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Digestibility in Yankasa Rams Fed *Brachiaria ruziziensis* – *Centrosema pascuorum* Hay Mixtures with Concentrate

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***Abstract*—**This study investigated the digestibility of *Brachiaria ruziziensis* and *Centrosema pascuorum* hay mixtures at varying proportions in Yankasa rams. Twelve Yankasa rams with average initial weight 10.25 ± 0.1 kg were assigned to three dietary treatments of *B. ruziziensis* and *C. pascuorum* hay at different mixtures (75BR:25CP, 50BR:50CP and 25BR:75CP, respectively) in a Completely Randomized Design (CRD) for a period of 14 days. Concentrate diet was given to the experimental animals as supplement at fixed proportion, while the forage mixture (basal diet) was fed at 3% body weight. Animals on 50BR:50CP had better nutrient digestibility (crude protein, acid and neutral detergent fibre, ether extract and nitrogen free extract) than other treatment diets, except in dry matter digestibility (87.35%) which compared with 87.54% obtained in 25BR:75CP treatment diet and also organic matter digestibility. All parameters taken on nitrogen balance with the exception of nitrogen retained were significantly higher ($P < 0.05$) in animals fed 25BR:75CP diet, but were statistically similar with values obtained for animals on 50BR:50CP diet. From results obtained in this study, it is concluded that mixture of 25%BR75%CP gave the best nutrient digestibility and nitrogen balance in Yankasa rams. It is therefore recommended that *B. ruziziensis* and *C. pascuorum* should be fed at 50:50 mixture ratio for enhanced animal growth and performance in Nigeria.

Keywords*—B. ruziziensis, C. pascuorum*, digestibility, rams, Yankasa.

I. Introduction

FEED shortage is a critical problem in livestock farming in most areas of the tropics. As grazing lands are gradually brought under cultivation to satisfy the food needs of the increasing human population, livestock are forced to graze on marginal areas, which combined with the use of low-quality crop residues as feeds has resulted in poor livestock performance. Natural pastures, from such marginal lands are generally high in fibre, low in protein and energy yet they form the main source of animal feed in Tropical Africa [1]. These resources are over utilized to the extent that they fail to meet even the maintenance requirements of indigenous animals especially when the dry season persists for long periods. This has resulted in significant decrease in milk production, loss of body weight, reduced draught power, increased susceptibility to diseases, reduced reproductive performance, retarded growth rate and high mortalities of young animals [2].

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The Nigerian livestock population estimates about 13.9 million cattle, 22.1 million sheep and 34.5 million goats [3], [4]. Sources of cheaper alternative forages of high quality for ruminant livestock production have been a subject of research in recent years [5] especially for small scale livestock producers in tropical areas during the dry season. Ruminant production systems throughout the world are based on forages with grassland feeds being predominant.

The nutritive value of Congo grass (*Brachiaria ruziziensis*) steeply declines with maturity; the crude protein declines to 9-10% after 10 weeks of re-growth, and can be lower than 8% after 15 weeks of re-growth [6]. One way to increase the nutritive value of Brachiaria grass and delaying the decrease of its nutritional quality is through cultivation with forage legumes. *Centrosema pascuorum* is a vigorous, trailing, twining and climbing perennial herb with trifoliate leaves and is fairly drought tolerant [7]. Reference [8] recommended that Centrosema spp. be integrated into the crop-livestock farming system of the low land areas of Northern Nigeria. Reference [9] reported judicious combinations of these feeds with the more abundant low-quality forages are needed. The digestibility would probably increase as the proportion of forage legume increases because the legumes often have higher digestibility than grasses [10].

Justification for the study: The low nitrogen (N) content of most matured grasses points to a need to combine them with forage legumes with high nitrogen (N) content. However, it has been reported that the high rates of release of soluble protein and breakdown to small particles from herbaceous legumes is associated with susceptibility of ruminants to bloat [11].

This study investigated the digestibility and nitrogen balance of growing Yankasa rams fed mixtures of *B. ruziziensis* and *C. pascuorum* hay supplemented with concentrate.

II. Material and Methods

A. Experimental Site

The feeding trial was conducted at the Teaching and Research Farm of the Department of Animal Production, Abubakar Tafawa Balewa University, Bauchi, Bauchi State. Bauchi lies between latitude 100°33′N and longitude 90°31′E. It is bordered by Seven States, Kano and Jigawa to the North, Taraba and Plateau to the South, Gombe and Yobe to the East and Kaduna to the West. It occupies a total area of 49,259.01

km^2, representing about 5.3% of the total land mass of Nigeria [12].

B. Management of Experimental Animals

12 Yankasa rams of between 9-12 months of age weighing between 10.18-10.28 kg were used for the nutrient digestibility studies. Each animal was given prophylactic treatment consisting of Ivomectin (*Ivomec*®) at 0.5 ml/25 kg body weight subcutaneously against ecto-parasites (such as fleas, mites and ticks etc.) and Oxytetracycline (*Tridox*®) antibiotics at 1.0 ml/10 kg body weight intramuscularly against bacterial infections one week before the start of the experiment. Other routine management practices included; de-worming against intestinal parasites using *Albendazole*® 10% solution which was administered in drinking water. The experimental animals were housed individually in an open sided and well-ventilated pen. The pens were cleaned, washed and disinfected with Izal solution before the arrival of the animals. The rams were allowed an adaptation period of two (2) weeks during which they were fed with the experimental diets and were given access to fresh clean water.

C. Experimental design and Treatments

12 Yankasa rams were randomly allotted into three dietary treatments with four (4) rams per treatment in a CRD. The experimental diets were: Treatment 1: 75% B. ruziziensis and 25% C. pascuorum hay, Treatment 2: 50% B. ruziziensis and 50% C. pascuorum hay, Treatment 3: 25% *Brachiaria ruziziensis* and 75% *Centrosema pascuorum* hay, respectively.

A concentrate diet was formulated using maize offal, cotton seed cake, cowpea husk, bone meal and common salt as shown in Table I. The ingredients used in formulation of the concentrate diet were purchased from Muda Lawal market at Bauchi, Bauchi State.

TABLE I
PERCENTAGE COMPOSITION OF FEED INGREDIENTS IN THE CONCENTRATE DIET FED TO YANKASA RAMS

Feed ingredients	% composition
Maize offal	67.0
Cotton seed cake	21.0
Cowpea husk	10.0
Bone meal	1.50
Common salt	0.50
Total	100
ME (MJ/kgDM)	11.81
Crude protein	13.78

ME = Metabolizable energy

The concentrate feed was offered to the animals at a fixed amount (200 g) while experimental diets consisting of forage mixtures were offered at 3% body weight of the animals throughout the experimental period of 90 days.

D. Experimental Procedure and Data Collection

Experimental animals were fed experimental diets (concentrate and basal diet) at 8:00 a.m. in the morning and 4:00 p.m. in the evening. The concentrate and experimental diets were weighed before feeding to the animals and left-overs weighed the next morning before feeding to determine the feed intake daily. The experimental animals were provided with fresh and clean drinking water in a graduated plastic container.

Dry matter intake (DMI), initial body weight, bi-weekly body weight and final body weight were measured while feed intake, feed efficiency and feed conversion ratio were calculated. Experimental animals were weighed at the beginning of the experiment and subsequently at two-week intervals up to 90 days to determine the bi-weekly live weight gain as well as the total live weight gain (TLWG).

E. Digestibility Trial and Nitrogen Balance

At the end of the growth performance trial, animals from each of the treatment groups were weighed and housed in individual metabolism crates ideal for separate collection of urine and faeces as described by [13]. The animals had free access to feed and clean drinking water. The experimental animals were allowed seven days to adjust to the metabolism crates which was followed by another seven days of faecal and urine collection to determine nutrient digestibility and nitrogen retention in the experimental animals.

The total faecal output was collected daily in the morning, weighed and mixed thoroughly before 10% subsample was collected for dry matter (DM) determination prior to storage. The total faecal sample collected over the seven-day period was bulked and sub-sampled for laboratory analysis after treating (sprinkle) with 20% formaldehyde to prevent further bacterial activity. The total urine output for 24 hours was collected, using a graduated plastic container containing 100 ml 0.1 M (H_2SO_4) which was placed under the metabolism crates. 10% of the daily urine output (aliquot) was taken from each ram, bulked and stored in a deep freezer at -20 °C.

F. Laboratory Analysis

DM contents of the faecal sample were determined by drying at 60 °C for 48 hours. Nitrogen content of the feed samples and urine was determined using Kjeldahl procedure [14]. The sample was ashed by charring in a muffle furnace at 500 °C for about 3 hours. Ether extract (EE) and crude fibre (CF) of the sample was analysed according to [14] procedure. The acid detergent fibre (ADF) and the neutral detergent fibre (NDF) of the faeces were analysed according to the procedure of [15]. Organic matter (OM) was obtained by subtraction of ash content from the DM of the feed sample while nitrogen free extract (NFE) was calculated by difference [100 (NDF + CP + EE + Ash)] and ME of the diets was estimated using the method described by [16].

$$ME\ (MJ/KgDM) = 11.78 + 0.00654CP + (0.000665EE)^2 - CF(0.00414EE) - 0.0118A$$

where; A = Ash content, CP = Crude protein.

G. Statistical Analysis for Growth Performance

Data collected during the digestibility trials were subjected to One-way Analysis of Variance (ANOVA) procedure [17] and Least Significant Difference ($LSD_{0.05}$) was used to

separate significant treatment means [18]. The following model was used in the studies;

$$Y_{ij} = \mu + A_i + e_{ij}$$

where, Y_{ij} = Record of observations for dependent variable; μ = Overall mean, A_i = Effect of the i^{th} treatment diets (i = 1, 2, 3), and e_{ij} = Random error.

III. Result and Discussion

A. Chemical Composition of Experimental Feed Materials Fed to Yankasa Rams

Table II shows the percentage composition of feed ingredients in the concentrate diet fed to Yankasa rams in this study while the chemical composition of individual feed ingredients in the diet of Yankasa ram is presented in Table III.

TABLE II
Chemical Composition of Feed Materials of the Experimental Diets Fed to Yankasa Rams

Parameters (%)	*B. ruziziensis*	*C. pascuorum*	Concentrate diet
DM	90.84	88.13	87.65
OM	81.53	82.59	82.40
Crude protein	7.84	13.01	13.78
NDF	52.19	44.32	46.55
ADF	49.69	33.53	37.21
EE	0.65	0.63	0.63
Ash	9.31	5.54	5.25
NFE 30.01	36.50 33.79		
ME (MJ/kgDM) 11.72	11.80 11.81		

TABLE III
Chemical Composition of Experimental Diets Fed to Yankasa Rams

	Mixture of *B. ruziziensis* and *C. pascuorum* hay (%)		
Parameters (%)	75:25	50:50	25:75
DM	89.22	88.68	88.52
Crude protein	8.82	10.64	12.14
EE	0.34	0.36	0.39
Ash	2.70	2.62	2.97
Neutral detergent fibre	47.61	48.30	46.80
ADF	38.43	39.22	37.74
NFE	40.53	38.08	37.70
ME (MJ/kgDM)	11.80	11.82	11.82

B. Nutrient Digestibility of Yankasa Rams Fed Diets Containing Mixtures of B. ruziziensis and C. pascuorum Hay Supplemented with Concentrate

The results for nutrient digestibility of Yankasa rams fed experimental diets are presented in Table IV. DM digestibility was significantly ($P < 0.05$) higher in animals on 25%B.R: 75%C.P treatment diet (87.54%), which was at par with DM digestibility of 87.35% obtained in animals fed 50%B.R: 50%C.P treatment diet, but were both significantly different ($P < 0.05$) from DM digestibility of 85.25% in animals fed 75%B.R:25%C.P diet. However, the OM digestibility was significantly different ($P < 0.05$) across all treatment and ranged from 85.21% in 75%B.R:25%C.P treatment diet to 87.45% in 25%B.R:75%C.P treatment diets. The results showed an increase in crude protein, acid detergent, EE and NFE digestibility as *C. pascuorum* increased in the diets up to 50%B.R:50%C.P which subsequently declined with further increase in *C. pascuorum* in the diet. This result was similar to the result reported by [19] when highest digestibility was reported in rams fed *Panicum maximum* and *Centrosema pascuorum* at 50:50 mixture ratio, suggesting that as *C. pascuorum* replaced *P. maximum*, OM digestibility increased. Also, [20] reported the best performance of Yankasa rams on the basis of intake and digestibility from treatment diet with 50:50 Lablab-millet ensiled mixture.

The observation in this study is consistent with [21] who fed corncobs and Centrosema hay to West African Dwarf Sheep. Also, [22] and [23] affirmed that digestibility of nutrients varies with nutrient composition of diets. The higher acid and v observed in 50%B.R:50%C.P treatment diet might be related to changes in the rate of passage of ingesta from the rumen [24]. The inclusion of legume hay which has higher level of available nutrients could have provided nutrients for microbial growth especially fermentable nitrogen [25]. The effects of feeding increasing proportions of legumes in the mixtures on digestibility of nutrients differ with forage specie combinations. The lowest values for nutrient digestibility obtained in 75%B.R:25%C.P treatment diet may be due to lower crude protein content in the diets. Reference [26] reported that digestibility is much reduced when a ratio contains little protein in proportion to the amount of readily digestible carbohydrate. Also, [27] reported that higher fibre fraction lowers digestibility in feed which is the case in 75BR: 25CP having the highest ratio of *B. ruziziensis* hay with crude protein content lower than that of *C. pascuorum* hay.

TABLE IV
Nutrient Digestibility of Yankasa Rams Fed Diets Containing Mixtures of *B. ruziziensis* and *C. pascuorum* Hay

	Mixture ratios of *B. ruziziensis* and *C. pascuorum* hay (%)			
Parameters (%)	75:25	50:50	25:75	SEM
DM	85.25^{b}	87.35^{a}	87.54^{a}	0.62
OM	85.21^{c}	86.70^{b}	87.45^{a}	0.44
Crude protein	91.50	92.43	92.13	0.42
NDF	85.04^{b}	86.80^{a}	86.79^{a}	0.32
ADF	57.50^{b}	58.78^{a}	49.00^{c}	1.34
EE	92.82	92.42	91.83	0.11
NFE	84.36	85.86	85.59	0.42

[a, b, c] Means in the same row with different superscript are significantly different ($P < 0.05$), SEM = Standard error of mean.

The crude protein digestibility ranged from 91.50% in animals fed 75%B.R:25%C.P to 92.43% in animals fed 50%B.R:50%C.P diets and were not significantly different ($P > 0.05$) across treatment. The digestibility of ADF was significantly ($P < 0.05$) influenced by dietary treatment. Forage legume supplementation significantly improves DM, crude protein and ADF digestibility due to the fact that forage legume enhances efficient rumen fermentation which optimizes growth for increased digestibility [28]. The further reduction in nutrient digestibility in all parameters as *C. pascuorum* increases in the treatment diet further than 50%

could be explained by the fact that the protein in the legume increased the amino acid in the rumen beyond optimum and hence, reduced the ability of rumen microbes to optimally digest feed materials. The high crude protein as *C. pascuorum* increased in 25%B.R:75%C.P from 50%B.R:50%C.P, reduce the stability of rumen environment and also growth of rumen microbes which is responsible for the drop in digestibility of nutrients in the feed [29]. The digestibility obtained in this study for DMD, CPD were higher than values obtained by [30] when Yankasa rams were fed *B. ruziziensis* with different protein supplement.

C. Nitrogen Balance in Yankasa Rams Fed Diets Containing Mixtures of B. ruziziensis and C. pascuorum Hay Supplemented with Concentrate

The results obtained for nitrogen balance in Yankasa rams fed experimental diets containing different mixtures of *B. ruziziensis* and *C. pascuorum* are shown in Table V. The nitrogen intake value was not significantly different ($P > 0.05$) in animals fed 50%B.R:50%C.P (11.78%) and those fed 25%B.R:75%C.P diet (12.06%), but were significantly ($P < 0.05$) higher than those fed 75%B.R:25%C.P diet (9.75%). There was also significant difference ($P < 0.05$) in the faecal nitrogen across all the treatment diets with animals fed 25%B.R:75%C.P having the highest faecal nitrogen (0.95 g/day), with animals fed 75%B.R:25%C.P diet having 0.83 g/day. The nitrogen intake increased ($P < 0.05$) with increasing level of *C. pascuorum* in the diet; this is attributed to the higher DM and crude protein intake as the percentage of *C. pascuorum* increased across the dietary treatment which is also responsible for the highest faecal nitrogen (0.95 g/day) obtained for animals on 25%B.R:75%C.P diet.

The urinary nitrogen, total nitrogen loss, nitrogen balance and nitrogen absorbed were all higher ($P < 0.05$) in 25%B.R: 75%C.P treatment diets. The values for urinary nitrogen ranged from 0.50 g/day in animals fed 75%B.R:25%.CP to 0.64 g/day in animals on 25%B.R:75%C.P diet and were significantly different ($P < 0.05$) from each other. The significantly higher urinary nitrogen observed in animals fed 25%B.R:75%C.P could be explained by the fact that excess ruminal ammonia is absorbed and excreted in the urine in the form of urea as reported by [31]. However, for total nitrogen loss, 1.45 g/day obtained in animals fed 50%B.R:50%C.P diets was not significantly different ($P < 0.05$) from 1.59 g/day obtained in animals fed 25%B.R:75%C.P and 1.33 g/day in animals fed 75%B.R:25%C.P, but values obtained for animals on 75%B.R:25%C.P and 25%B.R:75%C.P were significantly different ($P < 0.05$) from each other. Nitrogen retention is the major indicator used to assess the protein nutritional status of ruminant livestock [32]. It was highest in 50%B.R:50%C.P treatment diet and could be attributed to lesser nitrogen loss in relation to nitrogen intake in the ram when compared to those rams on 25%B.R:75%C.P diet. However, the drop in nitrogen retention in 25%B.R:75%C.P could be attributed to the less efficient utilization of protein in line with the observation of [33] who reported decreased nitrogen retention when poultry litter supplied more than half of nitrogen in diets.

Animals fed 25BR:75CP diets had the highest mean nitrogen balance (10.47 g/day) which was at par with the 10.33 g/day obtained for animals fed 50BR:50CP, but were significantly higher ($P < 0.05$) than 8.42 g/day obtained animals fed 75%B.R:25%C.P diets. Nitrogen absorbed ranged from 8.92 g/day in animals fed 75%B.R:25%C.P diet to 11.11 g/day in animals fed 25%B.R:75%C.P diet and followed the same statistical trend as nitrogen balance afore mentioned. Animals on 25%B.R:75%C.P had the highest nitrogen balance and nitrogen absorbed values of 10.47 g/day and 11.11 g/day, respectively, but were not statistically different from values in 50%B.R:50%C.P (10.33 g/day and 10.88 g/day). This agrees with the report of [34] that nitrogen balance depends on good digestibility of nutrients and or utilization. In some cases, this effect is also found to be sufficient to maintain an adequate nitrogen balance.

TABLE V
NITROGEN BALANCE IN YANKASA RAMS FED DIETS CONTAINING MIXTURES OF *B. RUZIZIENSIS* AND *C. PASCUORUM* HAY SUPPLEMENTED WITH CONCENTRATE

Parameters (g/day)	75:25	50:50	25:75	SEM
Nitrogen intake	9.75[b]	11.78[a]	12.06[a]	0.36
Faecal nitrogen	0.83[c]	0.90[b]	0.95[a]	0.02
Urinary nitrogen	0.50[b]	0.55[b]	0.64[a]	0.03
Total N loss	1.33[b]	1.45[ab]	1.59[a]	0.04
Nitrogen balance	8.42[b]	10.33[a]	10.47[a]	0.28
Nitrogen absorbed	8.92[b]	10.88[a]	11.11[a]	0.30
N retained (intake %)	86.36[b]	87.69[a]	86.82[ab]	0.16

[a, b, c] Means in the same row with different superscript are significantly different ($P < 0.05$), SEM = Standard error of mean

IV. CONCLUSION AND RECOMMENDATION

Yankasa rams fed diet containing mixtures of 50%B.R:50%C.P diet had the best nutrient digestibility for crude protein, acid detergent, neutral detergent, NFE digestibility and nitrogen retention in rams compared to other treatment diets. It is therefore recommended that *B. ruziziensis* and *C. pascuorum* be mixed at 50% *B. ruziziensis* and 50% *C. pascuorum* in the diet of Yankasa rams for nutrient digestibility and retention.

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