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Performance of yankasa rams fed varying ratio of *Brachiaria ruziziensis-Centrosema pascuorum* hay mixtures

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Abstract

The performance of Yankasa rams fed varying ratios of *Brachiaria ruziziensis-Centrosema pascuorum* hay with concentrate was investigated. Twelve yearling rams having 10.25±0.1 kg average initial weight were assigned to three different diets of *B. ruziziensis* and *C. pascuorum* hays at varying proportions (75 B.R: 25 C.P, 50 B.R: 50 C.P and 25 B.R: 75C.P, respectively) in a Completely Randomized Design for 90 days. Forage mixtures (basal diet) were fed to the rams at 3% body weight while the concentrate diet was fed at fixed ratio**.** The growth trial showed that rams fed a mixture of 25% B.R: 75% C.P had the highest weight gain (3.92 kg). Similarly, the feed conversion ratio (18.07) obtained in 25% B.R: 75% C.P mixture was higher (P<0.05) than other treatment diets. Blood chemistry after feeding was mostly not significant (P>0.05) except glucose, alkaline phosphatase (ALP) and Urea Nitrogen (Urea N) which were significant (P<0.05). Animals fed 75 BR: 25 CP diets had better glucose (54 mmol) and ALP (18 µ/l) values after feeding, while Urea-N was higher (28.80 mmol) in animals fed 25BR:75CP diets. Animals on 25BR:75CP diets had best values after feeding for White Blood Cell (14.40 x10^6mm^3) and Urea-N (28.80 mmol). The feed cost per kilogram gain ranged from ₦1629.30 in 25% B.R: 75% C.P to 1845.50 in 50% B.R: 50% C.P diet, which showed that 25% B.R: 75% C.P diet had best weight gain relative to feed cost. Gross profitability margin was higher in the 25 BR: 75 CP diet (54%), but 5% lower (49%) in the 50 BR: 50 CP diet and 13% lower (41%) in 75 BR: 25 CP diet. In conclusion, 25 BR: 75 CP (1: 3) performed best and is recommended in diet of Yankasa rams for best performance.

Keywords: Diets, Mixtures, Profitability, Rations, Weight gain, Yankasa rams

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Introduction

Shortage of feed is a serious problem of ruminant animal farming in the tropics, as grazing lands are gradually cultivated to satisfy the increasing food demand of human population. Ruminant animals are left to graze on poor land areas and its combination with the use of poor-quality crop residues which resulted in low animal performance. Natural pastures and grasslands are the main source of ruminant animal feed in the Tropics and are generally known to be high in fibre and low in protein values (Teshome, 1987). These pasture land areas are over utilized such that they hardly meet the maintenance requirements of local breeds of animals most especially when the dry season persists for longer 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 and high mortalities of young animals (Alemayehu, 1997).

The Nigerian livestock population estimate is about 13.9 million cattle, with 34.5 million goats and 22.1 million sheep (Nigerian Institute of Animal Science [NIAS], 2019). Ruminant production systems throughout the world are based on forages with grassland feeds being predominant (Alan et al., 2013). Hence, cheaper forages of high nutritive values for ruminant production have been a subject of various researches in tropical Africa especially during the dry season period. 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 (Milford & Minson, 1968). To improve ruminant production in Nigeria, there is need to establish larger pasture and range areas with quality grass-based pasture. Hence, judicious combinations of legume feeds with the more abundant low-quality grasses are needed. *Centrosema pascuorum* is a vigorous, twining and climbing perennial herb with trifoliate leaves which grows well in the tropics and is fairly drought tolerant (Skerman et al., 1988). Also, Muhammad et al. (2002) recommended that Centrosema *spp.* be integrated into the crop-livestock farming system of the low land areas of Northern Nigeria. Topp (1995) reported that the digestibility of feeds in animals would probably increase as the proportion of forage legume increases because the legumes often have higher digestibility than grasses.

The quality of pasture grass can be improved by the inclusion of forage legumes, which are not so bulky and can maintain their high quality throughout the year (Tarawali, 1994). The low nitrogen (N) content of most matured grasses points to a need to combine them with forage legumes with high N content. However, it has been reported that the high rates of protein breakdown to small particles and release of soluble protein from herbaceous legumes is accompanied with susceptibility of ruminant animals to bloat (Dewhurst et al., 2009). This study, therefore, investigated the performance of growing Yankasa yearling rams on mixtures of *B. ruziziensis* and *C. pascuorum* hay at varying proportions, supplemented with a concentrated diet at Zaria, Kaduna-Nigeria.

Material and Methods

Experimental site

This study was carried out at the Teaching and Research Farm of the Department of Animal Production, Abubakar Tafawa Balewa University, Bauchi State. Bauchi 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 and lies between latitude 100°33´N and longitude 90°31´E. It occupies a total area of 49,259.01sq kilometers, representing about 5.3% of the total land mass of Nigeria (Ovimap, 2016).

Management of experimental animals

The performance trial was conducted using twelve (12) Yankasa yearling rams of between 9-12 months of age and weighing between 10.18-10.28 kg. Each of the experimental animal was given Ivomectin (*Ivomec*®) at 0.5ml /25 kg body weight subcutaneously against ecto-parasites and Oxytetracycline (*Tridox*®) antibiotics at 1.0 ml/10 kg body weight intramuscularly against bacterial infections before the commencement of the experiment. *Albendazole*® 10% solution was also administered in drinking water to de-worm. The yearling rams were fed the experimental diets and given access to fresh clean water during the adaptation period of two (2) weeks prior to the commencement of the actual study.

Experimental design and treatments

Twelve (12) Yankasa yearling rams were randomly allotted into three dietary treatments with four replicates (rams) per treatment in a Completely Randomized Design. The experimental diets were: Treatment 1**:** 75% *Brachiaria ruziziensis* and 25% *Centrosema pascuorum* hay, Treatment 2**:** 50% *B Brachiaria ruziziensis* and 50% *Centrosema pascuorum* hay, Treatment 3**:** 25% *Brachiaria ruziziensis* and 75% *Centrosema pascuorum* hay, respectively. A concentrated diet was formulated using; maize offal, cotton seed cake, cowpea husk, bone meal and common salt as shown in Table 1 below. The concentrate feed was offered to the animals at a fixed amount (200 g), while experimental diets consisting of forage mixtures were fed to experimental animals at 3% body weight throughout the experimental period of 90 days. Research with yankasa rams was conducted with 100% *B. ruziziensis* as controlled by Sani et al. (2017).

Table 1 Composition (%) of feed ingredients in the concentrate

Feed ingredients	% Composition
Maize offal	67.00
Cotton seed cake	21.00
Cowpea husk	10.00
Bone meal	1.50
Common salt	0.50
Total	100
ME (MJ/kgDM)	11.81
Crude protein	13.78

ME = Metabolizable energy

Source of feeds for experimental rams

Brachiaria ruziziensis and *Centrosema pascuorum* were grown in mixtures at Abubakar Tafawa Balewa University, Bauchi prior to commencement of the animal study. The forages were harvested separately, sun-dried and air drying in the shade was used to complete the processing into hay. The feedstuffs used in formulation of concentrates were purchased at Muda Lawal market, Bauchi.

Chemical and laboratory analysis

Feed samples were oven-dried in the laboratory at 70^0C for 48 hours and milled to pass through a 2.5mm sieve. Sample was also charred in a muffle furnace at 500^0C for about 3 hours to determine ash. The ether extract (EE) and Crude fibre (CF) content of the feed sample was analysed according to (Association of Official Analytical Chemists [AOAC], 2005) procedure. The Acid and the Neutral detergent fibre (NDF) of the feed samples and faeces separately were analysed using the procedure of Van Soest et al. (1991). Organic matter (OM) was calculated by subtraction of ash content from dry matter of the feed sample. Nitrogen free extract (NFE) was determined from 100- (NDF + CP + EE + Ash) while Metabolizable energy of the diets was calculated using the formula described by Alderman (1985) as shown below;

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

Where

A = Ash content; CP = Crude protein; EE = Ether extract; CF = Crude fiber

Growth performance (feed, water intake and body weight gain) measurement

Experimental rams were fed experimental diets consisting of concentrate and basal diet in the morning and at evening. The concentrate and basal diets were weighed before feeding to the animals and left-overs weighed the next morning before feeding. The difference between the weighted feed and left-overs gives the daily feed intake. The experimental animals were provided with clean drinking water in a graduated container and the amount of water consumed by each animal daily was measured and recorded. Animals were weighed at the commencement of the experiment to obtain initial body weight and subsequently at two weeks intervals to determine the weekly live weight gain. The final weight gain minus initial weight gain, gave the total live weight gain (TLWG).

Haematological and blood biochemical profile measurement

At the end of the feeding trial, blood samples were collected from the jugular vein of the rams (two rams per treatment) using a sterilised syringe with needle at week 10 of the trial. Blood samples of about 5 ml were collected from each animal into a plastic tube containing ethylene diamine tetra acetic acid (EDTA) for haematological analysis, EDTA is an anticoagulant which prevents blood from clotting in the tube. Blood samples were collected in the morning before feeding the experimental diets and 4 hours after feeding. Packed cell volume (PCV) and haemoglobin concentration (Hb) determined, red blood cell (RBC) and white blood cell (WBC) counts were carried out after appropriate dilution using Neubauer Haemocytometer according to the method of Jelalu (2014). In addition, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated according to the procedures and method of Jain (1993). Also, blood samples of about 5ml were also collected into free plastic tubes which were allowed to coagulate at room temperature. Biochemical analysis was done to determine creatinine, glucose, albumin, alp, calcium and Urea N using the methods described by Ogunsanmi et al. (2002).

Statistical analysis for growth performance

Data collected during and after the feeding trials were subjected to One-way Analysis of Variance (ANOVA) procedure (Statistical Analysis Software [SAS], 2005) and Duncan's multiple range test ($DMRT_{0.05}$) was used to separate significant treatment means (Duncan, 1955).
The model of the experiment used in the studies is as follows;
$Y_{ij}=\mu+A_i+e_{ij}$
Y_{ij}= Record of observations for dependent variable, μ =Overall Mean, A_i =Effect of the i^{th} Treatment diets (i=1, 2, 3), e_{ij} =Random error

Results and Discussion

Chemical composition of feed of the experimental diets fed to Yankasa rams

Table 2 showed the chemical composition of feed materials used in this study while the chemical composition of the feed mixtures and concentrate fed to experimental rams is shown in Table 3.

Table 2 Chemical composition of feed ingredients of the experimental diets fed to Yankasa yearling rams

Parameters (%)	*Brachiaria. ruziziensis*	*Centrosema pascuorum*	Concentrate diet
Dry matter	90.84	88.13	87.65
Organic matter	81.53	82.59	82.40
Crude protein	7.84	13.01	13.78
Neutral detergent fibre	58.19	54.32	46.55
Acid detergent fibre	49.69	43.53	37.21
Ether extract	0.65	0.63	0.63
Ash	9.31	5.54	5.25
Nitrogen free extract	30.01	36.50	33.79
ME (MJ/kgDM)	11.72	11.80	11.81

ME = Metabolizable energy

Table 3 Chemical composition of experimental diets fed to Yankasa rams

	Mixture of *Brachiaria. ruziziensis* and *Centrosema pascuorum* hay (%)		
Parameters (%)	75: 25	50: 50	25: 75
Dry matter	89.22	88.68	88.52
Crude protein	8.82	10.64	12.14
Ether extract	0.34	0.36	0.39
Ash	2.70	2.62	2.97
Neutral detergent fibre	47.61	48.30	46.80
Acid detergent fibre	38.43	39.22	37.70
Nitrogen free extract	40.53	38.08	37.70
ME (MJ/kgDM)	11.80	11.82	11.82

ME = Metabolizable energy

Growth performance of Yankasa yearling rams fed mixtures of *Brachiaria ruziziensis- Centrosema pascuorum* hay supplemented with concentrate

The dry matter intake ranged from 689.00-803.10g/d and was highest (P<0.05) in animals fed 50BR:50CP, it appeared that the combination of *B. ruziziensis* and *C. pascuorum* was probably more palatable and more acceptable to the experimental rams at 50% B.R: 50% C.P. Water intake ranged from 2.67-2.82 l/d and reduced as *C. pascuorum* increased in the diet, which agrees with the report of Hicks et al. (1998) that water consumption increased as dry matter increased in the diet. The growth performance of Yankasa yearling rams fed varying mixtures of *Brachiaria ruziziensis* and *Centrosema pascuorum* hay with concentrate is presented in Table 4. The total live weight gain and daily weight gain (3.92 kg and 43.56 g) were higher (P<0.05) in animals fed 25BR:75CP mixture which was at par with 3.50 kg for total live weight gain and 38.89 g for daily weight gain obtained, respectively for animals fed 50BR:50CP diet mixture. The highest weight gain (3.92 kg) obtained in animals fed 25% B.R: 75% C.P diet may be attributed to the highest crude protein and nitrogen free extract intake from the treatment diet (Table 4). The weight gain of rams indicated better weight gain as the level of *Centrosema pascuorum* increased in the diet mixtures. The total live weight gain in this study (2.80-3.92 kg) was higher than values reported by Sani et al. (2017) when *Brachiaria ruziziensis* with different protein supplementation was fed to Yankasa rams. This is because the basal diet in this study contained legume forage (*Centrosema pascuorum*) which helped to improve the quality of the basal diet. The result was similar to the results (2.00-3.70 kg) obtained by Nyako et al. (2012) when *Brachiaria decumbens* with different supplements were fed to growing Yankasa rams.

Feed conversion ratio ranged from 18.07 in animals fed 25% B.R: 75% C.P diet to 22.15 in animals fed 75% B.R: 25% C.P diet. There was a significant difference (P<0.05) in the feed conversion ratio for Yankasa rams across all treatment diets. Lower values for feed conversion ratio are an indication of better conversion of feed to flesh. Hence, animals on 25% B.R: 75% C.P were more efficient in utilizing their diets which gave rise to higher daily weight gains. The better feed conversion ratio obtained might be due to the more palatability, high dry matter and protein intake which enhanced digestibility of the diets (Adebisi et al., 2015).

Table 4 Growth indices of Yankasa rams fed diets containing mixtures of *Brachiaria ruziziensis* and *Centrosema pascuorum* hay supplemented with concentrate

Parameters (%)	Mixture of *Brachiaria ruziziensis* and *Centrosema pascuorum* hay (%)			
	75: 25	50: 50	25: 75	SEM
Initial weight (kg)	10.28	10.28	10.18	0.16
Final weight (kg)	13.08	13.78	14.10	0.46
TLWG (kg)	2.80^{b}	3.50^{ab}	3.92^{a}	0.45
ADWG (g)	31.11^{b}	38.89^{ab}	43.56^{a}	4.63
TDMI (g/d)	689.00^{b}	803.10^{a}	787.30^{a}	5.39
FCR	22.15^{c}	20.65^{b}	18.07^{a}	1.34
FER	0.05^{b}	0.05^{b}	0.06^{a}	2.32
Water intake (l/day)	2.82^{a}	2.80^{a}	2.67^{b}	0.08

$^{a, b, c}$ Means in the same row with different superscript are significantly different (P<0.05); TLWG = Total weight gain; ADWG = Average daily weight; TDMI = Total dry matter intake; FCR = Feed conversion ratio; FER = Feed efficiency ratio; SEM = Standard error of mean

Table 5 Cost benefits of feeding Yankasa rams with diets containing mixtures of *B. ruziziensis* and *C. pascuorum* hay supplemented with concentrate

Parameters	Mixture of *Brachiaria ruziziensis* and *Centrosema pascuorum* hay (%)			
	75: 25	50: 50	25: 75	SEM
Total feed intake (kg)	41.34^{b}	48.19^{a}	47.24^{a}	0.91
Feed cost per Kg (₦)	125	130	135.20	0.00
Feed cost/Kg gain (₦)	1845.50	1790	1629.30	0.00
Total feed cost (₦)	5167.50	6264.70	6386.85	0.00
Gross profit margin (₦)	9232.50	13735.30	16973.15	0.00
Gross profitability ratio (%)	41	49	54	0.00

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

Haematological indices of Yankasa rams fed diets of mixtures of *Brachiaria ruziziensis and Centrosema pascuorum* hay supplemented with concentrate

The results of haematological parameters of Yankasa rams fed the experimental diets are presented in Table 6. The values obtained for packed cell volume in this study ranged from 26.00-30.00% before feeding and 31.30%-36.80% after feeding treatment diets and were all significantly different ($P<0.05$) both before and after feeding across treatments. The increase in PCV across treatment after feeding could be attributed to increase in feed intake and quality of the diet as *Centrosema pascuorum* increased in the diet, this corroborates the report of Jain (1993) that an increase in the energy levels of feed leads to an increase in the PCV levels of blood. The results of PCV in this study were within the normal range of 25-45% (Merck Manual, 2016) for rams and was similar to the result of Alasa (2014) when West African Dwarf Rams were fed *Panicum maximum* with Lablab mixture.

Similarly, haemoglobin concentration (Hb) values in this study ranged from 8.50-10.10 g/l before feeding and 8.80-10.50 g/dl after feeding. The increase in Hb as *Centrosema pascuorum* increased in treatment diets both before and after feeding indicated higher feed intake and increased feed quality. Haemoglobin value decreased after feeding from 8.90 g/dl in 25BR:75CP to 10.50 g/dl in 50BR:50CP. This indicated a slightly negative effect in the diet as *Centrosema pascuorum* exceeded 50% probably due to increased ammonia (NH_3^+) in the rumen of the rams. This was also observed by Alasa (2014) with *P. maximum* 25% and *Lablab purpureus* 75% mixture and 50% *P. maximum* 50% *Lablab purpureus* mixture in a similar experiment when *P. maximum* and *Lablab purpureus* were fed to WAD rams. The haemoglobin concentration in this study was within the normal range for rams reported by (Plumb, 1999). The red blood cells (RBC) increased both before feeding and after feeding up to 50BR:50CP mixture., after which it declines in 25BR:75CP diet. Generally, values obtained in this study was lower than the normal values or range of 9-15x10^6mm^3 for sheep reported by Merck Manual (2016) but compared with RBC counts of 7.58-9.94, 6.4-10.47 and 6-4-14.70x10^6mm^3 for local, improved and Afec sheep respectively (Jawasreh et al., 2009). Variation in RBC counts in this study with other studies might be attributed to the age, gender of the animals used and geographical location for the study.

The values for white blood cells (WBC) obtained in this study ranged from 6.90-13.80x10^6mm^3 before feeding and 7.60-14.40 x10^6mm^3 after. The WBC count before feeding was higher ($P<0.05$) in animals on 25% B.R: 75% C.P (13.8×10^6mm) compared to values obtained in other treatment diets. WBC has the chief function of importing immunity into the body (Okunade et al., 2015). The mean corpuscular haemoglobin (MCH/g) in this study ranged from 13.5-14.4 pg before feeding and 13.70-13.90 pg after feeding which are similar to the values of 9.6-14.4pg for improved Awassi sheep (Jawasreh et al., 2009). MCH values were not significant ($P>0.05$) between treatments and were within the normal range of 31-34 pg for sheep reported by Plumb, 1999. Mean corpuscular haemoglobin concentration is very significant in diagnosis of anaemia and is an index of the capacity of the bone marrow to produce RBC (Njidda, 2013).

Values for lymphocytes before and after feeding were higher ($P<0.05$) in animals fed 25% B.R: 75% C.P diet (70.90% and 57.50%, respectively) compared to values obtained in other treatments. It ranged from 63.70-70.90% before feeding and 25.30%-57.50% after feeding and was mostly within the normal range of 40-70% reported for sheep (Duncan & Prasse, 1986). The lower value below the normal range obtained after feeding in 75BR:25CP and 50BR:25CP could be attributed to the animals being stressed up during blood collection (Girgiri, 2018).

Table 6 Haematological indices of Yankasa rams fed diets containing mixtures of *Brachiaria ruziziensis* and *Centrosema pascuorum* hay supplemented with concentrate

Parameters (%)	Mixture of *Brachiaria ruziziensis* and *Centrosema pascuorum* hay (%)				
	Period	75: 25	50: 50	25: 75	SEM
Packed cell volume (%)	BF	27.40^b	30.0^a	26.00^c	1.25
	AF	31.30^c	35.40^b	36.80^a	0.68
Haemoglobin (g/d)	BF	8.50^b	9.10^a	10.10^a	0.20
	AF	8.80^b	10.50^a	8.90^b	0.20
Red Blood cell (x10^6mm^3)	BF	6.10	7.31	7.03	0.16
	AF	6.36	6.83	6.39	0.06
White Blood cell (x10^6mm^3)	BF	7.80^b	6.90^b	13.80^a	0.92
	AF	7.90^b	7.60^b	14.40^a	0.95
Mean corpuscular volume (fl)	BF	44.90^c	48.50^b	52.40^a	0.92
	AF	49.20^a	33.30^c	40.70^b	1.96
Mean corpuscular haemoglobin(fl)	BF	13.90	13.50	14.40	1.80
	AF	13.80	13.70	13.90	0.20

MCHC (pg)	BF	31.0^{a}	31.60^{a}	27.40^{b}	0.56
	AF	28.20^{c}	31.00^{b}	34.20^{a}	0.74
Lymphocyte (%)	BF	63.70^{b}	65.20^{b}	70.90^{a}	0.94
	AF	25.30^{b}	27.90^{b}	57.50^{a}	4.40

$^{a, b, c}$ Means in same row with different superscript are significantly different (P<0.05); MCHC = Mean corpuscular haemoglobin concentration; SEM = Standard error of mean; BF = Before feeding; AF = After feeding

Blood serum chemistry of Yankasa rams fed diets of mixtures of *Brachiaria ruziziensis and Centrosema pascuorum* hay supplemented with concentrate

The result of blood serum biochemical parameters of Yankasa rams is shown in Table 7. The Creatinine values both before and after feeding were not significant (P>0.05) across treatments. Creatinine value ranged from 0.79 mmol before feeding in rams fed 25% B.R: 75% C.P diet to 1.03 mmol in rams fed 75% B.R: 25% C.P. Also, Creatinine value after feeding ranged from 0.77mmol in 75% B.R: 25% C.P to 0.98 mmol in animals fed 50% B.R: 50% C.P diet. Values for creatinine in this study are similar to the range of 0.9-2.0 mg/dl reported by Plumb (1999) and compared with the normal range of 1-2.7 mg/dl reported by Merck Manual (2016). Elevated creatinine levels may indicate renal dysfunction which is not the case in this study and suggests animals used in this study were healthy.

There was no significant difference (P>0.05) in glucose between treatment means before feeding but it varied significantly (P<0.05) after feeding. Serum glucose obtained in this study ranged from 49-52 mg/dl before feeding and 49-54 mg/dl after feeding. An increase in blood glucose concentration was observed before feeding while a decrease in glucose concentration after feeding as the level of *Brachiaria ruziziensis* decreased in the diet which could be as a result of *Brachiaria ruziziensis* being a grass and contained more energy and carbohydrate than *Centrosema pascuorum*. Blood glucose values in this study were within the normal range of 40-100 mg/d for sheep as reported by Khan (2010). Generally, normal glucose levels in the ram indicate synthesis in the liver from propionate metabolism as the major glucose precursor.

The mean values for albumin were not significant (P>0.05) across treatments both before and after feeding. Blood albumin in this study ranged from 3.40-4.00 g/dl before and was 3.20-4.30 g/dl after feeding. The values were similar to the values of 2.80-4.34 g/dl obtained by Alasa (2014) in a similar experiment on WAD goats feeding *Panicum maximum* and *Lablab purpureus* on similar mixture ratio. The highest value (4.30 g/dl) for albumin was obtained in 50 BR: 50 CP treatment animals after feeding, suggesting higher clotting ability of blood, hence prevention of haemorrhage (Roberts et al., 2003).

The result for alkaline phosphatase showed significance (P<0.05) before and after feeding in experimental rams. It ranged from 10.20-19.00 µ/l before feeding and 10-18 µ/l after feeding and were all within the range of 10.00-25.00 µ/l reported for normal sheep. Values for ALP when reasonably low indicate that the diet had enough protein as high value of ALP is an indication of poor-quality protein of the experimental diet (Ologhobo et al., 1993). Therefore, the highest value obtained in 75% B.R: 25% C.P showed that 75% B.R: 25% C.P had less quality protein in the diet which increased with increase in *Centrosema pascuorum* in the diet of experimental rams. Blood calcium was highest before and after feeding in animals fed 50% B.R: 50% C.P diets and were all not significant (P>0.05) compared to values obtained in other treatment diets. Calcium values generally increased with increase in *Centrosema pascuorum* in the diet and it could be due to the higher calcium levels in forage legumes when compared to grasses. It ranged from 2.80-2.90 mmol/l before feeding to 3.20-3.90 mmol after feeding, adequate calcium levels in the blood ensures proper growth in young animals.

Biochemical indices of Yankasa rams obtained in this study, showed that nitrogen level (N) was significant (P<0.05) before and after feeding as the highest level of blood urea was recorded for animals on 25% B.R: 75% C.P diet. It was observed that urea N increased both before and after feeding as *Centrosema pascuorum* increased in the treatment diets. This could be due to the increase in contribution of crude protein from *Centrosema pascuorum* in the diet. The values obtained in 75% B.R: 25% C.P and 50% B.R: 50% C.P were within the range of 10.00-25.00 mg/dl for sheep by Khanum et al. (2010).

Cost benefits of feeding Yankasa rams with diets containing mixtures of *Brachiaria ruziziensis and Centrosema pascuorum* hay supplemented with concentrate

The results of cost benefits of feeding diets with different mixture ratios of *Brachiaria ruziziensis* and *Centrosema pascuorum* in diets of growing Yankasa rams are shown in Table 5. Feed cost per kg in Naira increased from ₦125.00 in animals fed 75% B.R: 25% C.P to ₦135.20 in animals fed 25% B.R:75% B.R while feed cost per kilogram gain in Naira decreased from ₦1845.50 in animals fed 75% B.R: 25% C.P to ₦1629.30 in animal fed 25% B.R: 75% C.P diet. The highest feed cost per kg obtained in 25% B.R:75% C.P could be due to high proportion of *Centrosema pascuorum* in the diet. It was observed that the feed cost per kilogram increased as *Centrosema pascuorum* increased in the diet. This is as a result of *Centrosema. pascuorum* being a legume which generally is more expensive than grasses both as hay and seed (₦135.20). The feed cost per kg gain followed an opposite trend with feed cost per kilogram with the highest value of ₦1845.00 at 75 B.R: 25 C.P. The lowest values for feed conversion ratio and feed cost per kilogram gain in 25% B.R: 75% C.P indicated best economic benefits of feeding 25% *Brachiaria. ruziziensis* and 75% *Centrosema pascuorum* in the diet of Yankasa rams than other mixtures.

The total cost of feeding per treatment ranged from ₦5167.50 in 75% B.R: 25% C.P diet to ₦6386.85 in animal fed 25% B.R:75% C.P diet, while gross profit margin ranged from ₦9232.50 in 75% B.R: 25% C.P diet to ₦16973.15 in animal fed 25% B.R: 75% C.P diet. The gross margin profitability ratio was highest in 25% B.R: 75% C.P diet (54%), but was 5% lower (49%) in 50 B.R:50 C.P diet and 13% lower (41%) in 75% B.R: 25% C.P diet. The gross profitability margin was higher in 25% B.R: 75% C.P diets because the diet produced more weight gain at a lower feed cost per kilogram gain in the live rams than other diets. Similarly, gross margin profitability ratio was also highest in 25% B.R: 75% C.P diets which indicated the relative profitability of feeding 25% B.R: 75% C.P diets to Yankasa rams compared to other diets in Bauchi.

Table 7 Blood serum chemistry of Yankasa rams fed diets containing mixtures of *Brachiaria ruziziensis* and *Centrosema pascuorum* hay supplemented with concentrate

Parameters (%)	Period	Mixture of *Brachiaria ruziziensis* and *Centrosema pascuorum* hay (%) 75: 25	50: 50	25: 75	SEM
Creatinine (mg/dl)	BF	1.03	0.89	0.79	0.03
	AF	0.77	0.98	0.89	0.03
Glucose (mg/dl)	BF	49.00	44.00	52.0	0.99
	AF	54.00[a]	52.00[b]	49.0[c]	0.62
Albumin (g/dl)	BF	3.80	3.40	4.00	0.08
	AF	3.20	4.30	3.60	0.14
ALP (μ/l)	BF	19.00[a]	16.00[b]	10.20[c]	1.10
	AF	18.00[a]	12.00[b]	10.00[c]	1.03
Calcium (mmol/l)	BF	2.90	3.00	2.80	0.03
	AF	3.20	4.00	3.90	0.11
Urea N (mmol/l)	BF	9.40[b]	24.90[a]	28.40[a]	2.49
	AF	13.80[b]	23.70[a]	28.80[a]	1.88

[a, b, c] Means in same row with different superscript are significantly different (P<0.05); SEM = Standard error of Mean; NS = Not significant; ALP = Alkaline phosphatase; BF = Before feeding; AF = After feeding

Conclusion

In conclusion, 25%BR:75%CP diet gave best results in most growth and haematological parameters measured including weight gain, feed conversion ratio and feed cost per kilogram gain compared to other diets. It had 28.60% and 35.70% higher weight gained compared to 50%B.R:50%C.P and 75%B.R:25%C.P diets, respectively. Therefore, 25:75 BR: CP is recommended for growing Yankasa yearling rams.

Conflict of interest: The authors declare that they have no conflict of interest.

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