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Nutrient intake, body weight changes, apparent nutrient digestibility and nitrogen utilisation of West African Dwarf goats fed four phytogenic browse plant parts in their diets

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***Target Audience:** Livestock farmers, Ruminant nutritionists and Extension agents*

Abstract

The study was conducted to evaluate the nutrient intake, body weight changes, apparent nutrient digestibility and nitrogen utilisation of West African dwarf (WAD) goats fed four phytogenic browse plant (Mangifera indica, Nauclea latifolia, Gmelina arborea and Alchonea cordifolia) leaf meals. Four diets T_1, T_2, T_3, and T_4, were formulated such that 20% each of Mangifera Indica, Nauclea latifolia, Gmelina arborea and Alchonea cordifolia leaf meals was included to each of the four diets respectively. Four WAD bucks of about 6 – 8 months old were used for this experiment. Each of the goats received one of the four treatment diets in a 4 x 4 Latin Square arrangement. Data obtained from the study were subjected to analysis of variance (ANOVA) applicable to a 4 x 4 Latin Square experimental design. The results showed that supplement DM intake, basal DM intake, total DM intake, CP intake and ash were significantly ($P<0.05$) higher for the goats fed T_1, T_2 and T_3. The goats fed T_2 had significantly improved ($P<0.05$) daily weight gain and feed conversion ratio. The DM, CP, ash were better digested ($P<0.05$) in T_2 than in any other treatment. ADL was however better digested ($P<0.05$) in T_1. The nitrogen intake, N-balance, N-retention and N-absorbed values were significantly ($P<0.05$) higher for goats fed T_2. T_2 was recommended among the other diets for feeding goats, as it had better performance with respect to nutrient intake, body weight gain, feed conversion ratio, nutrient digestibility and utilisation.

***Keywords:** Mangifera indica, Nauclea latifolia, Gmelina arborea, Alchonea cordifolia, leaf meal, goats*

Description of Problem

Goats are among the most important livestock species in Nigeria with an estimated population of approximately 53.8 million heads (1). There are available markets for goats in the Southern Nigeria, since they are needed virtually in all cultural and traditional practices in Igbo land and its environs. Goat production is vital as it is seen as one of the futures of food security and to the realization of animal protein adequacy in Nigeria; with about 211,400,708 people currently depend on it as one of the major animal protein sources. Goats are well distributed and adapted to all ecological zones of the country. Their ease of adaptation and distribution maybe attributed to the increase in their numerical values.

Seasonal variations, which is accompanied by surplus of forages during the rainy season and deficit of forage during the dry season, has been seen as one of the major challenges to goat production (2). Natural pastures and crop residues available during the dry season are usually lignified and deficient of most essential nutrients needed for improved performance of the animals fed such diets. This has resulted to poor nutrient intake, poor growth rate, poor digestibility, weight loss, low birth, weaning and slaughter weights, lowered resistance to disease and overall poor performance of the animal. There is need to address this problem ravaging goat production/nutrition in Nigeria. In response to this, the usual practice has been to supplement ruminant diets with energy and protein rich conventional ingredients. This may have resulted to improved performance of the animal, but regrettably, these supplements are usually not fed on reason bothering on scarcity, competition between man and monogastrics and high cost. Cheaper alternative means of enhancing utilization of low quality forage is by supplementation with the foliage of phytogenic plants. Recently attentions are shifted to phytogenic plant materials due to their growth promoting and medicinal properties (3). It is worthy to note that the phytogenic plants considered in this study are browse plants. Browse plants have been reported (4) to have advantages over grasses due to their drought resistance ability, foliage availability throughout the year and they constitute one of the cheapest source of feed for ruminants.

Alchornea cordifolia is a relatively unexploited browse plant for goats (5). *Alchornea cordifolia* is known by diverse names, Christmas bush (English), Ububo (Igbo), Bambani (Hausa), Ipa/epa (Yoruba), is a small sprawling shrub, with many branches and found growing universally in the rainforest and derived savanna zones. A. *cordifolia* grows well in tropical environment and provides fodder all year round in the wild. The leaves have been reported to be high in vitamins, essential amino acids, minerals and antioxidants (6). The leaves are cherished by ruminants and are used by subsistence farmers who harvest them for their livestock (7). *A. cordifolia* leaves have been reported (8; 9) to have phytogenic and ethno-veterinary properties. *Nauclea latifolia,* pincushion tree (English), Uvuru ilu (Igbo), Egbo egbesi (Yoruba) and Tabasiya (Hausa**),** is an evergreen, multi-stemmed shrub of tropical Africa and Asia origin. It is a tropical plant that can be found in many parts of Nigeria especially in the rain forest and derived savanna zones. Three other related species *Nauclea pobeguini, N. diderichii*, and *N. vanderguchtii* are forest trees. The leaves are relished by goats and they contain appreciable amounts of vitamins, proteins, and minerals. *Nauclea latifolia* leaves have been reported (10; 11) to have phytogenic and ethno-veterinary properties. *Mangifera indica* Linn (common name: Mango) originated from South Asia from where it was dispersed to the rest of the world. *Mangifera indica* is a multi-purpose fruit bearing tree that still has considerable fodder yield during the rainy and dry seasons. *Mangifera indica* offers a good alternative source of feed during the dry season in Nigeria and most other countries. Mango leaves can be exploited for its potential use as a supplementary fodder for ruminants (12). The phytogenic and ethno-veterinary properties of mango leaves have been reported (13; 12; 14). *Gmelina arborea* is a deciduous evergreen perennial fast growing tree. They are multipurpose tree that produces appreciable quantities of fodder even at the peak of dry season. The leaves are unconventional materials that can be explored for the production of feedstuff. The leaves are one of the tree leaves considered as important sources of nutrient for ruminants especially areas with pronounced dryness (15). (16) reported enhanced weight gain and better performance on small ruminants fed *Gmelina arborea* leaves. The phytogenic and ethno-veterinary properties of *Gmelina arborea* leaves have been reported (17; 18). There is the need to search for plants leaves with phytogenic properties to enhance the nutrient intake, weight gain and utilization for goats. Alongside this framework**,** the nutrient intake, body weight changes, apparent nutrient digestibility and nitrogen balance of West African dwarf goats fed *Alchornea cordifolia*, *Gmelina arborea*, *Mangifera indica* and *Nauclea latifolia* leaf meal containing diets were studied.

Materials and Methods

The research work was carried out at Sheep and Goat unit of Federal College of Agriculture Ishiagu, Ivo Local Government Area of Ebonyi State, Nigeria. The College is located at about three Kilometer (3km) away from Ishiagu main town. The College is situated at latitude 5^0 6N and longitude 7^0 31'E with average rainfall of 1000-1600mm and a prevailing air temperature condition of 27-28^{0}C and relative humidity of about 88% respectively (2).

The leaves of *Mangifera indica, Nauclea latifolia, Gmelina arborea* and *Alchonea cordifolia* were sourced within the college and Ishiagu environs. Fresh, succulent, greenish not over matured leaves were harvested to ensure lower lignin content and higher nutrient content and availability. The leaves were air dried in batches to about 10-15% moisture before passing through a 10 mm hammer mill before used for the formulation of the experimental diets. Four diets T_1, T_2, T_3, and T_4, were formulated such that 20% each of *Mangifera Indica, Nauclea latifolia, Gmelina arborea* and *Alchonea cordifolia* was included to the four diets (T_1, T_2, T_3, and T_4) respectively as presented in Table 1.

Table 1: Composition of the experimental diets

Ingredients (%)	T_1	T_2	T_3	T_4
Palm kernel cake	31.5	31.5	31.5	31.5
Soy bean meal	5.0	5.0	5.0	5.0
Brewers dried grain	40.0	40.0	40.0	40.0
Mangifera indica	20.0	0.0	0.0	0.0
Nauclea latifolia	0.0	20.0	0.0	0.0
Gmelina arborea	0.0	0.0	20.0	0.0
Alchonea cordifolia	0.0	0.0	0.0	20.0
Salt	1.0	1.0	1.0	1.0
Bone meal	2.0	2.0	2.0	2.0
Premix	0.5	0.5	0.5	0.5
Total	100.0	100.0	100.0	100.0

Four WAD intact bucks of about 6 – 8 months old were used for this experiment. The animals were kept under zero grazing, and supplementary feeding was based on 3% body weight per head per day on DM basis. The animals were subsequently transferred to previously disinfected individual metabolism cages provided with facilities for collecting faeces and urine. They were fed four experimental diets in a 4 x 4 Latin square design. Each animal received the experimental diets consecutively in 4 phases.

Four WAD bucks of about 6 to 8 months of age and averagely weighing 6.24 kg were used for this trial. The bucks were housed in metabolism cages which allowed total urine and faecal collections. The bucks were accustomed to the metabolism cages for three days (adaptation period) prior to intake, digestion trials and nitrogen utilization study. The animals were adjusted to the diets for two weeks.

After the adjustment period, the animals were assigned randomly to the four test diets (T_1, T_2, T_3 and T_4) in a 4 x 4 Latin square design. The animals were fed the diets twice per day at 07:30 h and 13:00 h. Feed offered was based on 3% body weight per day; the animals in addition were fed 1kg wilted chopped *Panicum maximum* later in the day (17.00 h). Fresh clean water was provided free choice.

The metabolic cages had a mesh floor with a funnel tray underneath. The goats were given the experimental diets and the basal feed (*Panicum maximum*) for 28 days. Data collection was between day 21 and 28. The quantity of faeces excreted was measured daily over a 7-day collection period for each buck. Faeces collected were bulked for each buck over the 7-day period, and 20% of the faecal samples were bulked for each animal. Each animal had four bulked samples representing the four treatments groups, thus giving 16 bulked faecal samples. The faecal samples were then freezed, dried and stored until further analysis. Faecal samples were analyzed for nitrogen content.

The funnel tray underneath the crate allowed for urine collection into a plastic bucket. Each day, 240ml of concentrated sulphuric acid (H_2SO_4) was put into the collection bucket to prevent nitrogen loss. The volume of urine collected per animal was measured daily and 10 % was pooled (for each period of the digestibility and nitrogen utilization study) over the 7-day period giving a total of 16 samples. The pooled samples were stored at 4°C for further analysis. Urine samples were analysed for Nitrogen.

All faecal samples were analysed for proximate components using (19) method. The fibre fractions such as neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined according to the methods of (20). Data obtained were analyzed using analysis of variance (ANOVA) as described by (21). Significant means were separated using the Duncan multiple new range test.

Results and Discussion

Table 2 shows the chemical compositions of the four phytogenic browse plant parts. Crude protein (CP), ash, acid detergent fibre (ADF) and acid detergent lignin (ADL) showed significant ($p<0.05$) differences while dry matter (DM), gross energy (GE) and neutral detergent fibre (NDF) were not significantly ($p>0.05$) influenced across the groups. The CP value of *Mangifera indica* was significantly ($p<0.05$) lower than *Nauclea latifolia*, but similar ($p>0.05$) to *Gmelina arborea* and *Alchonea cordifolia*. The mean CP value of 18.97% obtained in this study is high in comparison with that of grasses of tropical origin, which rarely surpass 15% CP (22). The mean CP value of 18.97% compare favourably with 17.66% CP reported for cassava leaf meal reported by (23) and higher than the 10 to 12% minimum protein requirements for goats estimated by (24). The lowest CP value of 17.22% for *Magnifera indica* reported in this study is well above the 7.0–8.0 g/100 g DM recommended as grave limit, below which intake of forages by ruminants and rumen microbial activities may be negatively affected (25). The relatively high CP content of the phytogenic browse plants parts in this study is a suggestion of their dietary superiority for ruminants since CP value is a very important index of nutritive quality of a diet. This thus justifies their use as supplements to poor quality crop residues. The CP range of 17.22 to 20.84% reported in this study compared with 13.32 – 25.85% reported by (26) for leaf meals of selected browse plants of southeastern Nigeria. The 20.84% CP of *N. latifolia* compares favourably with 19.14% and 18.66% for *G. arborea* and *A. cordifolia* respectively. The mean ash content of the four browse fodders (12.86%) is high when compared with 6.83% and 8.51% reported by (27) for some guinea savannah browse plants of Nigeria and (26) for selected browses of southeastern Nigeria. *Nauclea latifolia* recorded significantly ($p<0.05$) high proportion of ash (16.65%) than the values recorded for the other browse forages. The ash content of any feed indicates the mineral value of that particular feed. ADF refers to a fraction of indigestible plant material in forage, usually cellulose fibre coated with lignin. The mean ADF and ADL fractions obtained in the present study compare favourably with 27.61% and 8.91% reported by (27) for some guinea savannah browse plants of Nigeria. The mean ADF and ADL values of 23.89% and 11.30% were low to moderate when compared with low quality roughages, which ruminants can successfully degrade (28). The low to moderate fibre fraction contents of the phytogenic browse fodders may indicate high nutritive worth since fibre plays an important role in voluntary intake and digestibility. *Nauclea latifolia* produced significantly ($p<0.05$) lower ADF and ADL values in comparison with other browses in this study. Lignin content is negatively correlated to the digestibility of feedstuff, so the lower the lignin content in the diet, the higher the feed value. The variability in the nutrient contents of the phytogenic browse leaf meals may be attributed to species differences, season, harvesting regimen, location, soil type and age.

Table 2: Chemical composition of the four phytogenic plant parts

Phytogenic plant parts (leaf meal)	*Mangifera indica*	*Nauclea latifolia*	*Gmelina arborea*	*Alchonea cordifolia*	Mean	SEM
Dry matter (%)	93.36	92.17	93.02	92.79	92.84	1.10
Crude protein (%)	17.22^{b}	20.84^{a}	19.14^{ab}	18.66^{ab}	18.97	0.51
Ash (%)	12.65^{b}	16.65^{a}	11.57^{b}	10.55^{b}	12.86	0.81
Gross energy (MJ/Kcal/g)	381.20	343.12	392.33	391.21	376.97	14.83
Neutral detergent fibre (%)	40.81	41.62	46.94	44.26	43.41	1.32
Acid detergent fibre (%)	25.70^{a}	19.11^{b}	24.58^{a}	26.18^{a}	23.89	1.56
Acid detergent lignin (%)	12.17^{a}	6.50^{b}	12.39^{a}	14.13^{a}	11.30	1.20

$^{a-b}$ Means within the same row with different superscripts are significantly different ($P<0.05$)

The chemical composition of the experimental diets is presented in Table 3. CP, ash and ADL showed significant ($p<0.05$) differences while DM, gross energy, NDF and ADF remained similar ($p>0.05$). T_2 showed significantly high CP value when compared with the other treatments. The high CP reported for T_2 may be attributed to the high CP value of *Nauclea latifolia.* However, the CP range of 12.87 – 15.62% obtained in this study is well above the minimum protein requirement of 6 – 8 g/100g for ruminants suggested by (29). Ash content varied among the treatments with T_2 having the highest value (15.36%) and T_1 having the least value (11.60%). The significantly high ash value reported for T_2 may imply that T_2 could be high in essential mineral elements, which may be essential for high productivity for goats. Hence, mineral deficiencies may not likely occur among the goats fed diet. T_2 showed significantly lower ADL value when compared with T_1. The low ADL reported for T_2 may be attributed to lower value reported in this study for *Nauclea latifolia.* The low to moderate ADL 9.18 -11.58% reported in this study may imply that the quality of the experimental diets were not compromised.

Table 3: Chemical compositions of the experimental diets

Parameter	Dietary levels T_1	T_2	T_3	T_4	SEM
Dry matter (%)	92.67^b	93.01^a	92.10^b	92.28^{ab}	0.12
Crude protein (%)	13.55^b	15.62^a	13.33^{bc}	12.87^c	0.32
Ash (%)	11.60^c	15.36^a	12.72^b	12.66^b	0.44
Gross energy (MJ/Kcal/g)	381.16	387.30	381.81	382.41	15.01
Neutral detergent fibre (%)	29.85	29.31	31.56	29.73	1.39
Acid detergent fibre (%)	25.53	23.71	23.90	25.36	0.53
Acid detergent lignin (%)	11.58^a	9.18^b	10.00^{ab}	10.83^{ab}	0.38

$^{a-c}$ means within the same row with different superscripts are significantly different (P<0.05)

The nutrient intakes of West African dwarf goats fed four phytogenic browse plant leaf meals in their diets are presented in Table 4. All the parameter except total dry matter intake as percentage of body weight (total DMI % BW) NDF, ADF and ADL intakes showed significant (p<0.05) differences across the groups. T_4 produced significantly lower supplement dry matter intake in respect to the other groups. The potential role of the phytogenic browse plant leaf meals in improving dry matter intake by goats on poor quality tropical grasses cannot be over emphasized. Hence, the high supplement dry matter intake of the WAD bucks observed in this present study agree with (30) who reported high supplement dry matter intake among WAD bucks fed selected browse plants fed in combination with *Panicum maximum*. The study also agreed with the finding of (31) who reported that higher level of crude protein content of diet stimulates high dry matter intake. This is evidenced as the diet with the lowest crude protein value produced the lowest supplement dry matter intake. The basal dry matter intake was significantly high for the T_4 group. The high basal DM intake observed in T_4 may be attributed to lower supplement intake observed for the respective treatment, as the rumen may need to be filled with the consumption of more basal diet. (32) observed that even though dietary nutrients and palatability are necessary factors, which, influence intake in animals, satiety signals are set by a combination of such complex factors as gut fill, body fat and changes in the body chemical constituents. The animals fed T_4 had lower total DMI (g/day) than those fed other groups, which seem to suggest that high crude protein lead to increased DMI (g/day) in goats. This observation is in agreement with the converse relationship between DMI and crude protein content of diet reported by (33). The dry matter intake as % body weight though not significantly (P>0.05) influenced among the treatment groups were within the 2.8 - 4.0% recommended daily DM intake (as % BW) requirements for indigenous goats in Nigeria by (34). The crude protein intake (CPI) (g/day) of the T_2 group was significantly (P<0.05) higher than those of T_1, T_3 and T_4, probably as a result of a higher dietary crude protein content of T_2. It is worthy to note that the crude protein intake of the goats fed the four phytogenic browse plant leaf meal were higher than the minimum 41.50g/day recommended for goats (35).

Table 5 presents the body weight changes of WAD bucks fed four phytogenic browse plant leaf meal in their diets. There was no significant (p>0.05) difference for the initial weights of the WAD bucks but significant (p<0.05) differences were observed in the final body weights of the WAD bucks. Body weight gain and the daily weight gain were observed to have a similar pattern with bucks on T_2 having significantly (p<0.05) higher values and bucks on T_1 having significantly (p<0.05) lower values. The feed conversion ratio had significant (p<0.05) differences as the values ranged from 4.35 – 8.40, with goats on T_2 diet having the lowest value of 4.35 while those fed T_1 had the highest value of 8.40. There was improvement in final body weight, body weight gain, average daily weight gain, and feed conversion ratios among the bucks fed T_2 diet. Goats fed T_2 had the highest weight gain, this may be attributed to increased nutrient intakes, better digestibility and nitrogen utilization of the diet. The finding of this study is in agreement with the results of (36) who reported that weight gain is dependent on dry matter and protein intakes and the digestibility of the nutrients by the animals. The difference in feed conversion ratio among the experimental groups may be attributed to differences in the browse plants used. T_2 produce the best feed conversion ratio which may be attributed to the higher nutrient intakes and digestibility of the goats fed the diet. In this study, all the goats had improved weight gain, nutrient intakes and feed conversion ratio; this may imply that generally, the phytogenic browse plant leaf meals can be used to formulate dry season supplemental diets for goats due to the year round availability and nutritive values.

Table 4: Nutrient intakes of West African dwarf goats fed four phytogenic browse plant leaf meal in their diets

	Dietary levels				
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**
Supplement dry matter intake (g/d)	370.35^a	373.59^a	355.81^a	280.85^b	11.89
Basal dry matter intake (g/d)	86.97^b	86.96^b	80.11^b	103.95^a	5.32
Total dry matter intake (g/d)	457.32^a	460.55^a	435.91^a	383.85^b	13.18
Total DMI % BW (%)	3.52	3.74	3.23	3.23	0.98
CP intake (g/d)	51.65^b	62.74^a	51.50^b	41.77^c	2.97
Ash intake (g/d)	45.16^C	61.70^a	49.14^b	50.81^b	3.29
Neutral detergent fibre intake (g/d)	64.47	67.73	61.93	61.32	6.54
Acid detergent fibre intake (g/d)	57.37	55.24	52.33	51.78	4.77
Acid detergent lignin intake (g/d)	35.10	36.87	38.63	43.46	2.82

$^{a-c}$ means within the same row with different superscripts are significantly different (P<0.05)

Table 5: Body weight changes of West African dwarf goats fed four phytogenic browse plant leaf meal in their diets

	Dietary levels				
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**
Initial body weight (kg)	6.67	5.68	5.86	6.83	0.05
Final body weight (kg)	12.32^{ab}	15.21^{ab}	12.10^a	10.94^b	0.37
Body weight gain (kg)	5.95^b	9.53^a	6.24^b	4.11^c	0.34
Daily body weight gain (g/d)	66.11^b	105.89^a	69.33^b	45.67^c	0.98
Total dry matter intake (g/d)	457.32^a	460.55^a	435.91^a	383.85^b	13.18
Feed conversion ratio	6.90^b	4.35^c	6.29^b	8.40^a	2.97

$^{a-c}$ means within the same row with different superscripts are significantly different (P<0.05)

Table 6 shows the apparent nutrient digestibility of West African dwarf goats fed four phytogenic browse plant leaf meal in their diets. Results showed that T_2 had the highest ($p<0.05$) digestibility values for dry matter and crude protein. The dry matter digestibility (DMD) values ranged between 63.12 – 72.63%, with T_1 having 63.12% and T_2 having 72.63%. The crude protein digestibility of WAD bucks fed T_2 had the highest ($p<0.05$) value of 82.19% and least ($p<0.05$) value was observed in those fed T_1 (66.01%). The ash digestibility was also significantly high for bucks fed T_2 and T_3 in comparison with bucks T_1. NDF and ADF were not significantly ($p>0.05$) influenced. Nutrient digestibility have been reported (37) to increase with dry matter intake; this was also established in this present study as the dry matter digestibility of the goats was significantly high in T_2 with a corresponding significantly high dry matter intake. This study showed a positive relationship between protein intake and digestibility as the treatment (T_2) with the highest protein intake, also produced the highest protein digestibility. This is in consonance with the report of (38) who revealed a positive relationship between digestibility of diets and protein intake. ADL digestibility was best for goats in T_1 in comparison with other groups. The lower ADL digestibility observed T_2 may be attributed to the lower ADL content and ADL intake observed in in the respective treatment.

Table 6: Apparent nutrient digestibility of West African dwarf goats fed four phytogenic browse plant leaf meal in their diets

	Dietary levels				
Parameters (%)	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**
Dry matter	63.12^d	72.63^a	68.83^b	64.53^b	1.13
Crude protein	66.01^c	82.19^a	74.05^b	68.04^c	1.97
Ash	54.65^b	56.82^a	57.36^a	55.66^{ab}	0.45
Neutral detergent fibre	57.63	55.73	55.63	57.36	0.97
Acid detergent fibre	20.26	24.38	20.77	20.46	0.65
Acid detergent lignin	19.09^a	13.55^c	17.04^b	15.82^b	0.89

$^{a-c}$ means within the same row with different superscripts are significantly different ($P<0.05$)

The nitrogen utilization of West African dwarf goats fed four phytogenic browse plant leaf meal in their diets are presented in Table 7. The nitrogen intake, N- balance, nitrogen retention and nitrogen absorbed were significantly ($p<0.05$) 05) influenced by the diets. Urinary nitrogen, faecal nitrogen and total nitrogen excreted were not significantly ($p>0.05$) affected. Goats fed T_2 had the highest nitrogen intake of 18.96g/day while T_4 had the lowest of 11.45g/day. The superior nitrogen intake observed for buck fed T_2 may be attributed to the significantly high protein content and protein intake of the diet. This is in agreement with the findings of (30; 36). Nitrogen balance and nitrogen absorbed were significantly high in T_2 in comparison with other groups. This suggested a high utilization of protein in the diets by the WAD bucks. (39) noted that high nitrogen absorbed is an indication of positive nitrogen balance. The significantly high nitrogen retention obtained in T_2 is an indication of reduced nitrogen excreted by the WAD bucks, thus suggesting an improved nitrogen utilization and performance of goats on the diet. The enhanced nitrogen retention observed in T_2

could perhaps be due to the higher nitrogen intake by goats on the diet. The positive nitrogen utilization recorded in this study may suggest that the maintenance requirements of the goats were met adequately by the diets they consumed. This may also suggest that the nitrogen was well metabolized and utilized by the animals for muscle growth as nitrogen intake was higher than nitrogen excreted. This also submits that all the diets were adequate to meet the protein requirements for efficient rumen microbial activities.

Table 7: Nitrogen utilization of West African dwarf goats fed four phytogenic browse plant leaf meal in their diets

	Dietary levels				
Parameters (%)	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**
Nitrogen intake (g/day)	15.09^b	18.96^a	15.69^b	11.45^c	0.98
Urinary Nitrogen (g/day)	2.11	1.76	2.19	2.04	0.04
Faecal Nitrogen (g/day)	3.91	3.65	3.76	3.98	0.09
Total Nitrogen excreted (g/day)	6.02	5.41	5.95	6.02	0.71
Nitrogen balance(g/day)	9.07^b	13.55^a	9.74^b	5.43^c	0.83
Nitrogen retention (%)	60.11^b	71.47^a	62.08^b	47.42^c	1.97
Nitrogen absorbed(g/d)	11.18^b	15.31^a	11.93^b	7.47^c	0.68

$^{a-c}$ means within the same row with different superscripts are significantly different (P<0.05)

Conclusion and Applications

This study showed:

1. That the nutrient composition of the phytogenic browse plant leaf meals were nutritionally viable at 20% inclusion to form a dry season supplement for WAD goats.
2. That the WAD goats fed the four treatment diets showed improved performances especially on nutrient intake, weight gain, digestibility and nitrogen utilization.
3. That 20% Nauclea latifolia containing diet gave better performance and nutrient utilization response.

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