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# EVALUATION OF SOME SEMI-ARID BROWSE FORAGES AS FODDER FOR RUMINANT LIVESTOCK

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## Abstract
An experiment was conducted to determine the feed of an indigenous browse plats is Borno State of Nigeria. Sixteen bucks of mixed breeds (Borno white *x* Sokoto red) weighing an average of 12.0 $\pm$0.31kg was divided into four groups with four animals per group. Each group was randomly assigned to one of the four dietary treatments in a Latin Square Design (LSD). The diets compared were *Acacia nilotica, Balanite aegyptiaca, Khaya senegalensis* and *Ziziphus muaritiana.* The results showed that the average daily gain (ADWG), dry matter intake, per metabolic weight (0.07kg day$^{-1}$, 641.37kg day$^{-1}$, 74.58g day$^{-1}$) and feed conversion ratio (0.12) were significantly ($p<0.05$) better with animals on diet $T_4$ (*Ziziphus mauritianna*). The result also revealed that $T_3$ had the best in terms of feed cost per kg gain (N60.49), and percent reduction in feed cost (N53.04%). From the results, it can be concluded that feeding of *Ziziphus mauritiana* to growing goats at 30% level of inclusion is beneficial.

**Keywords: Ruminant, Nutrients, Digestibility, and Nitrogen**

## Introduction
Feed potential of browse in the diet of herbivores in Nigeria is reflected in report of Salem *et al*. (1979). Browse plants play a significant role in nutrition of ruminant livestock in tropical regions. Browse species, because of their resistance to heat, drought, salinity, alkalinity, drifting sand, grazing and repeated cutting, are the major feed resources during the dry season (Fagg and Stewart, 1994). Some parts of browse species can be found during the dry season including pods, fruits and leaves. Most trees/shrubs produce their leaves during wet season, thus browse is more available during the spring (August to May) (Palgrave, 1983). The nutritional importance of browse is especially significant for free ranging goats in extensive communal system of production. Unfortunately, many tropical tree fodders and shrub legumes contain high concentrations of secondary compounds, particularly tannins (Salem *et al*., 2006; Mbugua *et al*., 2008) that can be reacting negatively with other nutrients (Mangan, 1988), and could have detrimental or beneficial effect on animal nutrition (Mbugua *et al*., 2008; Waghorn and McNabb, 2003). Special attention is paid to toxins or anti-nutritional factors such as tannins, which can strongly limit fodder utilization (Urbani and Tewe, 2001; Rejendiran and Kardivel, 2002). Although the digestive tract of goats is anatomically similar to that of sheep and cows, goats have a large physiological capacity to adapt to high tannin levels in the diet. *In vivo* and *in vitro* conducted studies revealed that goats are more efficient than sheep digesting feed stuffs with low nitrogen, high fibre or high tannin contents of tree fodders and shrubs (Salem *et al*., 2006; Tefera *et al*., 2008). Goats thrive well in the semi-arid regions of Nigeria due to their ability to feed on different types of plant species, mainly browses and grasses. Goats have a great tendency to change their diet according to seasonal feed availability and growth rate of plants. Goats can express their optimum genetic potential in terms of productivity, if supplementary feeds are available. According to McDonald *et al*. (1995), supplementation of crop residues in the diet of goats with cassava residue, leaves of mango, and pawpaw promote optimum growth and improved reproductive characteristics. The objective of the study therefore, is to test the effect of some selected browse forges use as feed for goats in semi-arid area of Borno State, Nigeria.

## Materials and Methods
***Experimental site*:** The study was conducted at the Ramat Polytechnic Teaching and Research Farm, Maiduguri, Borno State. Maiduguri is located at 11.05$^{o}$ North and 30.05$^{o}$ East and at an elevation of about 364m above are level in the North-East part of Nigeria. The ambient temperature is 31$^{o}$C at August, and as high as 40$^{o}$C or more at April and May (Ijere and Daura, 2000). The hottest period occurs from March to June, while it is cold between November and February. Rainfall varies from 150-600mm with a relative humidity (Ijere and

Daura, 2000).

***Experimental Animals*:** Twenty male goats of mix breeds (Borno white and Sokoto red) and aged between 10 to 11 months ($11.5 \pm 0.21$) were used for the feeding trial. The animals were purchased from local livestock market in Maiduguri.

***Experimental Design and Treatment*:** The animals were randomly assigned to four dietary treatments in a 5 x 4 latin square design with periods of 3 weeks duration. The dietary treatments consist of browse foliage *Acacia nilotica, Balanites aegyptiaca, Khaya senegalensis* and *Ziziphus mauritiana* which were harvested from the study area.

***Feeding and management*:** During the experimental period, the animals were housed in pens with concrete floors and roofed with asbestos sheet. The walls have wide windows. The pens were cleaned morning and evenings. The animals were de-wormed before trial, there was free access of water and mineral licks. The study comprise of 14days of feed adaptation, followed by 84days measurement period. Feed was offered twice daily at 8:00hrs. The daily output of faeces and total urine voided was recorded from each animal and sampled for chemical analysis. Samples of feed offered, was taken daily during the measurement period for chemical analysis. Body weight of the animal was weighed once weekly.

***Digestibility trial*:** One animal from each treatment was randomly selected for the digestibility trial. The metabolism cages used were made of metal. The animals were weighed and caged individually and fed their treatment diets for 14 days adaptation period and 7 days measurement period. Fresh clean water and mineral salt lick were provided *ad-libitum*. Nutrient digestibility of the feed was estimated thus:

Apparent Nutrient digestibility =

$$\frac{\text{Feed consumed} - \text{Faecal output x 100}}{\text{Feed consumed}} \text{ x } 100$$

***Statistical analysis*:** Data obtained will be subjected to statistical analysis using ANOVA procedure SAS (1988). Significant treatment means will the be compared by Duncan option.

**Results and Discussion**

***Chemical Composition of the Experimental Feeds*:** Chemical composition and fibre analysis of the five semi-arid browses used in the feeding trial is shown in Table 1. Significant difference ($P<0.05$) were observed in the crude protein (CP) values for all the browsers forages with highest value observed in *Ziziphus mauritiana* (182g $kg^{-1}$ DM), and significantly least value observed in *Acacia nilotica* (97.70g $kg^{-1}$DM). The ash content of the browse forages were higher in $T_2$ (*Balanites aegyptiaca*) than in the other treatment groups with lowest $T_4$ (*Ziziphus mauritiana*) value (30.0g $kg^{-1}$). The result also show no significant difference ($P>0.05$) among the browse forages for acid detergent lignin and organic matter. The result obtained for chemical composition of the browse forages is similar to those reported by (Njidda *et al*., 2010a; Njidda, 2010). Generally all browse forage used in the current study had a CP content of above 7% DM, which can support optimum microbial growth. The result of the fiber fraction shows that NDF, ADF and ADL are high and can affect digestibility. Higher levels of NDF and ADL have been reported to have negative effect on DM intake DM digestibility (Bakshi and Wadhwa, 2004). Several reports (Njidda *et al*., 2010a; Njidda *et al*., 2010b and Njidda, 2010) shows that semi-arid browses of North East Nigeria are generally high in fiber and lignin during the dry season.

***Growth Performance*:** The growth performance of goats fed selected semi-arid browses is shown in Table 2. The average of initial live body weights of the animals in the different dietary treatments did not vary significantly ($P<0.05$), indicating a close weight of the test animals at the start of the experiment. However, the final live body weight significantly ($P<0.05$) differed with animals on diet $T_4$ (*Ziziphus mauritiana*) being the heaviest on the average with a weight value of 17.63kg. The lowest mean final live body weight value (14.50kg) was recorded with animals on $T_1$ (*Acacia nilotica*). Metabolic mass of the animals differed significantly ($P<0.05$) between the diets. It ranged from a low value of 7.43$LW^{0.75}$ to a high of 8.60$LW^{0.75}$. This does not follow the same pattern in terms of statistical significance in total weight gained by the animals. The average daily dry matter intake (641.37g) was significantly higher ($P<0.05$) in $T_4$ (*Ziziphus mauritiana*). The dry matter intake (g $kg^{1}W^{0.75}$) was higher for $T_3$ (77.22g $kg^{-1}W^{0.75}$) (*Khaya senegalensis*), and lowest for $T_1$ (59.92g $kg^{-1}W^{0.75}$) (*Acacia nilotica*). Feed conversion rate was best in $T_4$ (*Ziziphus mauritiana*), and poorer in animals on diet $T_1$ (*Acacia nilotica*). Concerning the browse leaves intake of *A. nilotica,* this can be explained by the high NDF and lignin content. The explanation regarding CP and fiber content could be valid for the difference observed in intake. Apart from *Z.mauritiana,* the result indicates that the studied forages could constitute the main component of goat rations and would be well consumed. The animals increased in weights, especially with *Z.mauritiana* leaves, which could indicate efficient utilization of these feed. The intakes expressed in g/kg $W^{0.75}$ were high compared to the estimation of Devendra and McLeroy (1982) for tropical goat breeds. The low DMI of T1 can be explained by the high NDF content, while the low CP content could be the limiting factor for intake in T1. The high DM intake observed in T4 was probably due to a better balance between energy and protein, as more OM (916.00g $kg^{-1}$) was consumed from leaves diet. The small size of the leaves of *Ziziphus mauritiana,* mostly small leaflets around 5mm long, could have influenced intake, because goats are shown to be extremely sensitive to diets poor in fiber, and rich in concentrate or forage characterized by small particles size, which decrease the rumen pH, resulting in a fall in intake (Morand-Fehr, 2005). However, increased dietary NDF is shown to decrease DM intake linearly in growing goats

(Luginbuhl and Poore, 1998). Many other factors, including particles size, chewing frequency and effectiveness, of reticular contractions are also involved. Apart from T1, the result indicated that the forage studied could constitute the main component of goat diets, and would be well consumed. The intakes expressed in g/kg $W^{0.75}$ were high compared to the estimation of Devendra and McLeroy (1982) for tropical goat breeds. The weight gain by all goats was lower than expected as nutrient intakes from all diets were higher in protein (97.70 to 182.40g $kg^{-1}$ CP), than in the estimated requirements (74.30g $kg^{-1}$ CP). The difference can be explained either by the inadequacy of the requirement estimates for other breeds, or the low genetic potential of sahelian goats marked by low capacity for growth of low efficiency of nutrient utilization. The ADG varied from 0.003 to 0.07kg $day^{-1}$ and the control diet (T1) had the lowest ADG (0.03kg/day), suggesting a low efficiency were somewhat similar compared to the result obtained by Njidda *et al*. (2010a) in Nigeria. Almost all literature on the use of shrub and tree fodders to supplement either natural grasses or crop residues have shown positive responses with respect to productivity of cattle, sheep and goats (Norton, 1998).

***Nutrients Digestibility of Goats Fed Selected Semi-Arid Browser*:** The nutrient digestibility of selected semi-arid browses fed to goats is shown in Table 3. Nutrient digestibility for the different browses varied significantly ($p<0.05$) between the diets. The nutrient digestibilities were generally low except for dry matter. There were significant differences ($p<0.05$) among treatments. Animals on diet T2 (*Balanites eagyptiaca*) had the highest crude protein, organic matter, neutral detergent fiber and acid detergent fiber digestibility. Digestibility values obtained for acid detergent insoluble ash and cellulose varied significantly at 4% and 18% respectively, between the dietary treatments. There were high variations in nutrient digestibility. Studies on the digestibility of browse fodders are very important as they allow the estimation of nutrients really available for animal nutrition. The main progress has been in the quantity of information on the ingestibility, digestibility and nutritive value of these fodders. Results on milk or growth performance are often given since digestibility values cannot always be interpreted in performance results (Rejendiran and Kardivel, 2002; Bamikole*et al.,* 2003). The *in vivo* technique is the classical and direct method for estimating feed digestion by animals. However, due to difficulties in its application, indirect methods are frequently used. Most of the studies on digestibility of browse fodders used the *in vitro* technique, which provides a comparative estimate of DMD and can be used to rank the quality of the feed. However, the significance of the method is limited as it does not take into account the intake of the forage by the animal. The *in sacco* method has the advantage of measuring the rate of digestion of different feed components (protein and starch) through nylon bags suspended in the rumen and can also be used to rank feeds. The *in sacco* method is known to usually overestimate *in vivo* digestibility (Guteridge and Shelton, 1998). In the present study, the *invivo* method was applied using goats, owing to their preference for browse forages. The comparison of the results with other data is uncertain due to different experimental conditions: the methods used, animal species used and the level of browse fodder in the diet. The leaves were used with a fixed amount of hay at a minimum level, since it was anticipated that leaves could not be fed alone due to possible anti-nutritive factors, while the pods were fed as a single feed. The factors involved in the variation in digestibility among browse fodders include the concentration of N, cell wall content, especially lignin and tannins. A low level of CP (less than 80g/kg DM) is shown to depress digestibility, as it is not sufficient to meet the needs of the rumen bacteria (Norton, 1998). On the other hand, low NDF content (20 to 35%) has been shown to be resulted in high digestibility, while lignifications of the plat cell wall decrease the digestibility of plant material in the rumen. Many studies (Moore and Jung, 2001) have reported a negative correlation between lignin concentration, and cell wall digestibility by its action as a physical barrier to microbial enzymes. Negative corrections between tannin and protein or DM digestibility have also been studied (Balogun and Holmes, 1998; McSweeney *et al*., 1999). Hence information on the NDF, ADF, lignin and tannin content of tree foliage essential for the assessment of their digestibility. Luginbubl and Poore (1998) noted that goats are not able to digest cell walls and shorter period of time. On the other hand, Morand-Fehr (2005) reported similar retention time of feed particles in the whole digestive tract of sheep and goats eating the same quality of good quality forage, but the retention time of goats receiving poor quality forage was longer. Hence, sheep and goats have similar patterns of digestion of moderate to high quality forages, but goats are better in digesting forages rich in cell walls and poor in nitrogen. This seems to be related to their ability to recycle urea nitrogen (Silanikoe, 2000). A wide range of variation in digestibility is reported in tropical browse species. Breman and Kessler (1995) showed a mean OMD of 0.53 in Sahelian and Sudanian zones of West Africa. Le Houerou (1980), reported a mean DCP of 510g/kg for West African browses, with 760g/kg for legumes. Fall (1991) reported large variations in DMD, ranging from 0.26 to 0.88 between species and plant parts. In the present study, OMD (54.99 to 62.23% DM) was high, and CPD (20.62 to 22.86% DM) was low, except for *Balanites aegytiaca* (68.27% DM).

***Live Weight of Goats Fed Semi-arid Browses Forages*:** In spite of the adaptation to harsh environments and poor quality feeds, goats require for optimum growth, an efficient utilization of nutrients that supply adequate energy and protein. Knowledge of nutrient requirements is therefore important for the estimation of genetic potential of the animals. It is well documented that the nutrient requirement depends on body size, and growth rate or production potential of animals, environmental conditions (temperature, humidity) and the quality of the feed (Sahlu *et al*., 2004; Mandal *et al*., 2005). The sahelian goats are well adapted in the semi-arid zones.

The weight gain by all goats was lower than expected, as nutrient intakes from all diets were higher in protein (97 to 182g/kg) than the estimated requirements (74.3g). The difference can be explained either by the inadequacy of the estimated requirement for other breeds, or the low genetic potential of sahelian goats marked by low capacity for growth or low efficiency of nutrient utilization. The ADG varied from 30 to 70g/day and the diet with *A. nilotica* leaves resulted in the lowest performance, suggesting a low efficiency in utilization of this forage type. When used as a sole feed in the voluntary intake trial, the weight gains were somewhat moderate to high compared to the result of Sawe *et al.* (1998) supplementing goats (57 to 68g/day) with tree leaves and pods in Kenya. Similar results to the present study were obtained by Mtenga and Kitaly(1990) with indigenous goats in Tanzania.

***Feed Conversion Ratio*:** The feed conversion ratio was low for $T_1$ than other treatments. Hence the leaves of *A.mauritaniana* and *K.senegalensis* could be an alternative, because of the high FCR and availability in the area where the foliage can be collected and stored for stall-feeding. The aim of this study was to compare different types of browse forages in terms of digestive utilization, economic and their effect and animal performance. They were then used *ad libitum,* though the economic feasibility of this technique was considered. However, ad *libitum* feeding of browse forages should be limited if the high CP content of browse fodders is to be exploited and it will require large amount of forages to store. Since the leaves of these browse forages are sold in the local market, this could limit the availability. The use of these browse species as a supplement should be evaluated and the levels that allow optimum growth at lower cost must be assessed.

***Nitrogen Utilization*:** The result of nitrogen utilization by goats fed selected semi-arid browses is shown in Table 4. Nitrogen intake differ significantly ($p<0.05$), and was the highest for diet T4 (29.39g $day^{-1}$) (*Ziziphus mauritiana*). Faecal nitrogen output was also significantly different ($p<0.05$) with highest T4 (*Ziziphus mauritiana*) value (2.29 g $day^{-1}$). Urinary nitrogen (N) output value recorded for the different diets are 4.39g $day^{-1}$, 3.28g $day^{-1}$, 5.04g $day^{-1}$and 1.67g $day^{-1}$ for T1, T2, T3, and T4 respectively, and differ significantly. Nitrogen absorbed and refined differ significantly ($p<0.05$) among treatments which ranged from 86.41% to 94.09% and 66.72% to 86.52% respectively. Nitrogen retention is considered a better criterion of measuring protein quality than digestibility. Nitrogen retention is associated with the amount of nitrogen used for protein quality (Quinion *et al*., 1996). The browse forages offered gave a positive N balance. Ruminants can use dietary or non-protein nitrogen (N) to meet protein requirement, largely because of the symbiotic relationship between the host and its rumen microbes (Silanikove, 2000). This demonstrated that the browse forages was efficiently used as a fermentable nitrogen source for microbial growth in the rumen. Moreover, rations that are well balanced in energy, protein and minerals result in reduced N and P excretion (Paengkoum *et al*., 2002). Such excretion is an ever increasing problem due to its effect on environmental maintenance. The values for the N balance were higher than the values reported by Wampana *et al.* (2008) who fed agro-industrial by-product.

***Cost/benefit Analysis of Feeding selected semi-arid Browse to Goats*:** Values for the cost/kg feed (N) ranged from N24.70 in T4 (*Ziziphus mauritiana*) to N31.00 in T1 (*Acacia nilotica*). The total feed cost was highest (N1439.43) in T3 (*Khaya senegalensi*) and lowest (N1159.40) in T1 (*Acacia nilotica*). Feed cost per kg gain (N/kg) decreased from T1 to T4. Reproduction percent in feed cost was higher in T4 (53.04) % and lower in T4 (53.04%) and followed by T3 (31.05%). T4 (30% *Ziziphus mauritiana)* was better than the other diets in terms of feed cost/kg feed (N24.70), feed cost per kg gain (N60.49) and reduction percent in feed cost (N53.04) (Table 3). Therefore diets containing *Ziziphus mauritiana* could be fed to growing goats without compromising the growth and economic performance.

## Conclusion

In conclusion, based on the protein content, the leaves of all the browse forages are suitable as supplements to poor quality rations. However, *K.senegalensis,* with the lowest crude protein and highest fiber and lignin content, had low intake characteristics, and this resulted in low weight gain during the experimental period. The browse forages could be used as alternative low cost sources of protein in livestock feeding.

## References


Bakshi, M.P.S. and Wadhwa, M. (2004). Evaluation of forest leaves of semi-hilly arid region as livestock feed. *Asian-Australasian J. Ani. Sci*., 95: 93 – 104.

Bamikole, M.A., Babayemi, O.J., Arigbede, O.M. and Ikhatua, U. (2003). Nutritive value of *ficus religiosa* in West Africa DwarfGoats. *Anim. Feed Sci. Technol*., 105: 71 – 79.

Balogun, R.O., Jones, R.J. and Holmes, J.H.G. (1998). Digestibility of some tropical browse species varying in tannin content. Animal Feed Science and Technol., 76: 77 – 88.

Breman, H. and Kessler, J.J. (1995). Woody plants in Agro – ecosystems of semi – Arid Regions. Advanced series in agricultural sciences no. 23. Springer Verlag, Berlin, Germany. 340pp.

Devendra, C. and Mcleroy, G.B.(1982).*Goat and sheep production in the tropics. Intermediate Tropical Agriculture series*. Longman group Ltd, Longman, London, New York. 271pp.

Fagg, C.W. and Stewart, J. L. (1994).The values of *Acacia* and *prosopisin* arid and semi-arid environments. *J. Arid Environments*, 27:3-25.

Fall, S. (1991). Improvement of nitrogen level in ruminant's diet the problem of dissemination of research results on utilization of urea and browse as nitrogen sources in sahelian feeding systems. In:

Dzowela, B.H. said, A.N. Wendem-Agenehu, A. Kategile, J.A. (Eds.), *and utilization of research* *results on forage and agriculture by – product as animal feed resources in Africa*. PANESA/ARNAB – ILRI, Addis Ababa, Ethiopia.

Gutteridge, R.C. and Shelton, H.M. (1998). *Forage tree legumes in agriculture*. CAB international, Wallingford, UK.

Ijere, J.A. and Daura, M.M. (2000). "Borno State" In: A.B. Mamman, J.O. Oyebanji and S.W. Peters (eds). Nigeria: A people United, A future Assured. Volume 2.Gabumop Publishers, Calabar.

Le Houerou, H.N. (1980). *The role of browse in sahelian and sudanian zones. Browse in Africa. The current state of knowledge*. ILCA, Addis Ababba, 83. 102pp.

Luginbuhl, J.M. and Poore, M.H. (1998). Nutrition of meat goats. www. cals.ncsu.edu/an-sci/extension/ animal/meat goat/MGNutr.htm.

Mandal, A.B., Paul, S.S., Mandal, G.P., Kannan, A. and Pathak, N.N. (2005). Deriving nutrient requirements of growing Indian goats under tropical condition. *Small ruminant Res.*, 58: 201-217.

Mangan, J.L. (1988). Nutritional effects of tannins in animal feeds. *Nutr. Res. Rev*., 1:209 – 231.

Mbugua, D.M., E.M. Kiruiro and A.N. Pell, (2008). In vitro fermentation of intact and fractionated tropical herbaceous and tree legumes containing tannins and alkaloids. *Anim. Feed Sci. Technol.,* 146: 1 – 20.

McDonald, P.M., Edwards, R.A.,Greenhalgh, J.F.D. and Morgan, C.A. (1995). Animal Nutrition. 5 th Edn. Addison Wesley Longman, Singapore Pte. Ltd. Livestock Health and Welfare. Pp. 305-510.

Morand-Fehr, P. (2005). Recent developments in goat nutrition and application: *A review. Small Ruminant Res*., 60, 25 -43.

Moore, K.J. and Jung, H.J.G. (2001).Lignin and fiber digestion. *J. Range Manage.,* 54: 420 – 430.

McSweeney, C.S., Dalrymple, B.P., Gobius, K.S., Kennedy, P.M., Krause, D.O., Macke, R.I. and Xue, G.P. (1999). The application of rumen biotechnology to improve the nutritive value of fibrous feedstuffs: pre- and post-ingestion. Livest. *Prod. Sci*., 59: 265 – 283.

Mtenga, L.A. and Kitaly, A.J. (1990). Growth performance and carcass characteristics of Tanzanian goats fed chlorisgayana hay with different levels of protein supplement. *Small Ruminant Res*., 3: 1-8.

Njidda, A.A., Ikhimioya, I. and Muhammad, I.R. (2010a). Feed potential of *Ziziphus Mauritian ato* goats in sudan-sahelian region of Nigeria. In: O.J. Babayemi, O.A. Abu and E.O. Ewuola (eds.) Proc. 35th. Nig. Soc. For Anim. Prod.14 – 17 March, 2010, University of Ibadan, Nigeria. Pp.473-476.

Njidda, A.A. (2010). In vitro gas production and stoichiometric relationship between short chain fatty acid and in vitro gas production of semi-arid browse of North-Eastern Nigeria. *Global Veterinarian*, 4(3): 292 – 298.

Njidda, A.A., Ikhimioya, I., Muhammad, B.F. and Amaza, I.B. (2010b). Chemical composition, fiber fraction and anti-nutritive substances of selected semi-arid browses. In: O.J. Babayemi, O.A. Abu and E.O. Ewuola, (eds). Proc. 35th. Nig. Soc. For Anim. Prod. 14-17 March, 2010, University of Ibadan, Nigeria, Pp. 473 – 476.

Norton, B.W. (1998). The nutritive value of tree legumes. In: Gutteridge, R.C. Shelton, H.M. (Eds.), *Forage trees legumes in tropical agriculture*. Tropical grassland society of Australia Inc. St Lucia Queensland.

Paengkoum, P., Liang, J.B., Jelan, Z.A. and Basery, M. (2002). Effects of protein and energy in N balance and N excretion by dairy goats. In: proceedings of the 4th international livestock waste management symposium and Techn. Expo. Penang, Malaysia, 19-23 May 2002. Pp. 157 – 160.

Palgrave, K.C. (1983). Trees of southern Africa. 2ndedition. Struik publishers. Cape Town.

Quinion, N., Dourmad, J.Y. and Nobet, J. (1996). Effect of energy intake on the performance of different types of pigs from 45 to 100kg body weight 1.Protein and lipid deposition. *Anim. Sci*., 63: 277 – 288.

Rejendiran, A.S. and Kardivel, R. (2002). Evaluation of Casuarinas leaf meal based complete diet for goats. *India J. Anim. Nutrient*., 19: 25 – 30.

Sahlu, T., Goetsch, A.L. Luo, J.,Nsahlai, I.V., Moore, J.E., Gal yean, M.L., Owens, F.N., Ferrell, C.L. and Johnson, Z.B. (2004). Nutrient requirement of goats: developed equations, other considerations and future research to improve them. *Small Ruminant Res*., 53: 191 – 219.

Salem, A.Z.M., Salem, M. Z. M., El-Adawy, M.M. and Robinson, P.H. (2006). Nutritive evaluations of some browse tree foliages during the dry season: secondary compounds, feed intake and in vivo digestibility in sheep and goats. Anim. *Feed Sci. Technol.*, 127:251 – 267.

Saleem, M.A., Oyatogun, O.M. and Checa, H.R. (1979). Nutritive value of browse plants in the Sudan Savanna of North West Nigeria. *Nig. j. Anim. Prod*., 6:3 – 7.

Sawe, J.J., Tuitoek, J.K. and Ottaro, J.M. (1998). Evaluation of common tree leaves or pods as supplements for goats on range area of Kenya. *Small Ruminant Res*., 28: 31 – 37.

Silanikove, N., (2000). The physiological basis of adaptation in goats to harsh environments. *Small Ruminant Res*., 35: 181-193.

SAS (1988). Statistical Analysis System institute Inc. SASSTAT programmed, Cary, NC: SAS institute Inc., 1988.

Tefera, S., Mlamnoa, V., Dlamini, B.J. Dlamini, A.M., Koralagama, K.D.N. and Mould, F.L. (2008). Chemical composition and in vitro ruminal fermentation of common tree forages in the semi-arid rangelands of Swaziland. *Anim. Feed Sci. Technol*., 142:99-110.

Urbani, O.N. and Tewe, O.O. (2001). The nutritive value of some tree/shrub leaves as feed for goats. T*rop. Sci*., 41: 13-15.

Wampana, D.D., Abbator, F.I. and Njidda, A.A. (2008). Effect of supplementation on the performance of goats fed native pasture in semi – arid zone. *Nig. J. Exptl. Appl. Biol.*, 9(2): 119-123.

**Table 1: Chemical composition of experimental rations (g $kg^{-1}$ DM)**

| Nutrients | $T_1$ (an) | $T_2$ (be) | $T_3$ (ks) | $T_4$ (zm) | SEM |
|---|---|---|---|---|---|
| Dry matter | 949.70 | 955.00 | 945.00 | 946.00 | $95.33^{NS}$ |
| Crude protein | $97.70^{d}$ | $118.20^{b}$ | $132.50^{b}$ | $182.40^{a}$ | $13.27^{*}$ |
| Esther extract | $48.00^{a}$ | $23.30^{b}$ | $46.70^{a}$ | $23.30^{b}$ | $3.27^{*}$ |
| Crude fibre | $215.00^{a}$ | $166.70^{b}$ | $200.00^{a}$ | $176.70^{b}$ | $18.96^{*}$ |
| Ash | $60.00^{a}$ | $65.00^{a}$ | $46.70^{b}$ | $30.00^{b}$ | $5.04^{*}$ |
| Nitrogen Free Extract | $529.70^{a}$ | $581.80^{a}$ | $519.10^{b}$ | $533.60^{b}$ | $54.10^{*}$ |
| Organic matter | 889.70 | 890.00 | 908.30 | 916.00 | $90.10^{NS}$ |
| Neutral Detergent Fibre | 524.90 | 486.30 | 502.40 | 506.30 | $50.48^{NS}$ |
| Acid Detergent Fibre | 425.10 | 392.30 | 401.10 | 412.40 | $40.07^{NS}$ |
| Acid Detergent Lignin | 98.40 | 97.30 | 96.30 | 101.10 | $9.82^{NS}$ |
| Total Condensed Tannin | 0.12 | 0.23 | 0.21 | 0.21 | $0.06^{NS}$ |

**a, b, c, means in the same row with different superscript differ significantly ($p<0.05$); SEM = Standard error of means; NS =Not Significant; *= Significant**

**Table 2: Performance of goats fed semi – arid browses**

| | Treatments | | | | |
|---|---|---|---|---|---|
| **Parameters** | **$T_1$ (an)** | **$T_2$ (be)** | **$T_3$ (ks)** | **$T_4$ (zm)** | **SEM** |
| Initial weight (Kg) | 12.25 | 12.25 | 12.13 | 12.13 | NAS |
| Final weight (Kg) | $14.50^{d}$ | $16.00^{c}$ | $16.75^{b}$ | $17.63^{a}$ | $0.04^{*}$ |
| Metabolic mass ($Kg^{0.75}$) | $7.43^{c}$ | $8.00^{b}$ | $8.28^{a}$ | $8.60^{a}$ | $1.11^{*}$ |
| Body weight gain (Kg) | $2.25^{d}$ | $3.75^{c}$ | $4.62^{b}$ | $5.50^{a}$ | $0.02^{*}$ |
| Average daily body weight gain (Kg) | $0.03^{d}$ | $0.05^{c}$ | $0.06^{b}$ | $0.07^{a}$ | $0.003^{*}$ |
| Average daily Dry matter intake (Kg) | $445.23^{d}$ | $548.81^{c}$ | $639.40^{b}$ | $641.37^{a}$ | $1.21^{*}$ |
| Dry matter intake (g/Kg $w^{0.75}$) | $59.92^{d}$ | $68.60^{c}$ | $77.22^{a}$ | $74.58^{b}$ | $0.25^{*}$ |
| Feed conversion ratio | $0.20^{b}$ | $0.15^{a}$ | $0.14^{a}$ | $0.12^{a}$ | $0.004^{*}$ |

**a, b, c, means in the same row with different superscript differ significant ($p<0.05$); SEM = Standard error of means; * = significant; NAS = Not analyzed statistically**

**Table 3: Nutrients digestibility of goats fed semi -arid browses (% DM)**

| | Treatments | | | | |
|---|---|---|---|---|---|
| Nutrients | **$T_1$ (an)** | **$T_2$ (be)** | **$T_3$ (ks)** | **$T_4$ (zm)** | **SEM** |
| Dry matter | $92.49^{d}$ | $93.74^{c}$ | $94.37^{b}$ | $95.28^{a}$ | $0.56^{*}$ |
| Crude protein | $22.58^{b}$ | $68.27^{a}$ | $20.62^{b}$ | $22.86^{b}$ | $1.01^{*}$ |
| Esther extract | 25.63 | $15.21^{a}$ | $42.83^{a}$ | $18.84^{c}$ | $0.77^{*}$ |
| Crude fibre | $71.30^{a}$ | $19.94^{c}$ | $13.35^{d}$ | $26.37^{b}$ | $1.12^{*}$ |
| Ash | $37.50^{a}$ | $31.43^{b}$ | $32.27^{b}$ | $33.40^{b}$ | $0.98^{*}$ |
| Organic matter | $54.99^{b}$ | $62.31^{a}$ | $62.10^{a}$ | $56.88^{b}$ | $0.93^{*}$ |
| Neutral detergent fibre | $32.84^{bc}$ | $36.29^{a}$ | $27.89^{c}$ | $29.82^{c}$ | $1.01^{*}$ |
| Acid detergent fibre | $40.23^{bc}$ | $43.99^{a}$ | $34.90^{d}$ | $34.90^{d}$ | $0.59^{*}$ |
| Acid detergent lignin | $59.35^{a}$ | $46.25^{b}$ | $33.23^{c}$ | $32.84^{c}$ | $1.21^{*}$ |
| Acid detergent insoluble ash | $4.56^{a}$ | $4.21^{b}$ | $1.80^{d}$ | $3.83^{c}$ | $0.02^{*}$ |
| Cellulose | $10.17^{d}$ | $15.37^{b}$ | $11.76^{c}$ | $17.40^{a}$ | $0.01^{*}$ |

**a, b, c, means in the row with different superscript differ significantly ($p<0.05$); SEM = Standard error of means; * = significant**

**Table 4: Nitrogen utilization (g $day^{-1}$)**

| | Treatments | | | | |
|---|---|---|---|---|---|
| | **$T_1$ (an)** | **$T_2$ (be)** | **$T_3$ (ks)** | **$T_4$ (zm)** | **SEM** |
| Nitrogen intake (g/day) | $17.75^a$ | $17.55^b$ | $24.38^d$ | $24.38^d$ | $0.09^*$ |
| Nitrogen in faces (g/day) | $1.47^c$ | $2.56^a$ | $1.44^c$ | $2.29^b$ | $0.002^*$ |
| Nitrogen in urine (g/day) | $4.39^b$ | $3.28^c$ | $5.04^a$ | $1.67^d$ | $0.002^*$ |
| Nitrogen absorbed (g/day) | $16.28^c$ | $14.99^d$ | $22.94^b$ | $27.10^a$ | $0.001^*$ |
| Nitrogen retained (g/day) | $11.89^c$ | $11.71^c$ | $17.90^b$ | $25.43^a$ | $0.08^*$ |
| Nitrogen absorbed as % $N_2$ intake | 91.72 | 85.41 | 94.09 | 92.20 | $10.65^{NS}$ |
| Nitrogen retained as % $N_2$ intake | 66.99 | 66.72 | 73.42 | 86.52 | $9.70^{NS}$ |

**a, b, c, means in the same column with different superscript differ significantly ($p<0.05$); SEM = standard error means; NS = Not significant**

**Table 5: Cost/Benefit analysis of feeding selected semi-arid browses to goats**

| | Treatments | | | | |
|---|---|---|---|---|---|
| | **$T_1$ (an)** | **$T_2$ (be)** | **$T_3$ (ks)** | **$T_4$ (zm)** | **SEM** |
| Number of goats | 4 | 4 | 4 | 4 | - |
| Initial weight (Kg) | 49.00 | 49.00 | 48.50 | 48.50 | - |
| Final Weight (Kg) | $58.00^d$ | $64.00^c$ | $67.50^b$ | $70.50^a$ | $0.004^*$ |
| Total weight gain (Kg) | $9.00^d$ | $15.00^c$ | $19.0^b$ | $22.00^a$ | $0.02^*$ |
| Total Feed Intake/goat (Kg) | 37.40 | 46.10 | 53.71 | 53.88 | - |
| Feed Cost/Kg feed (N) | 31.00 | 28.90 | 26.80 | 53.88 | - |
| Total feed cost (N) | 1159.40 | 1332.29 | 1439.43 | 1330.84 | - |
| Feed cost/Kg gain (N/Kg) | 128.82 | 88.82 | 75.76 | 60.49 | - |
| % reduction in feed cost | - | 31.05 | 41.19 | 53.04 | - |