



NUTRITIVE EVALUATION OF GROWING *YANKASA* RAMS FED COWPEA SHELL BASED TOTAL MIXED RATIONS WITH DIFFERENT NITROGEN SOURCES

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ABSTRACT

An experiment involving sixteen (16) growing *Yankasa* rams was conducted to evaluate their feed intake, growth performance, rumen metabolites as well as blood profile when fed cowpea shell based total mixed rations with different nitrogen sources for 70 days. Four diets were formulated as: 1(Urea/Maize offal), 2 (Sundried poultry litter/Maize offal), 3(Cotton seed cake/Maize offal) and 4(Groundnut cake/Maize offal). The results showed a significant ($P < 0.05$) differences in daily weight gain (DWG), daily feed intake (DFI) and feed conversion ratio (FCR). The DWG was highest for treatment 2 (102.50 g/day) and lowest for treatment 3 (70.00 g/day). The results for DFI indicated a significantly higher value for treatment 4(842.04g/day) and lowest for treatment 3(521.23g/day). However, the results for FCR showed that treatment 2 recorded the best feed efficiency of 6.67 compared to others. The results for blood parameters indicated the following ranges: PCV (38.10 - 41.70%), haemoglobin (10.50 to 12.40 g/dL), white blood cells (8.90 to 12.50 $\times 10^9$ /L), red blood cells (10.50 - 14.90 ($10^6/\mu\text{L}$)), mean corpuscular volume (25.57 - 36.09fl), blood glucose (3.20 - 3.90 mmol/L), blood urea (7.50 – 9.60 g/mmol) and total protein (56.40 - 76.50(g/L)) were all within normal values for healthy animals. The pH (Before and After) feeding (6.28 – 7.10 and 6.58 – 7.05) and Rumen ammonia nitrogen before (9.65-12.15mg/100ml) and after (19.15 - 22.38mg/100ml) feeding within recommended values for optimum rumen function. The levels of total VFA obtained in this study indicated higher values post-feeding (10.42 - 12.13). The high level of VFA post feeding of rams may have resulted from active digestion of fibre in the available residue. The results of the current study shows that growing *Yankasa* rams could be fed cowpea shell based total mixed rations with different nitrogen sources without any deleterious effects on the feed intake, growth performance, rumen metabolites as well as blood profile of the animals. In addition, animals on treatment 2 (Sundried poultry litter/ Maize offal) had the best average daily weight gains of 102.50g and the most feed efficiency of 6.67, therefore is recommended for growing *Yankasa* rams.

Keywords: *Yankasa*, Rams, Cowpea, Nitrogen, Sources

INTRODUCTION

Nutrition plays a major role in the productive performance of livestock (Fialho *et al.*, 1995), however, in the dry season, ruminant diets are limited by shortages in amount and quality of available forage and usually comprises mature and fibrous grass or crop residue, which do not provide the minerals and protein needed to catalyze rumen fermentation and maintain the health of rumen microbes (Leng, 2003). In most developing nations, particularly animals within arid and semiarid regions of sub-Saharan West Africa, livestock production is affected by seasonal variation in the availability and quality of pastures (Yerima *et al.*, 2023). Animals that depend on natural vegetation for their nutrition suffer heavy losses during the dry season which coincides with productive performance Bamikole *et al.* (2006) , as dry season nutritional stress is a major constraint to ruminant livestock production in semi-arid region, in that when the rain ceases the quantity and quality of grazing falls rapidly so that dry season grazing is fibrous and low in crude protein (Yerima *et al.*, 2022). Similarly, one of the most difficult problems in ruminant production in the tropics and particularly, in Nigeria is the scarcity of energy and protein feed stuffs especially during the dry season. During the period, available forages are dry, the protein content is very low and there is marked decrease in voluntary intake, digestibility, milk yield, and growth rates (Adegbola *et al.*,



1988). The shortage of proteins and energy feed materials during this period pose a setback to ruminant production in the tropics.

Cowpea (*Vigna unguiculata*) is a vital leguminous crop in Nigeria, cultivated either as monoculture or intercropped with cereals (Dan abba *et al.*, 2021). This crop is a dual purpose in the agricultural system; its grains are used for human consumption, while the haulms and shells (residues) are used as livestock feed. The use of cowpea residues as supplements to cereal stover in animal production has been well-documented (Ashiru *et al.*, 2010). Optimizing the use of this readily available legume residue, could contribute to improving the growth performance, nutrient intake, and overall economic efficiency of smallholder livestock production systems. On the other hand, nitrogen supplementation of low quality roughages leads to improved animal performance. Supplementary nitrogen, depending on its form, may supply additional nitrogen and pre-formed metabolites for rumen microbes, or provide additional amino acids and glycogenic metabolites post-ruinally as in the case of undegradable protein (Preston and Leng, 1987). The current study was therefore designed to evaluate the feed intake, growth performance, rumen metabolites as well as blood profile of growing *Yankasa* rams fed cowpea shell based total mixed rations with different nitrogen sources

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the Bauchi state College of Agriculture Teaching and Research Farm, Bauchi. Bauchi is located on Latitude 10° 17' N and longitude 9° 49' E, with an altitude of about 690.2 meters above sea level. Bauchi fall within the Guinea savannah ecological zone with an annual rainfall of between 1000mm and 1300mm per annum, effective rainy season start from mid-May or sometimes early June. The weather in Bauchis has been described (Butswat *et al.*, 2000). The vegetation and seasons in Bauchi are reported by Butswat *et al.* (1994).

Experimental Animals and their Management

The quarantine and experimental pens were cleaned, disinfected with Rambo (pimethrin 0.60%) and labelled. Sixteen (16) growing *Yankasa* rams were purchased. The animals with average live weight of 16.40 kg were quarantined for two weeks during which they were dewormed and treated against ecto and endo parasites. During the quarantine period the animals were fed a mixture of groundnut haulms and maize offal *ad lib* as maintenance ration. They were also provided with good clean drinking water *ad lib*. The animals were given their respective diets every morning at about 0800hrs. The left over feeds of the previous day were weighed and discarded before feeding fresh ones. The animals were also provided with good clean drinking water *ad lib*. The pens and feeding containers were cleaned daily.

Experimental Diets and Animal Feeding

Experimental feed ingredients including Cotton seed cake, groundnut cake (local) maize offal, cowpea shell, bone meal and common salt were purchased from Muda Lawal market in Bauchi. The cotton seed cake was shredded to small sizes suitable for feeding small ruminants. Poultry litter was obtained from the Abubakar Tafawa Balewa University Bauchi Poultry farm. The litter was thoroughly raked to remove foreign or caked materials and sundried for about three weeks. The litter termed as sundried poultry litter was milled, sieved and used in preparation of the experimental diets.

Four diets (16% crude protein) were formulated using the ingredients above and were milled into complete diets and designated as diets 1, 2, 3 and 4 respectively. Ingredients and chemical composition of the experimental feed ingredients and diets are shown in Tables 1, 2 and 3. The animals were weighed at the beginning of the experiment and weekly. The experiment lasted for 70 days excluding the two weeks adaptation period. The experiment was conducted in a completely randomized design (Steel and Torrie, 1980) with four (4) treatments of four (4) animals each.



Table 1: Chemical Composition (%) of Experimental Feed Ingredients

Nutrients	SDPL	GNC	CSC	CPS	MO
Dry matter	89.10	92.70	94.65	91.87	94.87
Organic matter	73.40	93.79	84.20	80.79	79.81
Crude protein	27.30	44.34	34.70	12.34	10.89
Ash	26.60	6.21	15.80	19.21	20.19
NDF	50.70	32.45	79.61	81.00	46.90
ADF	39.90	19.46	48.30	46.76	26.79
Hemicellulose	10.80	12.99	31.31	34.24	20.11

SDPL = Sundried poultry litter, GNC = Groundnut cake, CSC=Cotton seed cake, CPS= Cowpea shell, MO= Maize offal

Table 2: Ingredients Composition of Experimental Diets Fed to the Animals

	INGREDIENTS			DIETS
	1 (UREA/MO)	2 (SDPL/MO)	3 (CSC/MO)	4 (GNC/MO)
Urea	3.00	0.00	0.00	0.00
Sundried Poultry Litter	0.00	30.00	0.00	0.00
Cotton seed cake	0.00	0.00	30.00	0.00
Groundnut cake	0.00	0.00	0.00	30.00
Maize offal	64.50	37.50	37.50	37.50
Cowpea shell	30.00	30.00	30.00	30.00
Bone meal	2.00	2.00	2.00	2.00
Salt lick	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00

Table 3: Chemical Composition of Experimental Diets Fed to Animals

	NUTRIENTS			DIETS
	1	2	3	4
Dry matter	90.91	89.97	90.56	91.46
Organic matter	84.58	88.78	87.51	86.41
Crude protein	16.20	16.61	16.10	15.85
Ash	15.42	11.22	12.49	13.59
N D F	32.46	37.61	39.10	36.48
A D F	18.47	27.10	24.42	29.59
Hemicellulose	13.99	10.51	14.68	6.89

NDF - Neutral detergent fibre, ADF – Acid detergent fibre

Blood Profile Studies

Blood samples were collected at the beginning of the experiment (0 week) and at the seventh week of the experiment, blood samples were collected via jugular veins from two animals each per treatment (total of 8) into an Ethylene Diaminetetra Acetic Acid (EDTA) Coated plastic tube for haematological study. . Blood plasma for biochemical analysis was harvested by centrifugation at rpm for 15 minutes in a centrifugated centrifuge and stored at -200C. The anti-coagulated blood was used to determined haemoglobin (Hb) concentrations, total white blood cells (WBC), red blood cells (RBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration (MCHC),



mean haemoglobin concentration (MHC), lymphocyte and packed cell volume (PCV) automatically using Haematoric blood analyser (Sysmex KX-21 Automated Hematology Analyser). Haemoglobin content was determined as described by Jain (1993). Red blood cells and platelets of the samples were measured and calculated as described by Xu *et al.* (2019). Packed cell volume and erythrocyte count were determined as described by Egbunike (2006). Albumin concentration and serum enzyme Alkaline Phosphatase (ALP) was determined using photoelectric calorimeter (Doumas *et al.* (1977). Plasma protein was determined according to the method described by Uko *et al.*, (2000). Blood Urea Nitrogen was determined as described by Baker (2000). Inorganic phosphorus was determined using Agappe test kit (AGAPPE, Diagnostic ltd. India).

Rumen Fluid Studies

Rumen fluid was collected from each animal during the seventh week of the experiment. The animals were placed on lateral recumbence and the fluid was collected using a stomach suction tube, before and 5hrs after feeding. 50ml of rumen fluid was collected from each animal, which was then poured, into labelled, sterilized bottles. The pH of each sample collected was immediately recorded using an AGB-75 laboratory pH-meter. The rumen liquor was strained through layers of surgical gauze to remove particulate matter before the addition of 10ml of 0.05N sulphuric acid. The samples were then taken to the laboratory for total volatile fatty acid (VFA) and Rumen ammonia-nitrogen analysis. Total VFA was determined according to Bamikole *et al.* (2006) and Rumen ammonia-nitrogen concentration by the method of Mgheni *et al.* (1994).

Chemical Analysis of Feed Samples

The experimental feed ingredients and diets samples were dried at 65°C for 24 hours and analysed for dry matter and crude protein according to AOAC (2010) procedures. Neutral detergent fibre and acid detergent fibre were also determined according to procedure described by Van Soest *et al.* (1991).

Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA) method as described by Steel and Torrie (1980) using the General Linear Model of SAS (1999-2000). Where significant differences in means exist, treatment means were separated using Least Significant Difference (LSD).

RESULT AND DISCUSSION

Performance of Yankasa Rams

The performance of Yankasa Rams fed cowpea shell based total mixed rations with different protein and energy sources is presented in Table 4. All animals in the current study gained weight, which indicated that, the intake of energy and proteins were well above maintenance requirements. The results of the daily weight gain (DWG) of animals obtained in the current study (70.00 - 102.50 g/day) is much comparable to the 78.89g/day reported by Bamikole *et al.* (2006) for West African Dwarf sheep fed cassava peel with varying levels of palm kernel cake. Abdu *et al.* (2012) reported an average daily weight gain of 67.38g/day for Yankasa rams supplemented with 14% CP diet containing Ziziphus leaf meal and cotton seed cake. This value fell within the values obtained in the current study. However, the average daily gains recorded in the current study were lower than the 147.14g/day reported by Yerima (2023) for Yankasa rams fed diets containing different nitrogen sources and the 167.20 to 199.90g/day reported by Xu *et al.* (2019) for sheep fed diets with urea supplementation. The average daily weight gain obtained in the current study are much higher than the 35.38g/day reported by Bogoro *et al.* (2006) for growing Yankasa rams fed urea treated sorghum stover supplemented with a mixture of cotton seed cake and maize bran, which was considered as being below optimum daily weight gain (Van Soest, 1994). Better growth rates and nutrient utilization efficiency in lambs fed ground paddy straw based complete diets were observed compared to those fed conventional diets (Nagi *et al.*, 2012). The daily feed intake (DFI) obtained in the current study (521.23 - 842.04g/day) were much lower than the values (1152.44 to 1171.41g/d) reported by Ikyume *et al.* (2021) in a study to determine the comparative effect of garlic (*Allium sativum*) and ginger (*Zingiber officinale*) and their combination on growth, rumen ecology and apparent nutrient digestibility in sheep. The FCR values in this study (6.67 - 9.36) were well comparable to the results



reported by Abebe (2011) who reported a highest FCR (9.0) with highest daily weight change of (55.67g/d). The good feed conversion ratio obtained in the present study might be associated with the high dry matter and protein intake that encouraged the digestibility of the diet (Adebisi *et al.*, 2015). This observation also supported that of Bamikole *et al.* (2006) who reported that weight gain was dependent of dry matter intake, protein intake, and digestibility of the nutrients.

Table 4: Performance of *Yankasa* Rams Fed Cowpea Shell Based Total Mixed Rations with Different Nitrogen Sources

Parameters	T1	T2	T3	T4	SEM
Initial weight gain (kg)	21.60	21.93	21.39	22.66	0.84NS
Final weight gain (kg)	27.66 ^{ab}	29.10 ^a	26.15 ^b	29.11 ^a	0.95*
Total weight gain gain (kg)	6.06 ^a	7.18 ^a	4.81 ^b	6.45 ^a	0.53*
Daily weight gain (g)	85.00 ^{bc}	102.50 ^a	70.00 ^c	90.00 ^{ab}	7.57*
Total feed intake (kg)	41.76 ^{bc}	46.75 ^b	36.49 ^c	58.94 ^a	2.72*
Daily feed intake (g)	596.50 ^{bc}	667.83 ^b	521.23 ^c	842.04 ^a	38.89*
Feed conversion ratio	6.82 ^a	6.67 ^a	7.52 ^a	9.36 ^b	0.64*

Hematological Parameters

Hematological Parameters of *Yankasa* Rams fed groundnut haulms based total mixed rations with different protein and energy sources are shown in Table 5. The PCV values obtained in the current study (38.10 - 41.70%) are comparable to the 32.72 – 43.18% reported by Raymond *et al.* (2020) for *Yankasa* rams fed urea ensiled crushed corn corbs supplemented with concentrates, but higher than those of Fajemisin *et al.*, (2015) who reported 36.30% for West African Dwarf Sheep fed differently processed corncob basal diets. The differences observed in the PCV values could be due to variation in nutrient utilization within individual animals. However, the PCV values obtained in this are within the normal range (27.00 – 45%) and (28.90± 0.02 – 43.8± 2.33) reported for sheep by Banerjee (2007), Njidda *et al.* (2014). This indicated that animals on the experimental diets in this study had adequate PCV and were not anemic. The range of values of 10.50 to 12.40 g/dL recorded for haemoglobin in the current study are within the normal range of 9 to 15g/dl reported by Duncan and Prasse Manual (1986) for sheep. The Hb concentration is accompanied with greater ability to resist disease infection and a greater advantage with respect to oxygen carrying capacity of the blood (Opera *et al.*, 2010) and low Hb level is an indication of disease infection and malnutrition (Cheesebrough, 2004). White blood cells (WBC×10⁶mm³) are the most important function of bringing immunity to the body (Okunade *et al.*, 2015). As such an increase or a decrease in circulation of WBC shows physiological state of the body. The range of White blood cell (WBC) values reported in this study (8.90 to 12.50 x10⁹/L) were in conformity with the normal range of 4-12×10⁶mm³reported for sheep by Plumb (1999). The mean values for red blood cell (RBC) range (10.50 to 14.90 x10⁶/L) are within the normal range of 9 to 15x10⁶/L (Jain, 1993). The RBC counts obtained in this study are much higher than the RBC counts of 4.49 – 7.30 for *Yankasa* rams (Girgiri, 2017). Variation in the RBC counts in this and previous studies might be closely associated with age, gender, geographical location and health status of the animals used for the study (Cheesebrough, 2004). The MCV range of values (25.57 - 36.09fl) were within the normal range of 23-48fl reported by Vojta *et al.* (2011). While values for MCV and MCH fell within physiologically normal values of 28 - 40fL and 8 - 12 g/dL respectively as reported by Jain (1993), the MCHC values were outside the normal range of values (33 - 38 g/dL). Changes in these values could be attributed to factors such as breed and age (Adili *et al.*, 2013).

Table 5: Hematological Parameters of *Yankasa* Rams Fed Cowpea Shell Based total Mixed Rations with Different Nitrogen Sources

Parameters	Treatments				*Standard values
	T1	T2	T3	T4	
PCV (%)	38.10	41.70	39.70	39.20	27–45
HGB (g/dL)	12.40	10.50	12.20	10.80	9–15
WBC (10 ⁹ /L)	8.90	12.50	9.70	10.20	4–12
RBC(10 ⁶ /μL)	14.90	10.50	11.00	13.40	9–15
MCV (fL)	25.57	33.36	36.09	29.25	28–40
MCH (g/dL)	8.32	8.40	11.09	8.06	8–12
MCHC (g/dL)	32.55	25.18	30.73	27.55	33–38

PCV=Packed Cell Volume, HGB= Haemoglobin, WBC=White blood cell, RBC=Red blood cell, MCV= Mean Corpuscular Volume, MCH = Mean Corpuscular Haemoglobin, MCHC= Mean corpuscular haemoglobin concentration *(Jain, 1993)

Serum Biochemical Parameters

The serum Biochemical Parameters of *Yankasa* Rams fed cowpea based total mixed rations with different protein sources are shown in Table 6. The range of values for blood glucose of rams obtained in the current study (3.20 - 3.90 mmol/L) are comparable to the 2.60 - 5.00 g/mmol normal values for healthy rams as reported by Jain (1993). The range of values for blood urea (7.50 – 9.60 g/mmol) was comparable to standard values for rams reported by Jain (1993). When blood urea is higher than normal range is a signal of kidney failure and when lower it indicates decreased hepatic function, which both are not the case in this study. Albumin values of the blood obtained in this study (g/L were within normal range of 26.0±. 0.17 - 33.0± 1.12 (g/L) reported by Njidda *et al.* (2014). Creatinine values in this study (mmol/L) were similar to the findings of Garba and Abubakar (2012) who reported 75.00 – 100.00mmol/L Elevated levels of creatinine may indicate renal dysfunction. The total protein values in this study were within normal range of 60 - 80g/L reported by Plumb (1999).

Table 6: Serum Biochemical Indices of Growing *Yankasa* Rams Fed Cowpea Shell based total Mixed Rations with Different Nitrogen Sources

Parameters	Treatments				*SV
	T1	T2	T3	T4	
Glucose (mmol/L)	3.80	3.90	3.50	3.20	2.6 - 5.0
Urea (mmol/L)	7.50	8.50	9.60	7.52	3.4 - 12.0
Cholesterol (mmol/L)	1.15	2.16	1.73	1.91	1.13 - 2.7
Albumin (g/L)	36.20	32.10	48.20	42.00	29 – 47
Creatine (μmol/L)	58.20	68.50	70.50	85.40	28 – 100
Total protein (g/L)	58.30	56.40	76.50	62.80	60 – 80

*SV= standard value, *Source: Jain, (1993)

Rumen Liquor

The pH, RAN and TVFA concentrations of rumen liquor of Growing *Yankasa* Rams fed groundnut haulms based total mixed rations with different protein sources are shown in Table 7. The rumen pH (Before and After) feeding the diets (6.28 – 7.10 and 6.58 – 7.05) respectively are within range of values reported by Khan *et al.*, (2005) but lower than the study conducted by Hamad *et al.*, (2010) who reported 7.43 mmol/100ml. The values of rumen liquor pH in this study is in agreement with observations made by Orskov (1990) who reported that cellulolytic bacteria require pH of 6.2 – 7.0 which were optimal for microbial growth when rams are fed on roughages, as such normal rumen pH implies that volatile fatty acids which are by-products of fermentation rapidly diffused through the rumen wall instead of accumulating within the rumen. The level of RAN that supports maximum



digestion of straw in the rumen will vary among diets (Mgheni *et al.*, 1994). The critical level of RAN has been variably reported as being 50-250mg/100ml of ammonia N per litre (5-25mg/100ml of rumen liquor) (Preston and Leng 1987). The level of RAN obtained before (9.65-12.15mg/100ml) and after (19.15 - 22.38mg/100ml) feeding in the present study suggested that all the diets achieved a level of RAN necessary for optimal fermentation. Thus, it would be expected that microbial growth and digestion of straw be maximized in all the treatments. Low RAN levels could be the most limiting factor to microbial activity in animals fed straw alone. Hence, the need for protein supplementation (Adegbola, 2002). The levels of total VFA obtained in this study indicated higher values post-feeding (10.42 - 12.13). This result revealed that supplementation has increased the post feeding values of the VFA. The high level of VFA post feeding of rams may have resulted from active digestion of fibre in the available residue, which supports the reports of Pritchard *et al.* (1983) and Lee *et al.* (1995).

Table 7: The pH, RAN and TVFA Concentrations of Rumen Liquor of Growing *Yankasa* Rams Fed Cowpea Shell based total Mixed Rations with Different Nitrogen Sources

Parameters		Periods					
		1	2	3	4		
pH	BF		6.28 ^d	6.88 ^b	6.58 ^c	7.10 ^a	0.08
	5hrAF		6.68 ^{bc}	6.58 ^c	7.05 ^a	6.78 ^b	
RAN (mg/100ml)							
	BF		9.78 ^b	9.80 ^b	12.15 ^a	9.65 ^b	0.05
	5hrAF		19.15 ^d	21.43 ^b	22.38 ^a	20.15 ^c	
TVFA (mmol/100ml)							
	BF		9.28 ^a	8.60 ^d	9.15 ^b	8.73 ^c	0.04
	5hrAF		10.42 ^d	10.63 ^c	12.13 ^a	11.78 ^b	

RAN - Rumen ammonia-nitrogen, TVFA - Total Volatile fatty acids, BF - Before feeding, AF - After feeding, SEM - Standard error of mean, LS - Level of significance,

* - $P < 0.05$, NS - Not significant

CONCLUSION AND RECOMMENDATION

The results of the current study shows that growing *Yankasa* rams could be fed cowpea shell based total mixed rations with different nitrogen sources without any deleterious effects on the feed intake, growth performance, rumen metabolites as well as blood profile of the animals. In addition, animals on treatment 2 (Sundried poultry litter/ Maize offal) recorded the best average daily weight gains of 102.50g and the most feed efficiency of 6.67. it is therefore recommended for feeding *Yankasa* rams.

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