Nutrient digestibility, nitrogen balance and rumen metabolites profile of growing Yankasa rams fed *Brachiaria ruziziensis* with concentrate mixture ratios in a total mixed ration

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ABSTRACT

A Digestibility trial which lasted for (21) days was carried out at the metabolic pen of the Small Ruminant Research Programme of the national animal production Research Institute (NAPRI), Ahmdu Bello University, Shika-Zaria to determine the nutrient digestibility, nitrogen balance and rumen metabolites concentration of growing Yankasa rams fed different ratios of Brachiaria ruziziensis and concentrate in a total mixed ration in Northern Guinea Savanna of Nigeria. Twelve healthy Growing Yankasa rams with an average live weight of 21.75kg±1kg were randomly allocated to four treatments with three replicates in a Complete Randomized Design (CRD). The treatment diets were ratio of Brachiaria ruziziensis to concentrate: (90:10), (80:20), (70:30) and (60:40) mixtures. The DM, OM, CP, CF, EE NFE and ADF digestibility showed significant variation (P<0.05) across the treatments. The Crude protein digestibility (CPD) was significantly (P<0.05) higher (84.25%) in (60:40) ratio B.ruziziensis to concentrate mixture while the least value of 76.12% was recorded in rams fed B.ruziziensis to concentrate mixture (90:10) ratio. Nitrogen intake, nitrogen absorbed, nitrogen retained and absorbed as percentage of intake (61.28%, 59.16%, 57.58%, 93.75% and 96.48%) respectively was significantly higher (P<0.05) in animals fed (60:40) mixture ratio. Rumen pH (6.80), Total volatile fatty acid (TVFA) (44.87), Rumen Ammonia nitrogen (NH_4-N) (16.18) significantly (P<0.05) differed across treatments with animal fed (60:40) ratio of B.ruziziensis to concentrate mixture recorded the highest value. Therefore, it could be concluded from this study that feeding Yankasa rams with 60:40 ratio B.ruziziensis to concentrate mixture ratio in a total mixed ration improved nutrient digestibility, nitrogen retention and rumen metabolites concentration in yankasa rams. Feeding of B.ruziziensis to concentrate at a ratio of 60:40 in a total mixed ration is hereby recommended for livestock farmers for better utilization in the Northern Guinea Savanna of Nigeria.

Key words: *Brachiaria ruziziensis,* Yankasa Rams, Total mixed ration, Concentrate, Digestibility.

Description of Problem

Small ruminants play a key role in bridging the wide gap in the supply of animal protein for human consumption (1) because of their special features with relatively short generation interval as compared to cattle, and also have high reproductive rate and low production cost. Given the estimated population of 72.5 million goats and 41.3 million sheep (2) and specifically about 70 percent of the sheep and goat populations are

concentrated in the northern region of the country. Concentration of Nigeria's livestock-base in the northern region is most likely to have been influenced by the ecological condition of the region, which is characterized by low rainfall duration, lighter sandy soils and longer dry season. Therefore, the importance and advantages of small ruminants cannot be over looked.

Feed scarcity is one of the major constraints to livestock production in the West African Sub-region (3). The poor quality of feed resources available to ruminants results into low plane of nutrition (4) and low productivity of our indigenous animals, (5). In Nigeria, the major challenge to livestock production is ensuring adequate feed supply throughout the year in terms of quality and quantity (6). Ruminants depend largely on crop residues during the long dry periods of the year for maintenance as well as production of meat, milk, skin and fibre. Feeding grains to ruminants is questioned, because of stiff competition from man and industries as raw materials and also from monogastric animals. On the other hand, ruminants are characterized by their ability to convert low quality roughage to products that are useful to man e.g. meat, milk natural fibers, leather and manure.

The main feed resources for ruminant animals are pastures, crop residues and other agro-industrial by-products. In the dry season and post-harvest periods, these feed resources become the main sources of energy for use by ruminants when poor quality forages from the range land prevail (7). The quantity and quality of available feedstuffs are the major factors influencing productivity of ruminants in many parts of the world, especially regions with high animal numbers. Crop residues are potential feed resources especially during the dry season. However, cereals from these crop residues are generally low in digestibility, because of high fibre content and are deficient in nitrogen, minerals and vitamins. The cell walls of low-quality roughages are generally high in indigestible fractions of lignin and silica (8). However, animal performance with such feedstuffs can be poor due to low voluntary intake and digestibility, which result from low protein concentrations and high levels of indigestible or slowly degradable fibre (9).

Brachiaria is one of the most important forage grasses grown for pastures in the tropics (10). *Brachiaria* is a species of grass originating from the Savanna of the Eastern part of Africa. The grass species is widely used as livestock feed. *Brachiaria* species are either annual or perennial grasses, with most of the species lacking rhizomes. The inflorescence has panicle branches composed of racemes and the entire plant usually do not grow higher than 1m. *Brachiaria* belongs to the C4 plants which tolerate drier conditions and more light exposure than many other plants (11). In this context, (12) reported that species of the genus *Brachiaria* are frequently used in no-till systems because these plants are highly adaptable and tolerant to limiting conditions that would affect other forage species negatively. *B. ruziziensi*s has a good nutritive value and is more palatable than most other *Brachiaria* spp. Its crude protein (CP) content commonly ranged from 7–13% and up to 20% with dry matter digestibility of 55–75%. For *B. ruziziensis* grass hay cut 45 days after seeding in northeast Thailand, the IVDMD, crude fibre, NDF and ME

concentrations were 61%, 80.5%, 72.8% and 7.9 MJ/kg, respectively (13). Selective grazing, heavy grazing pressure and the need for high soil fertility can result in the loss of *B. ruziziensis* grass (14).

Materials and Method

Location of the Study

This Experiment was carried out at the the metabolic pen of the Small Ruminant Research Programme of the national animal production Research Institute (NAPRI), Ahmdu Bello University, Shika-Zaria, in the Northern Guinea Savannah zone of Nigeria. Shika is geographically located between latitude 11^0 12'N and longitude 7^0 33'E at an altitude of 660m above sea level (15), Wet season starts from April to early May and ends in late September to early October. Long- term annual rainfall ranges from 1110 to 1580 mm with maximum temperature of 30^OC and relative humidity of approximately 70% (16).

Management of Experimental Animals:

Twelve (12) healthy Growing Yankasa rams of about 12 months old and similar weight (21 ± 0.3 kg) were obtained from a livestock market of Gadar Gayan Village in Igabi Local Government Area of Kaduna state and used. The Experimental animals were given profilactic treatment against both endo and ecto parasite using *Albendazole* 20 ml/ 10 kg, *Amiticks* spray (200 ml/ 20 ltr), *Ivermectin* (subcute) 0.1ml/10kg and Long-Acting Tetracycline (antibiotics) against bacterial infection. The Animals were acclimatized and fed experimental diet both the concentrate and forage obtained from the institute.

Digestibility Trial

At the end of the 90days feeding trial Phase, three (3) rams from each group were kept in an individual metabolic cage as described by (17). At the end of the 14days adjustment phase, urine and faeces were collected for a period of 7 days. he daily faceal output per treatment was weighed, Sub sampled and oven dried at 60 ^OC for 6 hours, for DM determination. The faeces were bulked and sub-sampled was milled and stored in polythene bags until ready for laboratory analysis. The Daily urine output was collected in plastic containers acidified with 10mls of 0.1M H_2SO_4 to prevent nitrogen loss through volatilization. Daily urine was bulk and 10% subsampled and kept in the refrigerator until ready for analysis to determine nitrogen as reported by (17).

Chemical Analysis

A Sub-sample from the bulk of the experimental diet and faecal sample were obtained, dried and milled and taken to the Central Laboratory Services Unit of the National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika-Zaria, for the determination of Crude Protein, Crude Fiber (CF), Ether Extract (EE), and Ash (A) content while soluble carbohydrates (NFE) by Formular That is: NFE = 100 − (% ash + % crude fiber + % crude fat + % crude protein). N-content was determined using the method of Micro Kjeldahl procedure of (18). M.E was calculated using the equation of Alderman, (1985) as ME(MJ/KgDM) = (0.012x CP) + (0.031x EE) + (0.005xCF) + (0.0014xNFE). Neutral detergent fibre (NDF), and Acid detergent fibre (ADF), by the method of (19). Mineral content (Calcium and Phosphorus) was determined by (18) Methods using the Atomic Absorption Spectrophotometer.

Statistical Analysis:

All data collected on the animal experiment was subjected to ANOVA using SAS package (20) and the means were separated using Duncan Multiple Rage Test (21).

Statistical Model:

$\mathbf{Y_{ij} = \mu + T_j + E_{ij}}$

Where:

Y_{ij} = Dependent variable.

μ = Population means.

T_j = Effect of Treatment Diet (j = 90:10, 80:20, 70:30 and 60:40 ratios of *B.ruziziensis* to concentrate).

E_{ij} = Random error.

RESULTS AND DISCUSSION

Chemical composition and Energy content of Experimental Diet (*Brachiaria ruziziensis* and Concentrate) ratios in a total mixed ration

Table 1 presents the chemical composition of the experimental diet. Organic Matter (89.70) of the concentrate diet was similar to (89.55) of the *Brachiaria ruziziensis* hay. C.P content of the concentrate diet (12.63) is higher ($P<0.05$) than the hay (8.25) which is above the minimum requirement of a ruminant animal for maintenance as reported by (22) and (23) which ranges between 6-8% CP as efficient for rumen function and maintenance. The organic matter of the different experimental diet mixtures presented in table 2 was similar across the treatments 90:10, 80/20, 70:30 and 60:40, (92.21,92.01,91.39 and 92.60) respectively. The C.P content of the mixture ratios was within the range of (6-8%) C.P in 90:10 and 80:20 but higher (8.13 and 11.75) in 70:30 and 60:40 respectively. M.E was similar (3807.75,3876.30 and 3893.26) in 80:20, 70:30 and 60:40 respectively and the least was 2292.9 kcal/kg in 90:10.

Table 1: Composition of Concentrate Diet

Ingredient	Percentage (%)
Maize	31.2
Maize offal	15.6
Wheat offal	15.6
Cotton seed cake	34.6
Bone meal	2
Salt	1
Total	100.0

Table 2: Chemical Composition and Energy Content of *Brachiaria ruziziensis* : concentrate mixture ratios in a total mixed ration.

Percentage (%)	(90:10)	(80:20)	(70:30)	(60:40)
Dry Matter	92.21	92.01	91.39	92.60
Organic Matter	87.55	85.14	87.22	86.86
Crude Protein	7.56	7.88	8.13	11.75
Ether Extract	9.49	7.26	8.26	8.04
Nitrogen free Extract	56.96	49.59	62.36	57.10
ASH	4.66	6.87	4.17	
ADF	32.01	32.56	25.13	22.95
NDF	53.14	48.85	49.97	40.42
Hemicellulose	21.13	16.29	24.84	17.47
M.E (kcal/kg DM)	2292.96	3807.75	3876.30	3893.26

Nutrient digestibility of *Brachiaria ruziziensis*: Concentrate mixture ratios fed to Growing Yankasa rams.

Table 3 presents nutrient digestibility, Pattern of *B.ruziziensis* concentrate mixture fed to Growing Yankasa rams. In this study, High (P<0.05) digestibility of the feed was recorded especially at (60:40) ratio of *B.ruziziensis* and concentrate mixture with DMD, OMD, C.P, C.F and E.E (85.43%,85.43%,84.25% 89.07% and 88.20%) with a decline across the treatments the lowest digestibility indices were recorded in Growing Yankasa rams fed 90:10 ratio (80.57,81.40 and 76.12%) respectively. The NFE was not significantly (P>0.05) different across the treatments. NDF and ADF digestibility showed significant (P<0.05) variation across the treatments. The high digestibility of (59.82 and 50.43%) recorded respectively in 90:10 mixture ratio could be to meet up the microbial need in the rumen which influenced microbial protein synthesis and facilitated fermentation and consequently improved intake and digestibility. (23) classified digestibility of feed as high (>60%), medium (40 - 60%) and low (<40%). This is also in agreement with the report of (24) that the activity of ruminant microbes is improved by the presence of nitrogen. The DMD values obtained in the present study was in agreement with the result obtained by (25) whose value ranged between 61.39% and 84.37% when fore stomach digesta and poultry waste was fed to Uda lambs. The Crude protein digestibility (CPD) was significantly (P<0.05) different, the values range from 76.12 - 84.25% with the highest at (60:40) ratio *B.ruziziensis* and concentrate mixture (84.25%) while the least value of 76.12% was recorded in growing yankasa rams fed (90:10) ratio *B.ruziziensis* and concentrate mixture. The result of this study is similar to the findings of (26) who reported digestibility values of 84.92 to 86.02%, and in conformity with the values reported by (27) whose value ranged between 75.5% and 81.06% when *Ficus sycomorus* leaves were fed to growing yankasa rams. The crude fiber digestibility (CFD) was significantly (P<0.05) different among the treatments and that the values 89.07% with rams fed (60/40) ratio *B.ruziziensis* and concentrate mixture recorded the highest CFD while the least CFD value of 73.90% was recorded in growing yankasa rams fed (90:10) ratio *B.ruziziensis* and concentrate mixture. The values recorded were higher than the values 52.70% to 53.7% reported by (28). The lower digestibility values recorded in (90/10) ratio could be attributed to the lower CP content of the *B.ruziziensis* and concentrate mixture diet. (29) reported that digestibility is much reduced when a ration contains little protein in proportion to the amount of readily digestible carbohydrate, also (30) concur on the fact that the higher the fibre fractions, the lower the digestibility. The Nitrogen Free Extract digestibility (NFED) of the growing yankasa rams was not significantly (P>0.05) different among treatments but higher than the range of 51.39 - 67.00% reported by (26) when the authors fed cassava peels substitute with *Cajanuscajan* hay.

Table 3: Nutrient digestibility of *Brachiaria ruziziensis:* Concentrate mixture ratios fed to Growing yankasa rams.

	B.ruziziensis : Concentrate				
Parameters	90:10	80:20	70:30	60:40	SEM
Dry Matter	80.57^{c}	82.62^{b}	82.30^{b}	84.90^{a}	1.06*

Organic matter	81.40[b]	82.47[b]	82.76[b]	85.43[a]	1.04*
Crude protein	76.12[b]	78.44[b]	77.14[b]	84.25[a]	2.26*
Crude fibre	73.90[c]	87.53[b]	85.05[b]	89.07[a]	1.36*
Nitrogen free extract	83.10	83.38	85.75	84.97	0.96[NS]
ADF	50.43[a]	51.11[a]	51.76[a]	44.31[b]	3.19*
NDF	59.82[a]	46.70[c]	55.77[a]	51.33[b]	2.48*
Ether Extract	84.94[b]	78.78[d]	82.38[c]	88.20[a]	1.01*

[a b c:] Means with different superscript within a row differed significantly (P<0.05). SEM: Standard error of mean, * Significant at 5%, ADF= Acid detergent fibre, NDF= Neutral detergent fibre.

Nitrogen Balance in Growing Yankasa Rams fed *Brachiaria ruziziensis*: Concentrate mixture ratios in a total mixed ration.

Table 4 presents Nitrogen balance in growing Yankasa rams fed *Brachiaria ruziziensis* and concentrate mixture ratios nitrogen intake was significantly (P<0.05) higher (61.28g) in growing Yankasa rams on treatment (60:40) ratio *Brachiaria ruziziensis* and concentrate mixture than the other treatments, Faecal nitrogen output was also higher (P<0.05) with growing Yankasa rams on 60:40 mixture excreting (2.13) which is similar to growing Yankasa rams on 90:10 ratio mixture (1.80) Urinary nitrogen output, total nitrogen output (1.59),(3.29) were also higher (P<0.05) in growing Yankasa rams fed on 80:20 mixture but similar to growing Yankasa rams on 60:40 mixture (1.55), (3.75), respectively. Nitrogen absorbed, Nitrogen retained and Nitrogen retained and absorbed as a percentage of intake (59.16,57.58,93.75 and 96.48) were significantly higher (P<0.05) in growing Yankasa rams fed 60:40 ratio mixture respectively. This provides the fermentable nitrogen for efficient synthesis of essential amino acids and positive nitrogen balance (33; 34). The nitrogen retention and nitrogen absorbed as percentage of intake were above 68.0 % and higher than 47.98 % reported by (31) who fed *Digitaria smutsii* hay supplemented with *Ficus sycomorus* leaf meal but in line with 95.84 % and 74.24 % reported by (32) who fed total mixed rations containing *Parkia biglobosa* forage included at graded levels. Nitrogen retention is the major indicator for assessing the protein nutritional status of ruminant livestock (33;34). It is also the proportion of nitrogen utilized by growing Yankasa rams from the total nitrogen intake for the body processes, hence the more nitrogen consumed and digested the more nitrogen retained and vice versa (35).

Table 4: Nitrogen Balance in Growing Yankasa Rams fed *Brachiaria ruziziensis* : Concentrate mixture ratios in a total mixed ration.

	***B.ruziziensis* : concentrate**				
Parameters	**(90:10)**	**(80:20)**	**(70:30)**	**(60:40)**	**SEM**
N intake (g)	28.49[c]	32.57[b]	33.92[b]	61.28[a]	0.99*
Feacal N output	1.80[a]	1.70[b]	1.48[b]	2.13[a]	0.12*
Urinary N output	1.04[b]	1.59[a]	1.02[b]	1.55[a]	0.02*
Total N output	2.84[b]	3.29[a]	2.49[c]	3.70[a]	0.25*
Nitrogen absorbed	26.69[c]	30.87[b]	32.44[b]	59.16[a]	1.04*

Nitrogen Retained	25.65[c]	29.26[b]	31.42[b]	57.58[a]	1.16*
N retained as % of intake	89.84[b]	89.80[b]	92.62[a]	93.75[a]	0.77*
N absorbed as % of intake	93.51[c]	94.75[b]	95.62[b]	96.48[a]	0.45*

[a, b, c:] Means with different superscript within a row differed significantly (P<0.05). SEM= Standard Error of Means. * Significant at 5%.

Effects of feeding *Brachiaria ruziziensis* and Concentrate ratios in a total mixed ration on some rumen metabolites of Growing Yankasa Rams

The result of rumen pH, presented in table 5 indicates that growing Yankasa rams fed diet with 60:40 ratio recorded the highest (6.80) which was followed with those fed diet 70:30 ratio (6.63) and least was recorded on growing Yankasa rams fed 80:20 ratios (6.20). (46) have reported a normal pH range of 6.2-6.9. The slightly alkaline rumen condition in this study was probably due to increased concentration of ammonia in the rumen. (36) obtained a pH of 7.1-7.31 when pigeon pea forages-based diets were fed to sheep on rice straw basal diets. Differences in ruminal pH may also result from variations of VFA concentrations, because ruminal pH reflects the rate of fermentation of carbohydrate (37). This can be attributed to the high concentrate inclusion in the total mixed ration, (38) reported that the levels of CP significantly alter ruminal pH. This may also be attributed to higher ruminal NH_3-N may be produced due to feeding high level of CP. TVFA (Total volatile fatty acid), the concentration of the TVFA obtained in this study indicated that growing Yankasa rams fed 60:40 ratio recorded the highest ($p<0.05$) value 44.87 Mmol/100ml and the least was in growing Yankasa rams fed 90:10 ratio 33.05 Mmol/100ml. Volatile fatty acids (Acetic, propionic and Butyric acid) are the main energy sources for ruminant feeding solely on roughages. Thus, their concentration in the rumen gave an indication of their energy values. The TVFA concentration value ranges between 33.05 – 44.87 Mmol/100ml in this study which was above 28.8- 56.8 Mmol/100 ml reported by (46) when groundnut haulm was fed to Growing Yankasa rams and 19.57-36.57mmol/lt reported by (36) when pigeon pea forage was supplemented in sheep diet. The increase in rumen TVFA in this study is possibly due to increased digestibility of the feed material. Rumen Ammonia (NH_4)-N significantly ($p<0.05$) differ along the treatments with growing Yankasa rams fed (60:40) ratio recorded the highest value (16.18mg/100ml) and the least was recorded in growing Yankasa rams on 90:10 ratios (12.30mg/100ml). This can be attributed to lower fermentation process due to low concentrate inclusion in the ration mixture. The increased concentration of NH_3-N with increasing CP content was observed by (39). The rumen NH_3-N concentration of 12.30 mg/100ml in this study was within the range of 11.42-14.43mg/100ml recorded by (40). (41) reported that between 3.6-17mg/100ml NH_3-N concentration promotes microbial protein production which is an important factor in determining the utilization of nitrogen in the rumen (36). Also, the increased concentrations of NH_3-N may be attributed to the ruminal degradation of CP as reported by (42). Higher ruminal NH_3-N concentration is accompanied with an increase in the level of dietary CP; Similar results were observed by (43). (44) and (45) also observed rumen NH_3-

N level increased with increasing CP level. The increased concentration of NH_3-N in the rumen was mainly explained by a higher production of ammonia from the degradation of proteins in the rumen (42).

Table 5: Effects of feeding *Brachiaria ruziziensis*: Concentrate mixture ratios on some rumen metabolites of Growing Yankasa Rams

	***B.ruziziensis* : Concentrate ratio**					
Parameters	**(90:10)**	**(80:20)**	**(70:30)**	**(60:40)**	**SEM**	**Normal range**
Rumen pH	6.64^{ab}	6.20^{c}	6.63^{b}	6.80^{a}	0.05^{*}	6.4-6.8
TVFA (Mmol/100ml)	33.05^{c}	42.45^{b}	42.59^{b}	44.87^{a}	0.36^{*}	70-150
RumenNH_3-N(mg/100ml)	12.30^{b}	12.92^{b}	12.77^{b}	16.18^{a}	0.29^{*}	8.5-30

[a, b, c:] Means with different superscript within a row differed significantly (P<0.05). SEM: standard error of means, * Significant at 5%.

CONCLUSION

It is possible to mix *B. ruziziensis* forage and concentrate to feed small ruminants at 60:40 ratio for improved utilization and better performance.

Feeding a 60:40 ratio of *B. ruziziensis* forage and Concentrate mixture gave higher nutrient digestibility of Dry matter 84.90%, Crude protein 84.25%, Nitrogen absorbed as % of intake 96.48% and TVFA concentration 44.87 Mmol/100ml.

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