

Effect of *Daniellia oliveri* leaf meal in total mixed rations on the performance of Savannah Brown goats

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Abstract

The study was carried out to determine the effect of *Daniellia oliveri* leaf meal (DOLM) in complete diets on feed intake, digestibility, nitrogen utilization and growth of Savannah Brown goats in a 90-day trial using the completely randomized design. Thirty-six does, with an average initial weight of 10.66 kg, were randomly divided into four groups of similar body weight (BW) and allocated to one of the four complete diets with DOLM inclusion levels at 0%, 20%, 30% and 40% respectively. Intakes of dry matter (DM) and organic matter (OM), and cost/kg BW gain were higher ($p < 0.05$) in the control diet than in the treatment diets. Intake of crude protein (CP) was higher ($p < 0.05$) for the control diet compared to the 30 and 40% DOLM diets. Feed conversion ratio and faecal nitrogen excretion of animals on 20% DOLM diet were lower ($p < 0.05$) than other diets. Final body weight, total weight gain and average daily weight gain were not ($p > 0.05$) affected by the diets. Digestibility of DM and CP, and nitrogen balance of animals on 0 and 20% DOLM diets were higher than those on 30 and 40% DOLM. Digestibility of OM and crude fibre was lowest ($p < 0.05$) for the control diet relative to other diets. Nitrogen intakes (NI) of 0 and 40% DOLM diets were lower ($p < 0.05$) compared to those of 20 and 30% DOLM diets. Nitrogen absorbed (NA) and nitrogen retention (as % of NA) were marginal ($p < 0.05$) for 30% DOLM diet relative to other diets. Nitrogen retention (as % of NI) was highest and lowest ($p < 0.05$) for 20% DOLM diet, and 30 and 40% DOLM diets respectively. The study shows that *Daniellia oliveri* leaf meal can be used up to 40% inclusion level to replace 100% of maize offal in the diet of Savannah Brown goats without adversely affecting the performance of the animals.

Keywords: *Daniellia oliveri*, growth, digestibility, nitrogen utilization, goats

Introduction

Intensive small ruminant production in Nigeria is affected by the increased cost of concentrate feedstuffs. The cost of concentrate feedstuffs is not only prohibitive but they are not readily available during certain periods of the year. This scenario has led to the search for alternative feed resources over the past few decades.

The potentials of browse fodders in overcoming this problem have been recognized (Okoli *et al.*, 2002; Olafadehan *et al.*, 2015; Olafadehan and Okunade, 2016).

Tropical trees and shrubs are an important component of the fodder resources for livestock and wildlife. The ability of their foliage to remain green and maintain

their crude protein (CP) content makes them potential sources of protein and energy (Olafadehan, 2013). The fodder value of their leaves and fruits are often superior to herbaceous plants, particularly in the case of legumes (Fadiyimu *et al.*, 2011). The scarcity and soaring cost of conventional protein feedstuffs necessitate research into alternative resources for sustainable ruminant production. Use of browse legumes as supplement could help to alleviate the problem of dry season feeding of ruminants and equally reduce high cost of feeding associated with the use of conventional protein feeds (Olafadehan, 2013). In arid and semi-arid zones, browse fodders provide the largest part of the protein supply during the driest months. For example, it is estimated that in the Sahel up to 80% of the protein ration is provided by plants of the *Capparaceae* family during the three driest months of the year (Baumer, 2011). *Azelia africana*, *Ficus thonningii* and *Daniellia oliveri* are examples of such browses used for this purpose.

Daniellia oliveri (Rolfe) leaves are cut by Fulani cattle herders for their animals which they eat with relish, especially during the dry season when grasses are scarce. In the work of Walden (1986) and Atta-krah and Reynolds (1989), the fodder value of *Daniellia* forage base on palatability, intake and digestibility is reported to be high, with 16.5% of crude protein. The objective of this study was to evaluate the effect of feeding varying levels of *Daniellia oliveri* leaf meal in complete diets on the performance characteristics of Savannah Brown goats.

Materials and Methods

Experimental location and preparation of test ingredient

The experiment was carried out at Halima

Farm, a private goat farm, located in Gwagwalada Local Government Area of the Federal Capital Territory. Leaf samples from both young and old trees of the experimental plant were harvested from various stands in February. They were cleaned, packed in the Kraft paper and cured under the shade for six days. The leaves were separated from the stalk after drying, milled to produce *Daniellia oliveri* leaf meal (DOLM), packed in sacks and stored until they were ready for use.

Experimental animals and management

Thirty six nulliparous Savannah Brown does of 5 to 6 months old, with an average initial body weight (BW) of 10.66 kg, were used for the study. The animals were divided into four treatment groups of three replicates, with three animals per replicate, and were assigned randomly to one of four dietary treatments in a completely randomized design. Animals in each group had similar mean initial BW. The treatments consisted of four iso-nitrogenous total mixed diets containing DOLM at 0, 20, 30 and 40%. The animals were fed at 3% body weight twice daily at 0800 h and 1600 h for a period of 12 weeks. Fresh clean water was provided *ad libitum*. Before the experiment commenced, the animals were vaccinated against *Peste De Peste Ruminants* (PPR) and given long acting oxytetracycline as prophylaxis against bacterial infection thrice at two days interval.

Digestibility and nitrogen balance studies

Digestibility and nitrogen balance studies were carried out immediately after the feeding and growth trials. Three goats were randomly selected per treatment and transferred to metabolism crates for faecal and urinary samples collection. They were allowed 10 days adjustment to the crates before the commencement of the data collection for 7 days. The goats were kept in individual metabolic crate and feed offered,

feed rejected, faeces and urine excreted were recorded daily. About 10% of total faecal and urinary output respectively were saved, pooled over the 7-day collection period and sub-sampled for each goat to produce representative samples for chemical analysis. Few drops of 10% sulphuric acid were used to trap the ammonia in the urine.

Chemical analysis

The proximate composition of the experimental diets and faeces and nitrogen content of the urine was carried out according to the methods of AOAC (2000). Condensed tannins (CT) concentration of DOLM was determined by the methods of Makkar (2003).

Economic analysis

Cost/kg of diet was calculated by multiplying the prevailing unit cost price of each ingredient by the quantity used in the ration and dividing the summation of the total cost by 100 kg. Cost/kg BW gain was calculated by multiplying the feed conversion ratio value with cost of feed/kg.

Statistical analysis

Data were analysed based on the completely randomized design using SAS (2000) package. Where significant, means were separated using Duncan's multiple range test. Significance was declared at a level of $p \leq 0.05$.

Results and Discussion

Whereas both crude fibre and metabolizable energy increased as the level of DOLM in the diets increased, the reverse was the case for ether extract which decreased with increasing level of the test ingredient in the diets (Table 1). The organic matter (OM) did not follow a particular trend. The high crude protein (CP) content of DOLM is consistent with previous report on this browse fodder (Okunade *et al.*, 2014; Olafadehan and Okunade, 2016) and is suggestive of its potential as a supplement to low quality roughages. The CP levels of DOLM and the experimental diets were higher than the recommended level (11 – 13%) for growing goats (Kearl, 1982).

Table 1: Ingredient and chemical composition of experimental diets

Ingredient	Inclusion level of <i>D. oliveri</i> leaf meal (%)				DOLM
	0	20	30	40	
Maize	23.5	26.5	27.5	29.5	
Cowpea husk	21.0	20.0	21.0	21.0	
Groundnut cake	12.0	10.0	8.00	6.00	
Maize offal	40.0	20.0	10.0	0.0	
<i>Daniellia oliveri</i> leaf meal	0.00	20.0	30.00	40.0	
Bone meal	2.00	2.00	2.00	2.00	
Salt	0.50	0.50	0.50	0.50	
Mineral-vitamin premix*	1.00	1.00	1.00	1.00	
Total	100	100	100	100	
Analysed content (%)					
Dry matter	94.20	94.40	94.60	95.10	96.90
Crude protein (% DM)	17.10	17.29	17.44	17.36	19.68
Crude fibre (% DM)	11.10	24.40	28.00	32.11	34.43
Ether extract (% DM)	14.40	13.03	12.01	10.34	9.11
Organic matter (% DM)	92.92	90.87	91.04	90.05	93.84
Ash (% DM)	7.08	9.13	8.96	9.95	6.16
Condensed tannins (% DM)	ND	0.90	1.35	1.80	4.50
ME (Kcal/kg DM)**	2664	2736	2768	2808	2564

*To provide the following per 100 kg of the diet: 440 mg. riboflavin ; 720 mg pantothenate; 2 g, niacin 2.2 g chloride; 15 mg folic acid; 1mg vitamin B₁₂; 15 mg retinol 165g vitamin D₂ ;1000 mg DL - tocopherol acetate; 1700 mg copper; 200 mg iodine; 3000 mg manganese; 5000 mg zinc 10,000 mg iron.

** ME -metabolizable energy calculated according to Pauzenga (1985).

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Table 2: Feed intake and performance characteristics of doelings fed *D. oliveri* leaf meal in total mixed rations

Intake (g/d)	Inclusion level of <i>D. oliveri</i> leaf meal (%)				SEM
	0	20	30	40	
Dry matter	384.20 ^a	320.60 ^b	315.40 ^b	300.60 ^b	13.88
Organic matter	363.40 ^a	300.50 ^b	310.30 ^b	290.60 ^c	10.18
Crude protein	100.17 ^a	102.06 ^{ab}	94.56 ^b	89.81 ^b	1.79
Growth performance					
Initial body weight (kg)	10.71	10.79	10.52	10.65	0.43
Final body weight (kg)	15.53	15.21	14.43	14.40	0.55
Total gain (kg)	4.82	4.42	3.91	3.75	0.10
Average daily gain (g)	57.38	52.61	46.54	44.64	9.10
Feed conversion ratio	6.70 ^a	6.09 ^b	6.78 ^a	6.73 ^a	0.32
Cost/kg weight gain (₦)	52.90	50.68	49.50	48.30	
Cost/kg BW gain	354.43 ^a	308.64 ^d	335.61 ^b	325.06 ^c	4.50

^{abc}Means with different superscripts in the same row are significantly different ($p < 0.05$)

The results of the feed intake and performance characteristics of the experimental goats are presented in Table 2. The DM intake of the goats fed the control diet was higher ($p < 0.05$) than that of the goats fed DOLM based diets which had similar DM intake. Lower feed intake of goats fed the DOLM based diets may be attributed to their higher fibre contents relative to the control diet. Fibre has been reported to result in gut fill and slow down the rate of passage of the digesta through the gastro-intestinal tract due to its bulkiness (Okunade *et al.*, 2014; Olafadehan *et al.*, 2014a). Similarly, the CT of DOLM may also be responsible for reduced DM intake by goats fed the DOLM based diets. Tannins have been reported to reduce feed palatability and consumption due to its astringent property (Olafadehan *et al.*, 2014a). The result agrees with previous findings (Olafadehan *et al.*, 2014a) who reported an inverse relationship between feed intake and dietary fibre level and CT respectively. The DM intake was lower than intake range of 433 – 443 g/d reported for the same breed of goat fed graded levels of *Gmelina arborea* leaf meal in complete diets (Abdu *et al.*, 2013). Lower intake in the current study could be due to sex effect,

as doelings were used compared to most studies that used bucklings. Intake of OM was higher ($p < 0.05$) for 0% DOLM than for DOLM based diets and among the DOLM diets, OM intake was lower ($p < 0.05$) for 40% DOLM than for 20 and 30% DOLM which were not ($p > 0.05$) different. Consumption of CP was higher for the control diet compared to 30 and 40% DOLM. Lower CP and OM intakes of the DOLM diets are obviously due to lower feed intake by goats on the diets. Olafadehan *et al.* (2014b) earlier opined that nutrient intake is a function of feed intake *ceteris paribus*. Though average daily gain declined with increasing level of DOLM in the diets, there was no difference between the control and the DOLM diets. This suggests that DOLM was well utilized by the goats and DOLM can be fed up to 40% in a practical goat ration without any negative effect on the body weight of the goats. Feed conversion ratio was significantly ($p < 0.05$) lower for 20% DOLM compared to the other treatment groups. The result shows that goats fed 20% DOLM diet efficiently utilized their diet better than goats on other diets because they consumed less amount of feed per kg of weight gain. This result underlines the

nutritive value of DOLM in goat diet. The cost/kg gain of the control diet was higher ($p < 0.05$) than that of 40% DOLM indicating that 40% DOLM inclusion rate was a more economically viable diet than the control diet. This further justifies the feeding potential of DOLM in goat diets. The apparent nutrient digestibility of Savannah Brown does fed varying levels of *Daniellia oliveri* leaf meal is presented in Table 3. The DM and CP digestibility of the control and 20% DOLM diets was higher ($p < 0.05$) than that of 30% and 40% DOLM diets. However, there were no significant ($p > 0.05$) differences between DM and CP digestibility of the control and 20% DOLM, and 30% and 40% DOLM. Lower digestibility of DOLM at higher inclusion levels could be due to higher fibre contents of the diets, in agreement with previous reports (Olafadehan, 2013; Isah *et al.*, 2015; Olafadehan and Adebayo, 2016). Both OM and CF digestibility were lower ($p < 0.05$) in

the control diet compared to DOLM diets. Increasing CF digestibility with increased level of DOLM in the diets suggests that the fibre levels of DOLM diets were lower than the threshold level at which dietary fibre inhibits digestibility. Nitrogen utilization of doelings fed diets containing varying levels of DOLM is presented in Table 4. The nitrogen intakes of the control and the 40% DOLM groups were ($p < 0.05$) greater compared to the nitrogen intakes of 20% and 30% DOLM groups. There was no significant difference ($p > 0.05$) in the urinary nitrogen excretion among the treatments. The faecal nitrogen of the 20% DOLM group was marginal ($p > 0.05$) relative to that of the control, 30% and 40% DOLM diets. Nitrogen balance declined ($p < 0.05$) with the increasing level of DOLM, with 30 and 40% DOLM having the lowest values. Lower nitrogen balance and nitrogen retention (as % of nitrogen intake) at higher levels of DOLM inclusion

Table 3: Apparent digestibility of doelings fed *D. oliveri* leaf meal in total mixed rations

Item (%)	Inclusion level of <i>D. oliveri</i> leaf meal (%)				SEM
	0	20	30	40	
Dry matter	86.90 ^a	83.70 ^a	86.60 ^b	85.40 ^b	3.08
Organic matter	64.04 ^c	70.50 ^b	76.70 ^a	70.00 ^b	4.40
Crude protein	63.30 ^a	63.10 ^a	56.70 ^b	53.70 ^b	6.66
Crude fibre	33.50 ^c	44.10 ^b	51.30 ^a	55.35 ^a	2.63

^{abc}Means with different superscripts in the same row are significantly different ($p < 0.05$)

Table 4: Nitrogen balance of doelings fed *D. Oliveri* leaf meal in total mixed rations

Variable (g/d)	Inclusion level of <i>D. oliveri</i> leaf meal (%)				SEM
	0	20	30	40	
Nitrogen intake	52.30 ^a	48.80 ^b	45.85 ^b	50.35 ^a	9.28
Faecal nitrogen	20.22 ^a	15.50 ^b	20.80 ^a	20.50 ^a	1.61
Urinary nitrogen	11.30	12.90	13.90	10.50	1.05
Nitrogen absorbed	32.08 ^a	33.30 ^a	25.05 ^c	29.85 ^b	4.05
Nitrogen balance	20.78 ^a	20.40 ^a	11.15 ^b	10.35 ^b	2.69
N retention					
% of N intake	39.73 ^b	41.80 ^a	24.32 ^c	20.55 ^c	8.45
% of N absorbed	61.34 ^{ab}	68.24 ^a	54.63 ^c	59.29 ^b	11.00

^{abc}Means with different superscripts on the same row are significantly different ($p < 0.05$)

may be due to the effect of the CT of DOLM which must have been more concentrated as the DOLM inclusion level increased. Tannins have been reported to have pronounced effect on nitrogen utilization of goats fed tannin-rich fodders (Olafadehan, 2013, Olafadehan *et al.*, 2016). Higher nitrogen retention (as % of N intake and % of N absorbed) of 20% DOLM is indicative of the fact that the diet promoted better nitrogen utilization. It appears the tannin level of the 20% DOLM diet was more beneficial than the tannin concentrations of higher levels of DOLM (30 and 40% DOLM). It is, however, pertinent to say that the better N utilization of the control and 20% DOLM diets did not result in pronounced average daily gain compared to 30 and 40% DOLM. The results imply that goats can tolerate up to 40% DOLM inclusion level without any negative effect on their growth performance. Olafadehan and Okunade (2016) had earlier demonstrated the impressive fodder value of *Daniellia oliveri* forage in goat nutrition.

Conclusion and Recommendation

The results of the study show the nutritive value of DOLM as a suitable fodder in goat nutrition. Inclusion of DOLM at 40% in a total mixed ration did not compromise the performance of the experimental goats but reduced the feed cost/kg BW gain. *Daniellia oliveri* leaves can be used as a fodder resource for intensive ruminant production.

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