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Effect of dietary inclusion of browse forage (*Ziziphus mucronata*) in a total mixed ration on performance of Yankasa rams.

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Abstract: An experiment was conducted to determine the feed value of *Ziziphus mucronata* forage in a total mixed ration.. Sixteen Yankasa rams weighing on the average 18.19±0.26kg were divided into four groups with four animals per group. Each group was randomly assigned to one of the dietary treatments comprising 0, 5, 10 and 15% *Z. mucronata* foliage which were designated as $T_{1,}$ $T_{2,}$ T_3 and T_4 (0%, 5, 10 and 15% respectively in a Complete Randomized. The results of the chemical composition reveals that all the parameters observed were significantly different (P<0.05). The ash, crude protein and ether extract were higher and crude fibre is lower in treatment 1 compared to other treatments. Aaverage daily gain (ADG, 0.09kg), average daily dry matter intake (ADMI, 0.04kg), dry matter intake per metabolic weight (0.09 kg day^{-1}, 0.04 kg day^{-1}, 20.11 kg $W^{0.75}$) and feed conversion ratio (0.51) were significantly (P<0.05) better for animals on $T_{4.}$ Apparent digestibility of dry matter, organic matter, crude protein, ether extract hemicellulose and lignin were higher (p<0.05) in T_4 compared to other treatment groups. Nitrogen utilization result showed positive nitrogen balance in all dietary treatments. In conclusion, the result shows that *Ziziphus mucronata* inclusion up to 15% in the diet of growing sheep led to better performance of the animals especially during the dry season.
Keywords: Intake, growth performan, browse forages, *Ziziphus mucronata*, Yankasa rans

INTRODUCTION

One of the major causes of low livestock productivity in tropical areas like Nigeria is poor quality and inadequate forage quantity during long period of dry season [1] and tends to be major causes of low livestock productivity in the areas. Animal consuming basal diet containing less than 7% crude protein (CP) will require supplementation for improved performance[2,3], hence there is need to exploit legume forage resource which are abundantly available and evergreen.

Browse plant play a significant role in nutrition of ruminant livestock in tropical region. 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[4]. Some part of browse species can be found during the dry season including pods, fruits and leaves. Most tress/shrubs produce their leaves during wet season, thus browse is more available during the spring (August to May)[5]. The nutritional importance of browse is especially significant for free ranging animals in extensive communal system of production.

The potentials of tree and shrubs as alternative fodder resources in ruminant's nutrition have attracted the attention of researchers worldwide. Several indigenous and exotic browse species have been investigated and evaluated for inclusion in ruminant feeding system in Nigeria. Unfortunately, the adaptation of most of these species by farmers has been faced with several challenges such as pest and diseases attack and presence of anti-nutritional factors. There is therefore the need for continue screening of browse plant to identify those with good potentials as livestock fodder and which could serve as alternatives to those species which have been already evaluated.

Ziziphus is grown in hot tropical region with less than 600m altitude and rainfall of 350 – 500mm. Jauhari [6] Reported that *Ziziphus* is a drought resistant plant and adaptable to soil need. According to Carter [7] stock eat the falling leaves of *Ziziphus mucronata* and the branches are sometime lopped and fed to cattle while the red berries are readily eaten from the ground by goat. Research effort to identify suitable materials that can replace completely or partially expensive ingredients with less expensive, unconventional protein and energy sources could be timely[8]. Therefore, the current study was designed to assess the influence of *Ziziphus mucronata* leaves on growth performance, nutrient digestibility and nitrogen utilization of Yankasa ram.

MATERIAL AND METHODS

Experimental Site

The experiment was conducted at the Research and Training Farm, Bayero University, Kano. The area lies on longitude 9º 30' and 12º 30' North and Latitude 9º 30' and 8º 41' East. The state is characterized by tropical wet and dry climate [38]. Annual rainfall and temperature range between 787 to 969 mm and 21ºC to 39ºC, respectively [9]. The climate is characterized by define wet season that normally begins in May and ends in September and dry season that last from October to April.

Experimental animals

The experiment was conducted at ruminant unit of the teaching and research farm of the Bayero University Kano, Kano State, Nigeria. A total of 16 sheep weighing between 7 and 10 kg and between 8 – 10 months old were purchased from the livestock market in Kano metropolis.

Feeding and Management

All animals were treated against internal parasites using levamisole (Kepro B.V. Holland, 1ml per 20 kg body weight), sprayed with Triatix (Cooper Ltd) and injected with long acting oxytetracycline 200 LA (Invesa Spain 1ml per 10kg body weight) before the commencement of the experiment. All sheep were kept in a house and confined in individual, well ventilated raised slatted floor cages. Water and basal forage were supplied *ad libitun*. The trial lasted for 90 days during which the animals were grouped into four treatments and fed a complete diet containing *Ziziphus mucronata* forage graded levels of 0, 5, 10, and 15%. Daily feed intake, water and live weight changes were recorded.

Experimental Design and Treatment

Sixteen (16) Yankasa rams were allotted to four dietary treatments in a complete randomized design, with four animals per treatment. The treatments compared were T_1 = 0%, T_2 = 5%, T_3= 10% and T_4 = 15% *Ziziphus mucronata* leaves inclusion levels. Animals were subjected to 2 weeks adaptation period and 10 weeks of experiment for data collection.

Faecal collection

After the feeding trial, total collection of daily faecal output of all the rams was done for 7days. The daily faecal output was weighed afterward, 10% portion were taken and oven dried at 60^0C for 48 h. The dried faeces and feed samples were milled through 2 mm screen and stored in polythene bags for chemical analysis.

Chemical Analysis of the Browse Samples

Proximate composition were determined according to standard methods of Association of official Analytical chemists (AOAC)[10]. Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined according to the methods Van soest *et al.*[11].

Statistical analysis

The data generated were subjected to analysis of variance (ANOVA) in a Complete Randomized Deign (CRD) using SAS package [12] and significant difference between the means were separated using Duncan Multiple Range Test of the same software.

RESULTS

Chemical composition of the experimental diets

The chemical composition of the experimental diets is shown in Table 2. Dry matter content ranged from 889.27 in T_1 to 905.60 g kg^{-1} DM in T_2. Ash content of the experimental diets ranged from 62.26 g kg^{-1} DM in T_4 to 96.30 g kg^{-1} DM in T_1. Values obtained for organic matter content of the experimental diets ranged from 792.97 in T_1 to 831.90 g kg^{-1} DM $T_{3.}$ Generally, the diets had high crude protein values ranging from 132.40 g kg^{-1} DM to 184.90 g kg^{-1} DM in T_1. The crude fibre content of the experimental diets ranged from 168.00 g kg^{-1} DM in T_1 to 222.30 g kg^{-1} DM in T_4. The range for ether extract in the diets was 67.30 g kg^{-1} DM in T_4 to 98.40 g kg^{-1} DM in T_1. The highest neural detergent fibre (NDF) content was observed in T_4 receiving (15% *Ziziphus mucronata* inclusion) The values was observed to increases with increase in level of *Ziziphus mucronata.* The acid detergent fibre (ADF) follows a similar pattern with T_4 having the highest value (305.27 g kg^{-1} DM). The acid detergent lignin levels and cellulose were generally high for all the dietary treatments. The hemicellulose content ranged from 90.30 to 94.40 gkg^{-1} DM.

Intake and growth performance of Yankasa rams fed graded levels of *Ziziphus mucronata*

The result of growth performance of Yankasa rams fed graded level of *Ziziphus mucronata* is shown in Table 3. The final weight ranged from 22.20 kg to 26.82 kg respectively and was highest (P<0.05) for T_4. Treatment (T_4) had higher body weight gain (BWG) of 8.09 kg compared to other treatment groups with T_1 having the least BWG of 3.40 kg. Metabolic weight of the animals differ significantly (P<0.05) between diets and showed similar trend as that of BWG. The values ranged from a low value of 16. 50 to a high value of 20.11 $LW^{0.75}$. The average daily body weight gain (kg day^{-1}), (0.09 kg day^{-1}), dry matter intake (DMI) (3.67 kg day^{-1}), and feed conversion ratio (0.51) were best in T_4 and poorest in T_1 (0% *Zizizphus mucronata* inclusion).

Nutrients digestibility Yankasa rams fed graded levels of *Ziziphus mucronata*

Apparent digestibility of DM, OM, CP, EE, ADL and hemicelluloses were higher (P<0.05) for animals fed T_1 compared to other treatments whereas digestibility of CF was lowest for T_1, cellulose digestibility was highest for T_3. Digestibility of ADF was higher for T_1 than for T_2.

Nitrogen utilization of yankasa rams fed graded level of *Ziziphus mucronata*

The positive N balance observed in the current study shows the positive influence of the dietary treatment feeds in feeding of yankasa rams. All parameters observed showed significant difference (P<0.05) among treatments. Nitrogen in faeces and urine N, intake, absorbed and retained as percent of N intake tended to decrease with increase in levels of *Ziziphus mucronata* while N absorbed as percent of nitrogen intake increases with increase the in levels of *Ziziphus mucronata*.

Table 1: Composition of experimental diets (%)

	Treatments			
Ingresients	T_1	T_2	T_3	T_4
Ziziphus mucronata	0	5	10	15
Groundnut cake	30	25	20	15
Rice Bran	19	19	19	19
Maize Offal	10	10	10	10
Sorghum Stover	10	10	10	10
Wheat Offal	20	20	20	20
Sorghum Offal	10	10	10	10
Bone meal	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5
Total	**100**	**100**	**100**	**100**
Metabolizable Energy (MJ)	10.50	9.88	9.75	9.50
Crude Protein (CP)	18.58	17.80	16.25	15.01

Table 2: Chemical composition of experimental diets

	Treatments				
Parameter	T_1	T_2	T_3	T_4	SEM
DM	889.27[b]	905.60[a]	898.30[a]	889.30[b]	5.25
Ash	96.30[a]	76.30[b]	67.30[c]	62.26[c]	3.87
OM	792.97[c]	829.30 [a]	831.00[a]	827.04[ab]	2.06
CP	184.90[a]	168.30[b]	136.10[c]	132.40[d]	2.08
CF	168.00[d]	191.40[c]	201.07[b]	222.30[a]	3.14
EE	98.40[a]	87.30[a]	68.30[b]	67.30[b]	5.19
NDF	351.40[d]	359.60[c]	387.40[b]	398.40[a]	2.21
ADF	264.43[d]	281.20[c]	293.40[a]	305.27[a]	2.41
ADL	114.00[c]	112.33[d]	132.60[a]	129.30[b]	1.18
CL	256.80[b]	264.30[b]	334.90[a]	293.40[ab]	2.06
HC	90.30[a]	78.40[b]	94.40[a]	93.00[a]	2.05

ADF= Acid detergent fiber; ADL= Acid detergent lignin; CL= Cellulose; CF= Crude fiber; CP =Crude protein; DM=Dry matter; EE= Ether extract; HC= Hemi cellulose; NDF= Nutrient detergent fiber; Mean within the same row with different super are significantly different (p<0.05); NS=Not significant

Table 3: Growth performance of Yankasa rams fed browse forage (*Ziziphus mucronata*)

	Treatments				
Parameters	T_1	T_2	T_3	T_4	SEM
Initial body weight (kg)	18.60	18.18	18.75	18.73	NAS
Final body weight (kg)	22.00[d]	22.89[c]	24.00[b]	26.82[a]	0.02
Body weight gain (kg)	3.40[d]	4.74[c]	5.25[b]	8.09[a]	0.04
Average Daily (BWG) (kg day^{-1})	0.04[bc]	0.05[b]	0.06[b]	0.09[a]	0.02
Dry matter intake (g kg $W^{0.75}$)	2.20[b]	2.54[b]	2.68[b]	3.67[a]	0.62
Average Daily DMI (kg day^{-1})	0.02	0.03	0.03	0.04	0.008
Metabolic weight (kg $W^{0.75}$)	16.50[d]	17.16[c]	18.00[b]	20.11[a]	0.32
Feed conversion ratio	0.72[a]	0.59[b]	0.56[a]	0.51[b]	0.04

Table 4: Nutrient digestibility by Yankasa rams fed *Ziziphus mucronata* (% DM)

	Treatments				
Parameters	T_1	T_2	T_3	T_4	SEM
DM	46.50^d	49.00^c	54.24^b	61.21^a	0.52
OM	41.95^d	44.56^d	48.60^b	55.20^a	1.21
CP	27.53^b	26.68^c	16.02^c	29.83^a	0.95
EE	68.72^c	75.60^{ab}	74.52^b	76.37^a	0.52
CF	46.49^a	36.42^c	38.89^b	32.25^d	0.29
NDF	22.17^a	21.91^a	17.53^b	17.50^b	0.52
ADF	33.40^a	30.30^b	32.55^{ab}	30.58^{ab}	1.26
ADL	25.61^d	39.06^c	48.42^b	56.46^a	2.20
CL	10.30^c	8.16^d	28.06^a	16.61^b	0.43
HC	20.51^c	14.12^d	51.84^b	53.03^a	0.46

ADF= Acid detergent fiber; ADL= Acid detergent lignin; CL= Cellulose; CF= Crude fiber; CP =Crude protein; DM=Dry matter; EE= Ether extract; HC= Hemi cellulose; NDF= Nutrient detergent fiber; Mean within the same row with different superscript are significantly different ($p<0.05$); NS=Not significant

Table 5: Nitrogen Utilization by Yankasa rams fed *Ziziphus mucronata* (g day^{-1})

	Treatments				
Parameter	T_1	T_2	T_3	T_4	SEM
N in faeces	1.2^a	1.00^b	0.50^b	0.30^b	0.61
N in urine	1.67^a	1.37^b	1.26^c	1.15^d	0.04
N intake	29.58^a	26.92^b	21.77^c	21.18^c	0.26
N absorb	28.32^a	25.93^b	21.61^c	20.89^c	0.63
N in retain	26.65^a	24.56^b	20.02^c	19.74^c	0.46
N absorb as % N_2 intake	95.70^b	96.28^b	97.00^a	98.58^a	0.58
N retain as % N_2 intake	26.65^a	24.56^b	20.02^c	19.74^c	0.46

Mean within the same row with different super are significantly different ($p<0.05$); NS=Not significant

DISCUSSION

Several reports by Ajayi *et al.* [13] and Ososanya[14] indicated that feed intake is an important factor in the utilization of feed by livestock and is a critical determinant of energy and protein availability as well as performance in small ruminant. The intake of DM from T_4 was somewhat higher than the other treatment groups probably due to a better balance between energy and protein. The DMI intake was observed to in crease with increasing level of *Ziziphus mucronata* leaves. This suggests that *Ziziphus mucronata* is palatable and acceptable to sheep. Earlier studies [15] reported decreased feed intake by goats was due to the problem of palatability of fibre content of the diets. It was observed that despite high level of NDF and ADL in T_4, the DMI was relatively higher for T_4 compare to other treatment groups. This finding is similar to the report of Jokthan *et al.* [16] who reported that the nature of feeds and acceptability plays an important role in regulating feed intake in small ruminant livestock. The explanation regarding CP and fibre content could be valid for the difference observed in intake. The result indicates that the inclusion of the studied browse forage could constitute the main component of sheep diets and would be well consumed as demonstrated in treatments receiving the highest level of Zi*ziphus mucronata*. The highest weight gain of T_4 indicates efficient utilization of this fodder in the total mixed diet. Many other factors, including particles size, chewing frequency and effectiveness, particle fragility, indigestible fraction, rate of fermentation of the potentially digestible NDF, and characteristics of reticular contractions are also involved. The weight gain by all rams was lower than expected as nutrient intakes from all diets were higher in protein (9.52 to 15.86% CP) than the estimated requirements (7.43% CP). The difference can be explained either by the inadequacy of the requirement estimates for other breeds, or this breed, or the low genetic potential of Yankasa sheep marked by low capacity for growth or low efficiency of nutrient utilization. The ADG varied from 0.01 to 0.09 kg day^{-1}, and the control diet T_1 had the lowest ADG (0.01 kg day^{-1}), suggesting a low efficiency in utilization of the experimental diet. 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 the productivity of cattle, sheep and goats[17].

Studies on the digestibility of browse fodders are very important as they allow for the estimation of nutrients actually available for animal nutrition. 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. In the present study the *in vivo* 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 method 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 minimal 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. In fact the effect of tannins on reducing fibre digestion has been regarded as a secondary anti-nutritional effect compared with CP digestion. Nevertheless, several studies have demonstrated that the extent of fibre degradation in the rumen is reduced in animals offered tannin-rich feeds[18,19]. According to McSweeney *et al.* [19] tannins could reduce fibre digestion by complexing with lignocelluloses and preventing microbial attachment and degradation, or by directly inhibiting cellulotic microorganisms, or both. A low level of CP (less than 80 g/kg DM) is shown to depress digestibility, as it is not sufficient to meet the needs of the rumen bacteria[17]. On the other hand, low NDF content (20 to 35%) has been shown to result in high digestibility, while lignification of the plant cell wall decreases the digestibility of plant material in the rumen. Bakshi and Wadhwa, [20] also reported that high NDF and ADL depress DM intake and DM digestibility. Several studies[21, 22] have reported a negative correlation between lignin concentration and cell wall digestibility by its action as a physical barrier to microbial enzymes. Negative correlations between tannin and protein or DM digestibility have also been studied [23,24]. Hence information on the NDF, ADF, lignin and tannin content of tree foliage is essential for the assessment of their digestibility. Luginbuhl and Poore [25] noted that goats as well as sheep are not able to digest cell walls as well as cattle because the feed stays in their rumen for a shorter period of time. On the other hand, Morand-Fehr [26] reported similar retention time of feed particles in the whole digestive tract of sheep and goats eating the same quantity 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[27].

A wide range of variation in digestibility is reported in tropical browse species. Breman and Kessler[28] showed a mean OMD of 0.53 in Sahelian and Sudanian zones of West Africa. Le Houerou [28] reported a mean DCP of 510 g/kg for West African browses, with 760 g/kg for legumes. Fall [37] reported large variations in DMD, ranging from 0.26 to 0.88 between species and plant parts. In the present study OMD (41.95 to 55.20% DM) was moderate whereas CPD was low (16.02 to 29.83% DM). It was observed that despite the high NDF and ADL which have been reported to depress intake, T_4 still had the best feed intake, FCR and liveweight gain compare to other treatment groups. This can be attributed to a better balance between energy and protein in the dietary treatment.

In spite of the adaptation to harsh environments and poor quality feeds, sheep 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, etc) and the quality of the feed [30, 31]. The Yankasa rams are known to adapt well in the semi-arid zones. The weight gain by all rams used in this study was appreciable. The ADG varied from 0.04 to 0.09 kg/day, and the diet with *0% Ziziphus mucronata* inclusion resulted in the lowest performance, suggesting the significance of inclusion of the forage.

The feed conversion ratio was best for T_1 (0.51) than the other treatments. Hence the leaves of *Z .mucronata* 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 influence of the diets of different levels of *Ziziphus mucronata* inclusion on nitrogen (N) intake, faecal and urinary N-output, N absorbed, N retained and N retained as percent of N intake of rams followed similar pattern of the CP of the diets. All these parameters were observed to decrease with increase in levels of *Ziziphus mucronata*. The higher urinary N output observed in all the treatments could probably be due to level of nitrogen in the rumen which depend on the quantity and solubility of the diets, that might have been lost from the rumen as ammonia and later converted to urea before being excreted as urine. This confirms the report of Okoruwa *et al.* [32] that nitrogen excreted in urine depends on urea recycling and the efficiency of ammonia utilization produced in the rumen by microbes for microbial protein synthesis. However, all the diets offered to the rams gave a positive N-balance. Nitrogen retention is considered a better criterion for measuring protein quality than digestibility. Nitrogen retention is associated with the amount of nitrogen used for protein deposition and biological value is a measure of protein quality [33].

Nitrogen retention is the proportion of nitrogen utilized by farm animals from the total nitrogen intake for body process, hence the more the nitrogen is consumed and digested the more the nitrogen retained and vice versa, as observed by Okeniyi *et al*. [34]. Nitrogen retention was best in sheep on T_4 possibly because of nitrogen utilization in the rumen. This observation is further buttressed by the fact that the diet was well balanced in energy and protein which reduced nitrogen excretion in urine[35]. The percentage of nitrogen retention values recorded in this study were within the range values (14.87 to 57.24%) reported by Ajayi *et al*. [13] for dwarf goats of similar body weight. The values for the N balance were higher than the values reported by Wampana *et al.* [36] who fed agro-industrial by-product.

CONCLUSION

It can be concluded that, dietary inclusion of *Ziziphus mucronata* in the diet of Yankasa rams upto 15% in total mixed ration increased intake and performance, digestibility and nitrogen utilization of Yankasa rams.

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