Performance response in goats fed shed leaves (*Vitellaria paradoxa*-, *Gmelina arborea*- and *Daniella oliveri*-) based diets

M. B. Yousuf* and A. A. Adeloye

Department of Animal Production, University of Ilorin, Ilorin Nigeria

*Correspondence Author: mb_yousuf@yahoo.com; +2348062303545

Abstract

*The present study was conceived with the aim of encouraging utilization of environmental wastes in the form of shed tree leaves for livestock feeds production. Three complete isonitrogenous (15.45 ± 0.17 % CP) diets, each constituted from shed leaves of *Vitellaria paradoxa*, *Gmelina arborea* or *Daniella oliveri* tree plus corn bran, soy bean meal, bone meal and sodium chloride, were evaluated through laboratory and nutritional studies for their suitability as complete diets for goat production. The diets were analyzed for dry matter and chemical contents while their feeding values were assessed in a 56-day growth and nutrients digestibility trial with goats. The three shed leaves-based diets were found to be similar in dry matter content but differed ($P < 0.05$) in the levels of crude protein, Neutral Detergent Fiber (NDF), calcium, phosphorous and condensed tannins. Results from the feeding trial indicated significant ($P < 0.05$) effects of treatments on feed intake, body weight gain and nitrogen retention in the goats. Goats on *Gmelina* shed leaves-based diet gained in body weight at a slower rate ($P < 0.05$) than the other treatment groups. No adverse effect on the general well being and behaviour of goats attributable to treatments was discernible during the 56-day feeding trial. Results of both the laboratory and feeding trials confirmed the hypothesis that each of the three shed leaves could be utilized to provide nutrients for goat production. In terms of feeding values to the goats the dried forages were ranked in the order: *Vitellaria* > *Daniella* > *Gmelina*.*

Key Words: shed tree leaves; complete feed; goat

Introduction

Ruminant livestock production in developing African countries is often characterized with low level of efficiency. Africa has about 40 % of the total world ruminant livestock population yet, produces about 5.5 % and 7.8 % of the world total meat and milk respectively (Steinfeld, 2003). The apparent inefficiency of ruminant livestock production in Africa was attributed (Adeloye, 2001) to unfavourable climate, disease prevalence and feed shortage especially during dry seasons. The first two factors tend to encourage adoption of intensive ruminant farming system which can further aggravate the problem of inadequate feed supply. Costs of feeds and feeding under intensive production

System account for about 60 % of the total production cost when compared to 40 % value under extensive production system (Atteh, 2002). A substantial reduction in the cost of feeds, achievable through the use of unconventional feed resources such as shed tree leaves, would bring about improvement in ruminant production efficiency in the resource poor developing countries like Nigeria.

The aim of the present work was to exploit the potential of shed tree leaves- which presently, are of little or no economic value but constitute environmental nuisance- for goat feeding under intensive system of production. Specifically, the study sought to; i- characterize three shed leaves in terms of nutrients and anti-

nutrients compositions and ii- assess nutritional values of the three shed tree leaves based feeds through a feeding trial with goat.

Materials and Methods

Site and Period of the Study

Feeding trial and laboratory analyses were conducted in the Animal Pavilion and Animal Production Laboratory respectively at the Department of Animal Production, University of Ilorin located on Latitude: 08° 29'N; Longitude: 004° 35'E; Elevation: 308 m, having a mean annual rainfall of 98.75 mm that is spread largely over the months of May to October.

Collection and Processing of Shed Tree Leaves

Shed leaves of three major tree species in the locality of the main campus of the University of Ilorin were collected during the dry season months of November and December. The three tree species involved in the study were; *Vitellaria paradoxa*, *Gmelina arborea* and *Daniella olliveri*. Fifty kilogram (50 kg) of each of the three shed leaves was sun dried for 2-3 days and kept inside jute bags in a well-ventilated open shed that was protected from rain and direct rays of sunlight. The leaves were later processed individually, by grinding in a hammer mill to pass through 2-mm sieve and kept in jute bags for subsequent feed formulation. Samples of the three shed leaves were analyzed for gross energy, dry matter and chemical components including minerals and condensed tannins (Table 1).

Feed Formulation and Processing

Each of the three ground shed leaves was mixed with corn bran, soy bean meal, bone meal and sodium chloride in the proportions indicated on Table 2. The resultant feeds were processed into crumbles to reduce dustiness, facilitate

handling and encourage intake by animals. Each feed was wetted with about 2 % (V/W) clean drinking water and sun-dried on concrete slab for 5-6 hours.

Feeding Trial with Goats

Design of the Experiment and Animal Management

A 56-day growth and nutrient digestibility trial was conducted with sixteen weanling male West African Dwarf goats of average initial live weight 12.18 ± 0.62 Kg. Goats were divided into three dietary treatment groups in a completely randomized design. Treatments consisted of shed leaves of *Vitellaria paradoxa*, *Gmelina arborea* or *Daniella olliveri* tree mixed in an all concentrate diet with corn bran, soy bean meal, sodium chloride, and bone meal (Table 2).

Collection of Data and Analyses

Goats were weighed on the first day and subsequently every fortnight, immediately prior to feeding. Faecal samples were composited for each animal over a 7-day collection period, oven dried until constant weight at 60° C, ground and stored in air-tight plastic container prior to nutrient analyses. Urine production by the individual goat was measured daily during the 7-day collection period. Urine was collected through a perforation in a polythene sheet fastened underneath metabolic cages and into a plastic bucket previously wetted with 10 ml concentrated sulphuric acid. Aliquots (10 %) of daily urine excretion were pooled and preserved for subsequent chemical analyses. Feed and faecal samples were analyzed for dry matter, and crude protein (AOAC, 1980), NDF and ADF (Van Soest *et. al.* 1991). The method of Porter *et al* (1986) was used to estimate levels of condensed tannins in the leaf and feed samples. Empirical data were subjected to statistical analysis (Steel and Torrie,

1980) with significant difference between means estimated using the Duncan's

(1955) multiple-range test.

Table1: Dry matter and Chemical Compositions of the Shed Tree Leaves

Item/Species	<i>Vitellaria, paradoxa</i>	<i>Gmelina, arborea</i>	<i>Daniella, olliveri</i>
Dry matter, %	96.21	94.72	96.87
Chemical components as % of Dry matter			
Crude protein	7.26 ^{ab}	8.43 ^a	6.84 ^b
NDF	66.27 ^{ab}	61.56 ^b	72.16 ^a
ADF	47.18	50.31	45.47
Calcium, %	0.41 ^a	0.56 ^a	0.25 ^b
Phosphorus, %	0.16 ^b	0.48 ^a	0.31 ^a
Condensed tannin, %	7.32 ^a	8.73 ^a	6.87 ^b

a,,b,c – means within a row having similar superscript letter are similar (P > 0.05)

Results and Discussion

Laboratory Assessments

Table 1 shows data on dry matter, and chemical compositions of the three shed leaves as obtained from laboratory analyses. Neutral Detergent Fiber and Acid Detergent fiber contents of the shed tree leaves were within the range of values reported (Eniolorunda *et. al.*, 2008) for *Panicum maximum* hay. Typically, the three shed tree leaves were deficient in crude protein but rich in fiber and therefore, could not be fed to promote production in the goats without appropriate supplementation. Corn bran and soy bean meal included in the feed formulation would respectively provide fermentable carbohydrate and nitrogen to compliment the supply of nutrients from the dry forages and encourage rumen degradation.

In terms of chemical composition, the shed tree leaves differed in crude protein, Neutral Detergent Fiber (NDF), calcium, phosphorous and condensed tannins levels. Higher level (P < 0.05) of NDF with a relatively lower level (P > 0.05) of Acid Detergent Fiber was observed in shed leaves of *Daniella oliveri* than in *Vitellaria olliveri* or *Gmelina arborea* shed tree leaves. The Acid Detergent Fiber (ADF) values range of 45.47 50.31 % recorded for the three shed tree leaves

In the present study, were higher than the average value of 31 % obtained (Akinlade *et. al.* 2001) on fresh *Ficus canpensis* tree leaves but felt within the range of values for roughages in the NRC (1984) Table of nutrients composition. High dietary NDF contents could reduce voluntary feed intake \and increase ruminal rate of passage in ruminants.

Condensed tannins concentrations of the shed leaves were; 7.14, 8.72 and 6.25 % dry matter for Daniella, Gmelina and Vitellaria tree species respectively. The values were above the range of 3.0-5.0 % reported (Reed 1986) as tannin contents of several browse species in Africa. Adverse effects of tannins on performance characteristic of goats at dietary concentrations above 5 % had been reported (Konolong 2001). Thus, the shed tree leaves could be unsuitable as sole sources of nutrients to goats because of their high tannin concentrations. However, when mixed with suitable feedstuffs a dilution of the tannins levels would be achieved. In the present study, tannin concentrations (% DM) of the shed tree leaves-based diets were; 3.48, 4.12 and 3.09 for Vitellaria, Gmelina and Daniella shed tree leaves respectively. At low dietary levels, tannin would reduce

incidence of bloat (Lees 1992) and protect dietary protein from rumen degradation (Bengaly *et. al.* 2006).

Growth and Digestibility Study with Goats

Composition and nutritional values of diets used in the 56-day growth and digestibility trial are presented in Table 2. Inclusion levels of the shed tree leaves at 54-57 % in the diets were lower than the 70 % level of shed *Magnifera indica* leaves previously used (Reddy and Reddy, 1984) in a complete diet fed to sheep. The crude protein levels of the three shed tree leaves based diets satisfied the ARC (1984) recommendation of 113 g crude protein /Kg diet, for growth in ruminant animals. An all concentrate diet of similar crude protein level had previously been used (Bengaly *et. al.* 2007) to obtain body weight gain of about 22 g/day in boar goats. The shed tree leaves based diets were palatable and acceptable to the goats with intakes high enough to allow for body weight gain. Dry matter intakes expressed as percentage of body weights were; 2.49, 2.01 and 2.33 % for goats on Vitellaria, Gmelina and Daniella shed leaves treatments respectively. Lower dry matter intake in goats on shed Gmelina tree leaves treatment is probably due to a higher level of tannins. High dietary tannins level has been attributed to a reduction in appetite (Provenza, 1995) and incidence of post-ingestive malaise (Silanikove, 2001) especially in animals on low-nitrogen diets. The high nitrogen contents of diets in the present study could have had ameliorative effects on tannins in the goats. Sheep on a high protein diet supplemented with tannin extracts consumed more feed than the

Control animals (Athanasiadou *et. al.*, 2001). Dry matter digestibility was lower ($P < 0.05$) for goats on Gmelina shed leaves treatment than for those receiving Vitellaria or Daniella shed leaves-based diet. A high level of Acid Detergent Lignin, ADL, high condensed tannin or both could cause a reduction in feed digestibility as observed by Longo *et. al.*, (2008). ADL was not estimated for in the present study, but condensed tannin content of Gmelina leaves was similar to that of Vitellaria indicating that differences in ADL levels or some other dietary factors could be responsible.

Shed Gmelina leaves based diet supported body weight gain in the goats but at levels lower ($P < 0.05$) than the body weight gains of goats on shed Daniella or Vitellaria dietary treatment. Body weight gain (g/day) of 18.75 recorded for goats on Gmelina shed leaves based diet only represented 66.87 and 68.63 % of the values obtained for goats on Vitellaria and Daniella shed leaves based diets,

respectively. Goats on Gmelina shed leaves treatment utilized feed for body weight gain poorly ($P < 0.05$) when compared with either of the other dietary groups (Table 3). The efficiency at which goats convert feeds for body weight in the present study compares favourably with the values obtained in a previous study (Yousuf *et. al.*, 2006) when West African Dwarf goats of similar body weights were fed *Panicum maximum* hay supplemented with Gliricidia-, Leucaena- or Cassava-leaf meal. Efficiency of feed utilization for production or reproduction is a function of nutrients profile of feeds as well as the level of production and physiological condition of the animals.

Shed leaves as feed for goat

Table 2: Ingredient Composition of Diets used in the Feeding Trial

Item/Diet	Vitellaria paradoxa	Gmelina arborea	Daniella olliveri	SEM
Vitellaria paradoxa	56	-	-	
Gmelina arborea	-	54	-	
Daniella olliveri	-	-	57	
Corn bran	25	28	22	
Soy bean meal	18	17	20	
Sodium Chloride + Bone meal (1:1)	1	1	1	
Chemical Composition, as % of Dry matter				
Crude protein,	15.68	15.37	15.40	1.36
Neutral Detergent Fibre, NDF	42.06	38.40	46.11	4.48
Acid Detergent Fibre, ADF	28.97	29.74	28.57	2.11
Calcium	0.31	0.36	0.23	0.11
Phosphorous	0.31	0.43	0.41	0.16

Effects of treatments on nitrogen economy in the goats differed significantly ($P < 0.05$) among treatment groups with goats on shed Gmelina leaves based diets having lower ($P < 0.05$) dietary nitrogen intake than the other dietary groups. Loss of nitrogen through urine was higher ($P < 0.05$) for goats fed Gmelina shed leaves based diet; the

differences caused a reduction ($P < 0.05$) in nitrogen retention. Lower nitrogen retention resulting from increased nitrogen losses through faeces or urine was attributed to higher tannin intake as noted (Tripathi *et. al.* 2006) in lambs fed tree leaves with varying levels of concentrate.

Table 3: Performance Characteristics of Goats fed the Shed Tree Leaves based Diets

Item/Diet	Vitellaria paradoxa	Gmelina arborea	Daniella olliveri	SEM
Live Weight Gain				
Initial Live weight, Kg	12.56	12.14	11.89	2.13
Final Live weight, (Kg)	14.13	13.19	13.42	3.18
Live weight gain, (g/d)	28.04	18.75	27.32	1.87
Dry matter Intake				
Dry matter intake, (g/d)	332.17 ^a	248.26 ^c	294.66 ^b	8.46
Dry matter intake, (g/W Kg/day)	47.59 ^a	36.98 ^b	43.91 ^a	4.43
Feed Conversion Ratio	11.85 ^b	13.24 ^a	10.78 ^b	0.76.
Dry matter and Nutrient Digestibility				
Dry matter, %	76.68 ^a	71.06 ^b	75.14 ^a	2.04
Crude Protein, % DM	46.25	44.51	42.87	7.26
NDF, % DM	62.09	61.74	63.82	5.71
ADF, % DM	58.77	57.94	57.72	8.23
Nitrogen Economy, g/day				
Nitrogen intake	8.35	6.12	7.27	0.39
Faecal nitrogen	4.74 ^a	1.39 ^b	3.51 ^a	0.62
Urinary nitrogen	2.43 ^b	3.87 ^a	2.68 ^b	0.25
Nitrogen retained	1.18 ^a	0.86 ^b	1.08 ^a	0.12

a, b, c – means within a row carrying similar superscript letter are similar ($P > 0.05$).

SEM - Standard Error of treatment Means

Conclusion

Each of the three shed leaves as used in the present study was found suitable as a source of roughage in the diets of goats. The shed tree leaves were ranked in the order; Vitellaria > Daniella > Gmelina on the basis of the animals' performance responses vis-à-vis, voluntary feed intake, nitrogen retention and body weight gain, to dietary treatments. The use of shed tree leaves in ruminant feed formulation would ensure non-seasonal availability of roughages and provide opportunity for economic recycling of a potential pollutant to the environment. Appropriate supplementation strategies to enhance the feeding values of shed tree leaves based diets are to be exploited in subsequent studies.

Acknowledgement

The assistance of Mr. Jaiyeoba, C. of Animal Production Laboratory, University of Ilorin in matters relating to chemical determinations is gratefully acknowledged.

References

- Adeloye, A. A. 2001.** Nigerian Small Ruminant Species PP. 3-15 Corporate Office Max Ilorin, Nigeria
- Akinlade, J., Olanite, J. A and Bamikole, M. A. 2001.** Dry matter degradation characteristics of rice stover with different proportions of *Ficus capensis* or *Alchornea cordifolia* in rumen fistulated sheep, goat or cattle. *Nig. J. Anim. Prod.* 28(2): 174-181
- AOAC, 1990.** Official Method of Analysis. Association of Official Analytical Chemists 15th.edition Washington, DC. USA.
- ARC 1984.** Agricultural Research Council. The Nutrient Requirements of Livestock. Commonwealth Agricultural Bureaux, Slough,

England.

- Athanasiadou, S., Kyriazkis, I., Jackson, F and Coop, R. L. 2001.** The effects of Condensed tannins supplementation of foods with different protein content on parasitism, food intake and performance of sheep infected with *Trichostrongylus columbriformis*. *Brit. J. Nutr* 86, 697-706.
- Atteh, J. O. 2002.** Principles and Practice of Livestock Feed Manufacturing. PP. 33-201 Adlek Printers Ilorin, Nigeria
- Bengaly, K., Mhlongo, S and Nsahlai, I. V. 2006.** Influence of wattle tannin on nitrogen utilization by goats. 41st Congress of South African Society for Animal Science(SASAS), 3-6 April 2006, Bloemfontein, Odeion, University of the Free State, South Africa
- Bengaly, K., Mhlongo, S and Nsahlai, I. V. 2007.** The effect of wattle tannin on intake, digestibility, nitrogen retention and growth performance of goats in South Africa. *Liv. Res. Rural Dev.* 19 (4) . <http://www.cipav.org.co/llrd/llrd19/4/cont1904.htm>
- Duncan, D. B. 1955.** Multiple range and multiple F-test. *Biometrics*. 11:1-2
- Eniolorunda, O. O., Jinadu, O. A and Ogungbesan, M. A. 2008.** Effect of combined levels of *Panicum maximum* and *Gliricidia sepium* on nutrient digestibility and utilization by West African Dwarf goat fed cassava based diet. In:
- Komolong, M. K., Barber, D. G and McNeill, D. M. 2001.** Post-ruminal protein supply and N retention of weaner sheep fed on a basal diet of Lucerne hay (*Medicago sativa*) with increasing levels of quebracho tannins. *Anim. Feed Sci. Tech.* 92, 59-

- Lees, G. L. 1992. Condensed tannins in some forage legumes: Their roles in the prevention of ruminant pasture bloat. In Plant Polyphenols (editors: R W Hemingway and P E Laks), PP. 915-934. Plenum, New York
- Longo, C., Nozella, E. F., Cabral Filho, S. L. S., Lavoretti, N., Vitti, D. M. S and Abdalla, A.L. 2008. Voluntary intake, apparent digestibility and nitrogen balance by Sheep supplemented with *Leucaena leucocephala*. *Liv. Res. Rural Dev.* 20 (11)<http://www.cipav.org.co/llrd/llrd20/111/cont2011.htm>
- NRC. 1984. Nutrient requirement of goats. Angora, Dairy and Meat goats in temperate and tropical countries. No 15. National Research Council National Academy Press, Washington, D. C, USA.
- Porter, L.J., Hrstich, L.N and Chan, B.C. 1986. The conversion of procyanidins and prodelphinidins to cyanidin and delphinidin. *Phytochemistry* 25:223230.
- Provenza, F. D. 1995. Postingestive feed back as an elementary determinant of food selection and intake in ruminants. *J. Range Mngt* 48: 2-17.
- Reddy, G. V and Reddy, M. R. 1984. Dry fallen mango tree leaves as roughage source in the complete feeds of sheep. *Indian J. Anim. Sci.* 54: 1046-1050.
- Reed, J. D. 1986. Relationships among soluble phenolics, insoluble procyanidins and fiber in East African browse species. *J. Range Mngt* 39: 5-7
- Silanikove, N., Perevolotsky, A and Provenza, F. D. 2001. Use of tannin binding chemicals to assay for tannin and their negative ingestive effects in ruminants *Anim. Feed Sci. Tech.* 91: 69-81
- Steel, R. G. D and Torrie, J. H. 1980. *Principles and procedures of statistics A biometric approach.* 2nd Ed. PP. 6 -23. McGraw Hill, New York
- Steinfeld, H. 2003. Economic constraints on production and consumption of animal Source foods for nutrition in developing countries. *J. Nutr.* 133:4054S-4061S.
- Tripathy, M. K., Karim, S. A., Chaturvedi, O. H and Singh, V. K. 2006. Effect of *ad libitum* tree leaves feeding with varying levels of concentrate on intake, microbial protein yield and growth of lambs. *Liv. Res. Rural Dev.* 18 (12):<http://www.cipav.org.co/llrd/llrd18/12/cont1812.htm>
- Van Soest, P.J., Robertson, J.B and Lewis, B.A. 1991. Method for dietary fiber, neural detergent fiber and nonstarch Polysaccharides in relation to animal nutrition. *J. Dairy Sci.* 74, 3583-3597.
- Yousuf, M. B., Belewu, M. A., Daramola, J. O and Ogundun, N. J. 2007. Protein supplementary values of cassava- leucaena- and gliricidia- leaf meals in goats fed low quality *Panicum maximum* hay. *Liv. Res. Rural Dev.* 19(2): <http://www.cipav.org.co/llrd/llrd19/2/cont1902.htm>