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NUTRITIONAL EFFECTS OF *Ziziphus mucronata* IN A 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 an average of 18.19±0.26 kg were divided into four groups with four animals per group. Each group was randomly assigned to one of the dietary treatments containing 0, 5, 10 and 15% *Z. mucronata* foliage which were designated as treatments T_1, T_2, T_3 and T_4, respectively in a Completely Randomized Design. The results of the chemical composition revealed that the ash, crude protein and ether extract were higher ($P<0.05$) and crude fibre is lower ($P>0.05$) for treatment 1 compared to other treatments. Average daily gain (ADG, 0.09 kg), average daily dry matter intake (ADMI, 0.04kg), dry matter intake per metabolic weight (20.11 kg $W^{0.75}$) and feed conversion ratio (0.51) were significantly ($P<0.05$) better for animals on treatment T_4. Apparent digestibility of dry matter, organic matter, crude protein, ether extract hemicellulose and lignin were higher ($p<0.05$) for treatment T_4 compared to other treatments. Results showed positive nitrogen balance for all dietary treatments. It was concluded that *Ziziphus mucronata* could be utilized up to 15% in the diet of growing sheep with better performance especially during the dry season.

Keywords: Intake; growth performance; *Ziziphus mucronata*; Yankasa rams

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 (Leng, 1990) and tends to be major causes of low livestock productivity in dry tropical areas. In Northern Nigeria, there is poor quality and inadequate forage quantity during long period of dry season (Leng, 1990). Animals consuming basal diet containing less than 7% crude protein (CP) will require supplementation for improved performance (Abdulrazak *et al*., 1997; Ondiek *et al*., 2000). There is need to exploit forage resources 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 (Fagg and Stewart, 1994). 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) (Palgrave, 1983). The nutritional importance of browse is especially significant for free ranging animals in extensive communal system of production. The potentials of trees 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 continuous screening of browse plants to identify those with good potentials as livestock fodder and which could serve as alternatives to those species which have been already evaluated.

Ziziphus mucronata is grown in hot tropical region with less than 600m altitude and rainfall of 350 – 500 mm. Jauhari (1960) reported that *Ziziphus* is a drought resistant plant and adaptable to soil need. According to Carter (1994) stock eat the falling leaves of *Ziziphus mucronata* and the branches are sometimes lopped and fed to cattle while the red berries are readily eaten from the ground by goats. 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 (Kallah *et al*., 2000). Therefore, the current study was designed to assess the influence of *Ziziphus mucronata* leaves on growth performance, nutrient digestibility and nitrogen utilization of Yankasa rams.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the Research and Training Farm, Bayero University, Kano, Kano State, Nigeria. The area lies between latitude 9° 30' and 12° 00' North and Longitude 9° 30' and 8° 31' East. The state is characterized by tropical wet and dry climate (Olofin, 1998). Annual rainfall and temperature range between 787 to 969 mm and 21°C to 39°C, respectively (KNARDA, 2001). 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.

Treatments and Design

A total of 16 sheep weighing an average of 18.19±0.26 kg and between 8 and 10 months old were purchased from livestock market in Kano metropolis. The 16 Yankasa rams were divided into four groups with four animals per group. Each group was randomly assigned to one of the dietary treatments containing 0, 5, 10 and 15% *Z. mucronata* foliage which were designated as T_1, T_2, T_3 and T_4 respectively in a Complete Randomized Design.

Feeding and Management

Prior to commencement of the experiment, all animals were treated against internal parasites using levamisole^R (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). The animals were kept in a well ventilated raised slatted floor pens. Water and basal forage were supplied *ad libitum.* The trial lasted for 12 weeks (2 weeks for adaptation and 10 weeks for data collection). During the feeding trial, daily feed and water intakes and live weight changes were recorded.

Faecal Collection

At the end of the feeding trial, a digestibility study was conducted. Total of daily faecal output of all the rams was collected for seven (7) days. The daily faecal output was weighed afterward, 10% portion was taken and oven dried at 60^0C for 48 h. The dried faeces and feed samples were milled separately and sieve through 2 mm screen and stored in polythene bags for chemical analysis.

Chemical Analysis of the Browse Samples

Proximate composition of the faeces and feed samples were determined according to standard methods of Association of official Analytical chemists (AOAC) (2002). Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined according to the methods of Van Soest *et al.* (1991).

Statistical Analysis

The data generated were subjected to analysis of variance (ANOVA) in a Completely Randomized Design (CRD) using SAS package and where significant differences exists, means were separated using Duncan Multiple Range Test.

Table 1: Gross composition of experimental diets (g kg^{-1} DM)

Ingredients	Treatments			
	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
Metabolize Energy (MJ)	10.50	9.88	9.75	9.50
Crude Protein (CP)	18.58	17.80	16.25	15.0

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 g kg^{-1} for T_1 to 905.60 g kg^{-1} DM for treatment T_2. Ash content of the experimental diets ranged from 62.26 g kg^{-1} DM for treatment T4 to 96.30 g kg^{-1} DM for treatment T_1. Values obtained for organic matter content ranged from 792.97 for treatment T_1 to 831.90 g kg^{-1} DM for treatment T_3.

Generally, the diets had high crude protein values ranging from 132.40 g kg^{-1} DM for treatment T_4 to 184.90 g kg^{-1} DM for treatment T_1. The crude fibre content of the experimental diets ranged from 168.00 g kg^{-1} DM for treatment T_1 to 222.30 g kg^{-1} DM for treatment T_4. The range for ether extract in the diets was 67.30 g kg^{-1} DM for treatment T_4 to 98.40 g kg^{-1} DM for treatment T_1. The neural detergent fibre (NDF) content was observed to increase with increase in level of *Z. mucronata* with highest value for treatment T_4 (15% *Z. mucronata* inclusion). The acid detergent fibre (ADF) followed a similar trend with treatment T_4 having the highest value (305.27 g kg^{-1} DM). The acid detergent lignin and cellulose levels were generally high for all the dietary treatments. The hemicellulose content ranged from 90.30 to 94.40 g kg^{-1} DM.

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

Parameters	Treatments				
	T_1	T_2	T_3	T_4	SEM
Dry Matter	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
Organic Matter	792.97^c	829.30^a	831.00^a	827.04^{ab}	2.06
Crude Protein	184.90^a	168.30^b	136.10^c	132.40^d	2.08
Crude Fibre	168.00^d	191.40^c	201.07^b	222.30^a	3.14
Ether Extract	98.40^a	87.30^a	68.30^b	67.30^b	5.19
Neutral Detergent Fibre	351.40^d	359.60^c	387.40^b	398.40^a	2.21
Acid Detergent Fibre	264.43^d	281.20^c	293.40^a	305.27^a	2.41
Acid Detergent Lignin	114.00^c	112.33^d	132.60^a	129.30^b	1.18
Cellulose	256.80^b	264.30^b	334.90^a	293.40^{ab}	2.06
Hemicellulose	90.30^a	78.40^b	94.40^a	93.00^a	2.05

Means in the same row with different superscript differ significantly ($P<0.05$) means in the same column with different superscript differ significantly ($P<0.05$)

Growth Performance of Yankasa Rams Fed Graded Levels of *Z. mucronata*

The result on growth performance of Yankasa rams fed graded level of *Ziziphus mucronata* is shown in Table 3. The initial body weight of the animals was similar ($P>0.05$) across the treatments. The final weight ranged from 22.20 kg to 26.82 kg respectively and differed significantly ($P<0.05$) between the treatments. Treatment T_4 had higher ($P<0.05$) final body weight (26.82 kg) and body weight gain (BWG) (8.09 kg) compared to other treatment groups. TreatmentT_1 recorded the least BWG of 3.40 kg. Metabolic weight of the animals also differs significantly ($P<0.05$) between the treatments and showed similar trend as that of BWG. The values ranged from 16. 50 $LW^{0.75}$ for treatment T_1 to 20.11 $LW^{0.75}$ for treatment T_4. The average daily body weight gain, (0.09 kg day^{-1}), dry matter intake (DMI) (3.67 kg day^{-1}), and feed conversion ratio (0.51) were all higher ($P<0.05$) for treatment T_4 (15% *Z. mucronata* inclusion) and lower in T_1(0% *Z. mucronata* inclusion).

Table 3: Growth performance of Yankasa rams fed *Z. mucronata* in a mixed diet

Parameters	Treatments				
	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

Means in the same row with different superscript (in bracket) differ significantly ($P<0.05$) means in the same coloum with different superscript differ significantly ($P<0.05$); DMI=Dry matter Intake; SEM=Standard error of means; BWG=Body weight gain.

Nutrients Digestibility of Yankasa Rams Fed Graded Levels of *Z. mucronata*

Results on apparent digestibility of DM, OM, CP, EE, ADL and hemicelluloses is presented in Table 4. The results showed that apparent digestibility of DM, OM, CP, EE, ADL and hemicellulose were higher ($P<0.05$) for animals fed diet T_1 compared to other treatment diets (Table 4), whereas digestibility of CF was lowest for treatmentT_1, cellulose digestibility was highest for treatmentT_3. Digestibility of ADF was higher for treatment T_1 than for T_2.

Table 4: Nutrient digestibility (% DM) by Yankasa rams fed *Z. mucronata* in a mixed ration

Parameters	Treatments				
	T_1	T_2	T_3	T_4	SEM
Dry Matter	46.50^d	49.00^c	54.24^b	61.21^a	0.52
Ash	41.95^d	44.56^d	48.60^b	55.20^a	1.21
Organic Matter	27.53^b	26.68c	16.02^c	29.83^a	0.95
Crude Protein	68.72^c	75.60^{ab}	74.52^b	76.37^a	0.52
Crude Fibre	46.49^a	36.42^c	38.89^b	32.25^d	0.29
Ether Extract	22.17^a	21.92^a	17.53^b	17.50^b	0.52
Neutral Detergent Fibre	33.40^a	30.30^b	32.55^{ab}	30.58^{ab}	1.26
Acid Detergent Fibre	25.61^d	39.06^c	48.42^b	56.46^a	2.20
Acid Detergent Lignin	10.30^c	8.16^d	28.06^a	16.61^b	0.43
Cellulose	20.51^c	14.12^d	51.84^b	53.03^a	0.46

Means in the same row with different superscript (in bracket) differ significantly ($P<0.05$) means in the same coloum with different superscript differ significantly ($P<0.05$).

Nitrogen Utilization of Yankasa Rams Fed Graded Level of *Z. mucronata*

The result of the Nitrogen balance is presented in Table 5. 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 *Z. mucronata* while N absorbed as percent of nitrogen intake increases with increase the in levels of *Z. mucronata*.

Table 5: Nitrogen utilization (g day^{-1}) by Yankasa rams fed *Z. mucronata* in a mixed

Parameters	Treatments				
	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	28.3^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

Means in the same row with different superscript (in bracket) differ significantly (P<0.05) means in the same coloum with different superscript differ significantly (P<0.05); **N**=Nitrogen

DISCUSSION

Several reports by Ajayi *et al.* (2005) and Ososanya (2010) 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 ruminants. The intake of DM from for treatment T_4 was higher (P<0.05) than the other treatment groups probably due to dietary balance between energy and protein. The observed increase in DMI intake with increasing level of *Z. mucronata* leaves suggests that *Z. mucronata* is palatable and acceptable to sheep. Earlier studies (Yousuf and Adeloye, 2010) reported decreased in feed intake by goats due to the problem of palatability of fibre content in the diets. Despite high level of NDF and ADL in treatment T_4, the DMI was relatively higher for T_4 compared to other treatment groups. Jokthan *et al.* (2010) reported that the nature of feeds and acceptability plays an important role in regulating feed intake in small ruminant livestock. The results as shown in Table 2 regarding CP and fibre content could be valid for the difference observed in intake. The result indicates that the inclusion of *Z. mucronata* could constitute the main component of sheep diets and would be well consumed as demonstrated in treatments receiving the highest level of (15%). The highest weight gain recorded from the animals in treatment T_4 indicates efficient utilization of the *Ziziphus mucronata* fodder in the total mixed diet. Although 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 rams for all the treatments was lower (P>0.05) than expected as nutrient intakes from all the diets were higher in protein (9.52 to 15.86% CP) than the estimated requirements (7.43% CP). This can be explained either by the inadequacy of the estimated requirement for this breed, or the low genetic potential of the Yankasa sheep marked by low efficiency of nutrient utilization leading to low capacity for growth and possible effects of anti-nutritive substances. The low ADG recorded which varied from 0.01 to 0.09 kg day^{-1} may suggest 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 (Norton, 1998). Studies on the digestibility of browse fodders are very important as they allow for the estimation of nutrients actually available for animal needs. 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 (Barry and McNabb, 1999; McSweeney *et al.,* 2001). According to McSweeney *et al.* (2001) 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 (Norton, 1998). 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 (2004) also reported that high NDF and ADL depress DM intake and DM digestibility. Several studies (Buxton and Redfearn, 1997; Moore and Jung, 2001) have reported a negative correlation between lignin concentration and cell wall digestibility by its action as a physical barrier to microbial enzymes. Information on the NDF, ADF, lignin and tannin content of tree foliage is essential for the assessment of their digestibility. Luginbuhl and Poore (1998) 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 (2005) 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 (Silanikove, 2000). A wide range of variation in digestibility is reported in tropical browse species. Breman and Kessler (1995) showed a mean OMD of 0.53 in Sahelian and Sudanian zones of West Africa. Le Houerou (1998) reported a mean DCP of 510 g kg^{-1} for West African browses, with 760 g kg^{-1} for legumes. Fall (1991) 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 live weight 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. 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^{-1} and the diet with 0% *Ziziphus mucronata* inclusion resulted in the lowest performance, suggesting the significance of inclusion of the forage.

The higher ($P<0.05$) feed conversion ratio for treatment T_1 (0.51) than the other treatments showed that the leaves of *Z. mucronata* could be an alternative to groundnut meal because of the high FCR recorded from the same treatment. This is in addition of the availability of browse forage in the area where the foliage can be collected and stored for stall-feeding.

The influence of different levels of *Ziziphus mucronata* in the diet on nitrogen (N) intake, faecal and urinary N-output, N absorbed, N retained and N retained as percent of N intake of rams were observed to decrease with increase in levels of *Ziziphus mucronata* which followed similar pattern with the CP of the diets. The higher ($P<0.05$) urinary N output observed for all the treatments could probably be due to the high CP content of the diets leading to high level of nitrogen in the rumen which depends 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.* (2013) 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 (Quinion *et al*., 1996). Hence the more the nitrogen (or CP) is consumed and digested the more the nitrogen retained and vice versa, as observed by Okeniyi *et al*. (2010). The higher ($P<0.05$) nitrogen retention observed in sheep in treatment T_4 was possibly because the diet was well balanced in energy and protein which reduced nitrogen excretion in urine (Noblet and Van Milgen, 2004). 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*. (2005) for dwarf goats of similar body weight. The values for the N balance were higher than the values reported by Wampana *et al.* (2008) who fed agro-industrial by-product.

CONCLUSION

It was concluded that, dietary inclusion of *Z. mucronata* in the diet of Yankasa rams up to 15% in total mixed ration increased feed intake and animal performance, digestibility and nitrogen utilization of Yankasa rams.

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