^{b}	12.01±1.44^{a}
Final weight (kg)	15.61±1.54^{b}	13.33±1.52^{b}	15.27±1.62^{b}	11.43±1.35^{a}
Weight gain (g/day)	19.37±3.50^{b}	10.00±2.90^{b}	20.79±2.25^{b}	-6.51±1.70^{a}
Feed conversion ratio (FCR)	28.50±8.20^{a}	35.06±8.85^{a}	23.91±8.20^{a}	-31.96±8.85^{b}

^{a,b} Means with different superscript within a column differ significantly ($p<0.001$).

SE = Standard error of mean.

T1 = Hay plus *Grewia similes*. T2 = Hay plus *Delonix elata*.

T3 = Hay plus *Tamarindus indica*. T4 = Hay plus Sunflower seed cake.

[1] Total intake is the sum of browse or sunflower supplement, hay and maize bran consumed. The amount of maize bran is not shown in the Table.

amount of the potentially degradable fraction (a+b), but slower rate of degradation (c) than *Grewia similis* and *Delonix elata*. The higher ADF and Tannin contents in *Tamarindus indica* may have caused this slow passage rate. According to Rubanza et al. (2003) high tannin content in indigenous browses depresses organic matter degradability and digestibility.

Feed intake and growth rate of goats

The pattern of DM intake observed in this study showed that the leaf meals of the three browses were more preferred compared to sunflower seed cake used, indicating that the former were more palatable than the latter. This is in accordance with the feeding behaviour of goats, which prefer browse fodder trees to other feed material (Devendra, 1990). The total DM intakes of *Grewia similis* and *Delonix elata* were similar to those reported by Goromela et al. (1997) working with lactating goats. Of the three browses, however, *Tamarindus indica* was highly consumed, probably due to it being the most palatable browse as it has a salty taste (Komwihangilo et al., 2001). The lower hay intake in the group supplemented with *Tamarindus indica* compared with the other two browses could be attributed to the lower rate of degradation and digestibility coefficient observed for this browse. According to Waldo et al. (1972) forage intake by ruminants is influenced by the extent of fibre digestion and outflow rate. The degradation rate of *Grewia similis* and *Delonix elata* increased rumen outflow rate and thus leading to greater consumption of hay. The intake of sunflower seed cake was lower than those observed by Goromela et al. (1997) in lactating goats. The low total DMI for goats supplemented with sunflower seed cake was a result of low hay intake. This could be attributed to high fat content in the sunflower seed cake as indicated by the ether extract content. High fat content in rations have been reported to decrease the digestibility of DM and crude fibre (Schneider and Flatt, 1975) and consequently lower intake of respective nutrients. This low DM intake resulted into loss of weight observed in goats supplemented with sunflower seed cake.

The superiority of the browse-supplemented groups over those on hay alone in terms of *in vivo* DM digestibility may be linked to the higher CP content in the browses, associated with lower values of ADF and NDF compared to the values observed in hay. Similar improvements in *in vivo* digestibility have been reported in goats when *Leucaena* and *Gliricidia* were fed in combination with Napier grass (Richards et al., 1994). Among the three browses, *Grewia similis* gave the best response in the digestibility of hay.

Improved daily weight gains for browse-supplemented goats that were observed in this study indicates that supplementation of poor quality *Cenchrus ciliaris* hay resulted in increased DM intake which in turn increased the growth rate of the animals. This is in agreement with the findings of Abdulrazak et al. (1996) and Kaitho and Kariuki (1998) that tree legume supplementation of grass diets with less than 70 g/kg DM CP content increases dry matter intake and animal performance. This is because tree legume supplements alleviate nitrogen deficiency, thereby improving the rate of degradation of the basal diet and the fractional outflow rate of liquid matter from the rumen (Ondiek et al., 2000). This results into improved feed intake, hence animal performance (Phimphachanhvongsod and Ledin, 2002). The highest growth rates of the animals supplemented with the browses were associated with higher total DM intake. This response can be attributed to the high

CP content of the browses, that might have overcome the depressing effect that low nitrogen concentration in *Cenchrus ciliaris* hay has on intake (Minson and Milford, 1967) and the browses provided ruminally degradable nitrogen or nitrogen that avoids degradation in the rumen (van Eys et al., 1986). Phimphachanhvongsod and Ledin (2002) have shown that including *Gliricidia sepium* in goat diet fed *Panicum maximum* increases CP intake which in turn results into higher daily live weight gain. Equally, the inclusion of browses in the diet that have tannins could have an influence on deterring worms that might have negative effect on performance of animals during the experimental period. The feed conversion ratios observed in this study are slightly higher than those reported elsewhere for goats supplemented with browse leaves (Phimphachanhvongsod and Ledin, 2002) and pods (Ntakwendela et al., 2002).

CONCLUSION

This study demonstrated that the addition of *Tamarindus indica, Grewia similis* and *Delonix elata* leaf meals to *Cenchrus ciliaris* hay increased total dry matter intake and *in vivo* digestibility which eventually improved growth rates of the animals. The loss of weight by animals supplemented with sunflower seed cake indicates that some of the conventional feedstuffs used in rural areas may not yield expected results if they are not properly handled. Among the browses, slightly higher growth rates and much better feed conversion ratio were observed in the animals that were supplemented with *Tamarindus indica* and *Grewia similis*. It is concluded that leaf meals of indigenous browses could be used as supplementary feeds for small ruminants fed on poor quality roughages during the dry season.

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