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# RUMEN FERMENTATION, NUTRIENTS DIGESTIBILITY AND NITROGEN UTILIZATION OF RED SOKOTO BUCKS FED *GMELINA ARBOREA* LEAF MEAL SUBSTITUTING SOYBEAN MEAL

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## ABSTRACT

A study was conducted to evaluate the effect of substituting soybean meal with *Gmelina arborea* leaf meal in twenty-four intact growing bucks (6 months old, live weight (LW) 6.29 ± 0.3 kg). The bucks were divided into four equal groups of similar LW in a complete randomized design. The anti-nutritive substances were all significantly different ($P<0.05$) except for total condensed tannin and alkaloid ($p>0.05$). Rumen ammonia ($NH_3$) and total volatile fatty acids (TVFA) showed significant difference ($p<0.05$) with higher values recorded in $T_1$ (0% GLM). Digestibility of DM and CP, OM, CF, NDF, ADF, ADL, were highest in $T_4$ (30% GLM substitution rate) while highest values was recoded Nitrogen free extract and ether extract digestibility in $T_1$. DCP, DOM, DCF were better in $T_4$ while DEE and DNFE were better in $T_1$. N retention, digestion absorbed, retained as N intake, absorbed as N intake were all highest for $T_4$ compared to other groups receiving *Gmelina arborea* leaf meal. Based on these findings, results indicates that *Gmelina arborea* leaf meal can substitute soybean meal in the diets of growing red sokoto bucks without causing any adverse effect on the animals.

## INTRODUCTION

Small ruminants form an integral part of the livestock economy in Nigeria. The arid and semi-arid areas are home to over 80% of small ruminants and their sustenance is reducing due to dependence on natural pastures (Kosgey *et al.*, 2008). They support 46-58% of pastoral households and play a significant role in the food chain and overall livelihoods of rural households, where they are largely the property of women and their children (Lebbie, 2004).

Browse plants have great potential as source of high quality nutrient for ruminants, being high in protein, minerals and vitamins (Njidda, 2011). They are available all year round because of their drought resistance, persistence, vigorous growth, re-growth and palatability (Crowder and Chheda, 1982). The use of browse plants as supplement has been shown to enhance intake, improve growth rate and increase reproduction in ruminants (Abdu *et al.* 2012; Njidda *et al.*, 2016 and Njidda *et al.*, 2018). Browse species because of their resistance to heat, draught, salinity, alkalinity, drifting sand, grazing and repeated cutting are the major feed resources in the dry season (Fagg and Stewart, 1994). Browse species that have shown remarkable promise in Nigeria are *Leucaena leucocephala, Gliricidia sepium* and *Gmelina arborea*.

*Gmelina arborea* Roxb (family verbenanceae) is a fast growing deciduous tree reaching up to 40 m tall and 140 cm in diameter, but usually smaller than this (Jensen, 1995). The leaves remain green to larger part of dry season and have been fed to ruminants with appreciable results (Lamidi *et al*., 2015). It is rich in protein (10.01 – 38.40% CP) reported by Osakwe and Udeogu 2007); Ahamefule *et al*., (2006) and Adu *et al*., (1996). Ukanwoko and Okehielem (2016) also reported that the high crude protein of *Gmelina arborea* makes it a good substitute for goat production. However, availability and cost reduction alone may not be beneficial (Crowder and Chheda, 1982). Browse plants are found all

year round in contrast to grasses which rapidly deteriorate with increasing fibre and decreasing protein content. Previous records (Osakwe and Udeogu, 2007; Ahamefule*et al*., 2006; Adu*et al*., 1996) have shown that the leaves contained as much as 10.01-38.4 % crude protein and 3.10-30.46 % crude fibre. However, availability and cost reduction alone may not be beneficial if performance indices such as growth, feed intake, weight gains and livability are adversely affected. This study was therefore carried out to ascertain the effect of *Gmelina arborea* leaves on the performance of red Sokoto goats (bucks) using groundnut haulms as replacer at varying levels.

## MATERIALS AND METHODS

### Experimental location

The experiment was carried out at the Kaduna State University Teaching and Research Farm, Kafanchan campus, Jema'a local Government area of Kaduna state, Nigeria. It is located within latitude 9°34'N and longitude 8°17'E. The vegetation of the area is the Guinea Savannah type and the area is designated as koppen's Aw climate with two distinct seasons, a wet season in summer and a dry season in winter. Rainfall occurs between the months of April to October with a peak in August. The mean annual rainfall is about 1800 mm and the mean monthly temperature is 25°C, while the relative humidity is about 63%, Ishaya and Abaje (2008).

### Animal management and diets

Sixteen Red Sokoto male goats (6 month old, live weight (LW) 6.29 ±0.3 kg) were housed individually in well-ventilated clean pens equipped with water and feed troughs. Before the experiment, all animals were given prophylactic treatments consisting of administration of antibiotics (Oxytetracycline), dewormed with albendazole and treated against ecto-parasites. An adaptation period of 2 weeks allowed the goats accustomed to the experimental diets and pen environment. At the end of the adaptation period, the goats were divided into three equal groups of similar LW, and groups were randomly assigned to one of three experimental fodders in a completely randomized design. Goats were weighed at the start of the experiment and at weekly interval. The dietary treatments compared were: $T_1$ fed diet containing 0% GLM, $T_2$ fed diet containing 10% GLM, $T_3$ fed diet containing 20% GLM and $T_4$ fed diet containing 30% GLM as shown in Table 1. The diets were offered twice daily (08.00 and 15.00 hours) in two equal portions. All animals had unrestricted access to water. Daily feed offered and orts were recorded and LW was measured weekly in the morning before feeding. The feeding and growth trials lasted for 84 days excluding the 2-week adaptation period.

**Table 1: Composition of the experimental diets (%)**

| Ingredients (%) | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|---|
| Gmelina leaf meal | 0 | 10 | 20 | 30 |
| Soya bean meal | 30 | 20 | 10 | 0 |
| Maize bran | 20 | 20 | 20 | 20 |
| Wheat offal | 20 | 20 | 20 | 20 |
| Groundnut cake | 10 | 10 | 10 | 10 |
| Cowpea husk | 18 | 18 | 18 | 18 |
| Premix | 2 | 2 | 2 | 2 |
| Total | 100 | 100 | 100 | 100 |

**Metabolism trial**

Immediately after the feeding trial, six goats were randomly selected per treatment and transferred into metabolism cages. Measurements of daily intake, faeces and urine for 7 d were preceded by 10 d of adaptation to the cages. Fresh feeds, feed refusals and faeces were sampled daily for determination of dry matter (DM) and chemical analysis. Samples of feed offered, orts, faeces and urine voided were collected every morning. Samples of the faeces and urine (100 g/kg portion of daily production) were pooled for each animal for the 7 d period and sub-sampled for analysis. The DM of feed and faeces was determined by drying to a constant weight in a forced air oven at $60^0$C. The dried samples were ground to pass through a 1 mm screen and preserved for chemical analysis. Urine was collected in plastic containers containing 20 ml of concentrated sulphuric acids to prevent loss of N by volatilization. The samples were later frozen pending chemical analysis.

**Rumen liquor collection**

Rumen fluid samples were collected before the morning feeding on the last day of the experiment by aspiration using stomach tube. The pH was measured immediately after collection with a digital pH metre. The liquor was then strained through four layers of muslin cloth, preserved by adding 5 ml of 1 M $H_2SO_4$ to 45 ml of rumen fluid and subsequently frozen pending analysis.

**Chemical analysis**

Samples were analysed for dry matter, ash, crude protein (CP), ether extract (EE) and acid detergent fibre (ADF) by the procedures of AOAC (2002). Neutral detergent fibre (NDF) was determined using sodium sulphite but without a heat stable alpha amylase (Van Soest *et al*., 1991). Both NDF and ADF expressed were inclusive of residual ash. Ruminal ammonia samples were analysed for Kjeldahl-N according to AOAC (2002). Concentrations of volatile fatty acid (VFA) in the rumen liquor were analysed by gas chromatography and auto-analyser as described by Zijlstra *et al.*. (1977). Condensed tannins (CTs) were determined by the methods of Makkar (2003) and expressed as gram equivalent leucocyanidins per kilogram DM.

**Statistical analysis and calculations**

Data were subjected to a one way ANOVA using version 9.1 of SAS software (SAS Institute, 2003). Significant difference between individual means were separated by Duncan's procedure.

## RESULTS

**Chemical composition of the diet**

There were significant difference ($P<0.05$) among all the parameters studied for the chemical composition (Table 2). Crude protein was highest (203.30 g $kg^{-1}$ DM) in $T_4$ (30% GLM substitution rate) and lower in $T_1$ (0% GLM substitution) while NDF, ADF, ADL were higher in $T_4$. $T_1$ has higher values for NFE hemicellulose compared to other treatment groups.

**Anti-nutritive substances**

The result of anti-nutritional constituents in the feed is shown in Table 3. Total condensed tannin varied from 0.43 mg/g DM in $T_2$ to 0.82 mg/g DM in $T_3$. Oxalate in the feed samples ranged from 0.92 mg/l DM in $T_3$ to 3.32 mg/g DM in $T_1$. Saponin content of the experimental diets range from 1.40 mg/g DM in for $T_1$ to 1.98 mg/g DM in $T_4$. The highest value of 1.57 and 0.58 mg/g DM was obtained in $T_1$ while $T_3$ had the lowest value of 0.74 and 0.24 mg/g DM for Phytic acid and hydrogen cyanide .The result showed no significant difference among the browse forages.

**Rumen Fermentation characteristics**

The results of rumen fermentation is shown in Table 4. The pH value was significantly higher ($p>0.05$) in $T_2$ compared to other treatment groups while, the values for $NH_3$ – N ranged from (29.49 to 31.77 mg/L). The TVFA was significantly ($p>0.05$) higher in $T_1$ ranging from 12.50 to 15.37 mg/L.

**Total tract digestibility and nutritive value**

DM, CP, OM, CF NDF, ADF, ADL digestibility were significantly (P<0.05) higher in $T_4$ while NFE and EE were highest in $T_1$ (Table 5). The nutrient digestibility was observed to increase with increasing level of *Gmelina arborea* leaf meal. The results of the nutritive value (Table 5). The values of all the parameters studied (DCP, DOM, DCF, DEE, DNFE g $kg^{-1}$ DM) were general higher (P<0.05) in $T_4$ compared to other treatment groups except for DEE and DNFE which was higher (P<0.05) in $T_1$.

**Nitrogen utilization**

N digestion, retention, absorption were greater (P < 0.05) in $T_1$ compared to other treatment groups (Table 6). Faecal N, Urinary N and N output were greater (P < 0.05) in $T_4$.

**Table 2: Chemical Composition of experimental diets (g $kg^{-1}$ DM)**

| | TREATMENTS | | | | |
|---|---|---|---|---|---|
| **Parameters** | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | **SEM** |
| Dry Matter | 873.20$^{d}$ | 892.40$^{c}$ | 897.80$^{b}$ | 902.10$^{a}$ | 0.61 |
| Ash | 431.00$^{d}$ | 623.00$^{c}$ | 781.00$^{b}$ | 832.00$^{a}$ | 0.21 |
| Organic Matter | 442.2$^{a}$ | 269.4$^{b}$ | 116.8$^{c}$ | 70.10$^{d}$ | 1.31 |
| Crude Protein | 162.10$^{d}$ | 183.30$^{c}$ | 174.20$^{b}$ | 203.30$^{a}$ | 0.02 |
| Crude Fibre | 111.80$^{a}$ | 100.21$^{b}$ | 91.12$^{c}$ | 83.31$^{d}$ | 0.11 |
| Ether Extract | 22.10$^{c}$ | 16.20$^{d}$ | 38.31$^{b}$ | 42.21$^{a}$ | 0.39 |
| Neutral Detergent Fibre | 527.00$^{d}$ | 532.70$^{c}$ | 537.31$^{b}$ | 540.31$^{a}$ | 2.33 |
| Acid Detergent Fibre | 325.00$^{d}$ | 352.80$^{c}$ | 371.42$^{b}$ | 321.31$^{a}$ | 1.21 |
| Acid Detergent Lignin | 60.00$^{d}$ | 71.14$^{c}$ | 86.32$^{b}$ | 91.19$^{a}$ | 0.81 |
| Nitrogen Free Extract | 577.20$^{c}$ | 592.69$^{a}$ | 574.17$^{b}$ | 573.28$^{b}$ | 1.21 |
| Cellulose | 265.00$^{d}$ | 281.66$^{b}$ | 285.10$^{c}$ | 330.12$^{a}$ | 1.31 |
| Hemicellulose | 202.00$^{a}$ | 179.90$^{b}$ | 165.89$^{c}$ | 219.00$^{d}$ | 2.06 |
| ME (MJ $Kg^{-1}$ DM) | 3.35 | 3.45 | 3.52 | 3.89 | - |

Means in the same row with different superscripts are significantly (P< 0.05) different. NDF=Neutral detergent fibre; ADF=Acid detergent fibre; ADL=Acid detergent lignin; NFE=Nitrogen Free Extract; SEM=Standard error of mean

**Table 3: Anti nutritive substances of the experimental diets (mg/l)**

| | TREATMENTS | | | | |
|---|---|---|---|---|---|
| **Parameters** | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | **SEM** |
| Total Condensed Tannin | 0.62 | 0.43 | 0.82 | 0.62 | 0,002 |
| Oxalate | 3.32$^{a}$ | 2.41$^{b}$ | 0.92$^{d}$ | 1.83$^{c}$ | 0.02 |
| Phytate | 1.57$^{a}$ | 1.53$^{a}$ | 0.74$^{b}$ | 1.13$^{a}$ | 0.03 |
| Cyanide | 0.58$^{a}$ | 0.44$^{b}$ | 0.24$^{c}$ | 0.31$^{c}$ | 0.005 |
| Saponin | 1.40$^{c}$ | 1.55$^{b}$ | 1.55$^{b}$ | 1.98$^{a}$ | 0.23 |

**Table 4: Rumen Fermentation Characteristic of goats (bucks) fed *Gmelina arborea* leaf meal**

| | TREATMENTS | | | | |
|---|---|---|---|---|---|
| **Parameters** | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | **SEM** |
| pH | 6.61 | 7.70 | 6.30 | 6.01 | 1.21 |
| $NH_3$ – N mg/L | $31.77^a$ | $31.48^a$ | $29.49^b$ | $31.75^a$ | 1.34 |
| TVFA mg/L | $15.37^a$ | $14.34^b$ | $12.50^c$ | $14.79^b$ | 0.64 |
| Total N mg/L | 2.00 | 2.85 | 2.85 | 2.17 | 0.97 |

**Table 5: Apparent and total tract digestibility and nutritive value of goat fed *Gmelina arborea* leaf meal**

| | Treatments | | | | |
|---|---|---|---|---|---|
| **Parameters** | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | **SEM** |
| Dry Matter | $687.31^d$ | $721.31^c$ | $771.06^b$ | $814.29^a$ | 2.16 |
| Crude Protein | $532.14^d$ | $621.06^c$ | $671.11^b$ | $721.14^a$ | 3.16 |
| Organic Matter | $560.00^d$ | $672.14^c$ | $714.86^b$ | $772.16^a$ | 1.58 |
| Crude Fibre | $201.00^d$ | $251.17^c$ | $268.27^b$ | $283.41^a$ | 3.21 |
| Neutral Detergent Fibre | $610.60^c$ | $670.80^b$ | $671.10^b$ | $731.40^a$ | 2.34 |
| Acid Detergent Fibre | $621.40^d$ | $721.30^c$ | $810.60^b$ | $887.20^a$ | 1.56 |
| Acid Detergent Lignin | $521.30^a$ | $460.90^b$ | $311.20^c$ | $273.30^d$ | 0.79 |
| Nitrogen Free Extract | $613.10^a$ | $341.40^b$ | $292.10^c$ | $73.3^d$ | 1.62 |
| Ether Extract | $521.00^a$ | $432.00^b$ | $331.00^c$ | $301.70^d$ | 2.21 |
| Nutritive value | | | | | |
| Digestible Crude Protein g $kg^{-1}$ | $67.60^c$ | $76.83^{ab}$ | $78.08^a$ | $79.90^a$ | 2.04 |
| DCP g $kg^{-1}$ $W^{0.25}$ | $23.57^b$ | $25.95^a$ | $26.26^a$ | $26.72^a$ | 1.52 |
| Digestible Organic Matter g $kg^{-1}$ | $71.14^c$ | $83.16^b$ | $83.17^b$ | $85.55^a$ | 1.52 |
| DOM g $kg^{-1}$ | $24.49^c$ | $27.53^b$ | $27.54^b$ | $28.13^a$ | 0.59 |
| Digestible Crude Fibre g $kg^{-1}$ | $25.40^b$ | $31.06^a$ | $31.21^a$ | $31.40^a$ | 1.03 |
| DCF g $kg^{-1}$ $W^{0.75}$ | $11.31^b$ | $13.16^a$ | $13.20^a$ | $13.26^a$ | 0.89 |
| Digestible Ether Extract g $kg^{-1}$ | $66.11^a$ | $53.45^b$ | $38.51^c$ | $33.43^d$ | 2.13 |
| DEE g $kg^{-1}$ $W^{0.75}$ | $23.18^a$ | $19.77^b$ | $15.45^c$ | $13.90^d$ | 1.26 |
| Digestible Nitrogen Free Extract g $kg^{-1}$ | $77.89^a$ | $42.24^b$ | $33.99^c$ | $30.28^d$ | 1.28 |
| DNFE g $kg^{-1}$ $W^{0.75}$ | 26.22a | 16.57b | 14.08c | 12.91d | 0.78 |

**Table 6: Nitrogen Utilization of bucks fed *Gmelina arborea* leaf meal substituting soybean meal**

| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| N intake g day$^{-1}$ | 13.01$^{b}$ | 11.21$^{d}$ | 12.33$^{c}$ | 14.56$^{a}$ | 1.42 |
| Faecal N g day$^{-1}$ | 3.21$^{c}$ | 3.76$^{c}$ | 4.22$^{b}$ | 4.96$^{a}$ | 0.62 |
| N digestion g day$^{-1}$ | 9.80$^{d}$ | 7.45$^{c}$ | 8.11$^{b}$ | 9.60$^{a}$ | 0.6 |
| N in Urine g day$^{-1}$ | 4.21$^{b}$ | 3.23$^{d}$ | 3.86$^{c}$ | 4.67$^{a}$ | 0.04 |
| Total N output g day$^{-1}$ | 7.42$^{c}$ | 6.99$^{cd}$ | 8.08$^{b}$ | 9.67$^{a}$ | 1.21 |
| N retained g day$^{-1}$ | 5.59$^{a}$ | 4.22$^{b}$ | 4.25$^{b}$ | 4.93$^{b}$ | 0.96 |
| N absorbed g day | 9.80$^{a}$ | 7.45$^{bc}$ | 8.11$^{b}$ | 9.60$^{a}$ | 1.26 |
| N retained as % N intake | 42.96$^{a}$ | 37.64$^{b}$ | 34.46$^{c}$ | 33.85$^{c}$ | 2.46 |
| N absorbed as % N intake | 75.32 | 66.45$^{b}$ | 65.77$^{b}$ | 65.93$^{b}$ | 3.26 |

N=Nitrogen

## DISCUSSION

### Chemical composition of the experimental diets

The nutrient composition of the experimental diets is consistent with previous reports on mixed ration (Njidda *et al*., 2018). The relatively higher CP and lower anti nutritive contents are suggestive of its superior nutritive value. However, the NDF concentrations of the experimental diets are below the range of 600–650 g kg$^{-1}$ DM suggested as the limit above which intake of tropical feeds by ruminants would be limited (Van Soest *et al*., 1991). High CP and relatively lower fibre composition indicate the diets potential as N rich to the bucks.

### Anti-nutritive substances

The total condensed tannins (TCT) ranged from 0.43 mg/g to 0.82 mg/g DM. The level is lower than the range of 60 to100 g Kg$^{-1}$ DM that is considered to depress feed intake and growth (Barry and Duncan, 1984). However, in ruminants, dietary condensed tannins of 2 to 3% have been shown to have beneficial effects because they reduce the protein degradation in the rumen by the formation of a protein-tannin complex (Barry, 1987). Oxalate content in this present study was low. Oxalate has been shown to deplete the calcium reserve, Ca and carbon are also released from the hydrolysis of Ca Oxalate some of which will be either absorbed or excreted by the ruminant animals (Njidda, 2011). The phytin levels reported in this study ranged from 0.74 to 1.57 mg/g DM. These levels are unlikely to have any adverse effects on the experimental animals (Okoli *et al*., 2003). The HCN contents of the browse species examined were equally low. The HCN ranged from 0.24 mg/g to 0.58 mg/g DM. The lethal dose of HCN for cattle and sheep is 2.0 to 4.0 mg per kg body weight. The lethal dose for cyanogens would be 10 to 20 times greater because the HCN comprised 5 to 10% of their molecular weight (Conn, 1979). The saponin value was range of 1.40 mg/g to 1.98 mg/g DM. Feedstuffs containing saponin had been shown to be defaunating agents (Teferedegne, 2000) and capable of reducing methane production (Babayemi *et al.* 2004b). Cheeke (1971) reported that saponin have effect on erythrocyte haemolysis, reduction of blood and liver cholesterol, depression of growth rate, bloat (ruminant) inhibition of smooth muscle activity, enzyme inhibition and reduction in nutrient absortion. Saponins have been reported to alter cell wall permeability and therefore to produce some toxic effect when ingested (Belmar *et al*., 1999).

### Rumen fermentation characteristics

The pH levels corroborate with the pH levels (6.49 – 7.67) reported by Isah *et al*., (2014) and (6.2-7.2) reported by Van Soest (1994) as being optimal for fibre digestion. There was

no case of acidosis in the animals. Ørskov and Ryle (1990), Kobayashi *et al.* (2008) and Islam *et al.* (1999) reported that the rumen pH has to be maintained above 6.0 in other to maintain rumen fibrolytic activities. The $NH_3$-N level in all groups was below 150 mg/l recommended as minimum acceptable level for optimization of ruminal fibre degradation (Leng, 1990). Reduced rumen $NH_3$-N in in the diets could be attributed to decreased N intake and protein degradation, in agreement with earlier reports (Ramos *et. al.*, 2009). Rumen ammonia concentration is largely dependent on the extent of protein breakdown metabolic activity of rumen microflora, evacuation rate of nutrient masses to the abomasum, the rate of absorption through the ruminal wall and the level of microbial protein synthesis (Hristov *et al.,* 1999) which are particularly determined by the species, breed and age of the animal, ration composition, concentrates/roughage ratio time and frequency of feeing. Varying forage level in a total mixed ration on rumen $NH_3$-N been reported by Das and Ghosh (2007) who indicated significantly decreased rumen $NH_3$-N with increasing level of forage replacement for goat. Lower degradability of $NH_3$-N was observed when concentrate mixtures were replaced with tree fodders like *sesbania* (Khalili and Varvikko, 1992) and *Gliricida* (Richard *et al.,* 1994). Total ruminal VFA concentrations is below the normal range (100–120 mmol/L) in forage-fed ruminants (Berman, 1990), reflecting the generally low degradability of the diets. Lower total VFA of the diets reflects its reduced DOM intake, degradability, and consequently energy supply to the goats. Decrease in ruminal VFA formation has been reported to reduce energy supply to the host (Aschenbach *et al.*, 2011).

**Total tract digestibility and nutritive value**

A wide range of variation in digestibility is reported in tropical feeds with browse inclusion. Breman and Kessler, (1995), Njidda *et al.* (2018) showed OMD of 53% in Sahelian and Sudanian zones of West Africa, while Njidda *et al.* (2018) reported values 26 to 67% (CP), 38 to 57% (NDF) and 11 to 21% (ADF) for red sokoto goats. Le Houerou (1980) reported a mean DCP of 510 g/kg for West African browses, with 760 g/kg for legumes. Fall (1991) reported large variations in DMD, ranging from 26 to 88% between species and plant parts. In the present study DMD (687.31 to 814.29 g $kg^{-1}$ DM) the values tend to increase with increase in the level of *Gmelina arborea* leaf meal CPD (532.14 to 721.14 g $kg^{-1}$ DM) follow the same pattern, this conform to the report of Shelton (2004) that browse forages have high level of protein and minerals.

The lower nutritive value of the experimental diets may be attributed to its relatively low energy which in association with its relatively high cell wall fibre. Condensed tannins (CTs) possibly limit the activity of rumen microbes and consequently microbial degradation. According to Olafadehan (2013), DOM and DCP are needed for enhancing the efficiency of rumen microbes for faster ruminal degradation and digesta outflow rate from the rumen for improved intake.

**Nitrogen utilization**

N retention increased accordingly following the trend observed for N absorption. Parallel observations were made by Foster *et al.* (2009). Reduced N absorption, balance and retention of the treatment groups than the control suggest lower rate and extent of degradation of N from its leaves. This concurs with earlier reports by Das *et al.* (2011) on Barhar leaves. In corroboration with previous findings (Melaku *et al.,* 2004), the higher N output in $T_4$ suggests that the diet supplied more by-pass protein than the animal could utilize.

## CONCLUSION

It was concluded that *Gmelina arborea* leaf meal can be used as a substitute for soybean meal in the diets of goats. It had improved feed intake, nutrients digestibility and nitrogen utilization. It is also recommended that 100% SBM substitution with GLM should be used by farmers to improve productivity of their animals.

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