



RESPONSE OF GROWING *YANKASA* RAMS TO GROUNDNUT HAULMS BASED TOTAL MIXED RATIONS WITH DIFFERENT PROTEIN AND ENERGY SOURCES

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ABSTRACT

The study was conducted to evaluate the feed intake, growth performance, rumen metabolites, as well as blood profile of growing *Yankasa* rams fed groundnut haulms based total mixed rations with different protein and energy sources. A total of 16 *Yankasa* rams weighing averagely 16.50 kg were assigned to four dietary treatments (16% crude protein) formulated to include: 1 (Cotton seed cake/Wheat offal), 2 (Cotton seed cake/Maize offal), 3 (Groundnut cake/Wheat offal) and 4 (Groundnut cake/Maize offal) such that the two ingredients collectively contributed 67.50% of the diets. The experiment, which lasted for 70 days, was conducted in a Completely Randomized Design, with four (4) treatments of four (4) animals each. The results of daily weight gain (DWG g/day) indicated a significant ($P<0.05$) difference across the treatments. DWG for animals on diet 4 (104.50 g/day) was significantly higher than those on the other diets. Animals on diet 1 recorded the lowest DWG of 60.00 g/day. However, all animals gained weight, which indicated that, the intake of energy and proteins were well above maintenance requirements. The result of the daily feed intake (DFI) of the animals revealed a significant ($P<0.05$) difference across the diets. The mean value of the DFI for animals on diets 4(772.36g/day) and 2(772.36g/day) were significantly higher than those for the other diets. Animals on diet 3 recorded the least value (576.59g/day). Feed conversion ratio (FCR) values of animals fed the test diets indicated a significant ($P<0.05$) difference across the treatments. Animals on diet 1 gave the best FCR value (7.28) compared to those on the other diets with animals on diet 2 having the least efficiently utilised diet (10.04). The results of haematological and serum biochemical parameters indicated that most of the parameters were within the normal values recommended for sheep indicating that the animals were healthy. The pH (Before and After) feeding (6.38 – 6.88 and 6.78 – 7.18) and Rumen ammonia nitrogen (RAN) before (10.78-20.18mg/100ml) and after (20.18 - 25.15mg/100ml) feeding were within recommended values for proper function of rumen. The RAN levels observed in the study suggest enhanced protein degradation and ammonia production, potentially due to the high proportion of groundnut haulms, which is known for its higher protein content. Total VFA concentrations increased after feeding (10.23 - 11.53mmol/100ml) across the diets, suggesting different levels of carbohydrate fermentation across the diets. From the results of the current study, based on the higher weight gains of 104.50g/day and normal levels of haematological and serum biochemical parameters and optimum RAN and total VFA production, diet 4 (Groundnut cake/Maize offal) is recommended for growing *Yankasa* rams.

Keywords: *Yankasa*, Rams, Groundnut, Haulms, Protein, Sources

INTRODUCTION

Inadequate supply of quality forages and / or feed on a year round basis is a major problem to the productivity of ruminant animals in the tropics. The situation is particularly more devastating for the Sudano-sahelian belt; the traditional home of most of Nigeria's ruminant livestock, which is characterized by a long dry season of about 7-8 months (October - May). Livestock farmers face their greatest challenge during the dry season when a "staircase" growth pattern is observed in animals as a result of inadequate feed (Yerima *et al.*, 2025). During this period, the available feed is scarce and of low quality, such that animals are not able to meet their protein and energy needs with consequent marked weight losses and productivity (Adegbola, 2002). At the beginning of the rains in April-May, there is growth of a limited number of high nutritive value grasses whose quality declines progressively as the season advances towards the dry season. For instance, during the early wet season,



the new regrowth of the perennial grasses has a crude protein (CP) content of 8-9%, but the amount of herbage on the ground is small (Adamu *et al.*, 1991), making supplementation to augment the dry matter necessary. Also, during this period the available pastures are yet to reach grazing stage. However, two months later the biomass increases but the level of CP decreases to less than 5% and at the beginning of the dry season the tall straw-like materials which are high in ligno-cellulose materials now contains only 1-2.5% CP in the dry matter (Adamu *et al.*, 1991). It is therefore clear that the native forage resources of the savanna zones of Nigeria can support only moderate levels of livestock production for only about 2-3 months of the year (Adamu *et al.*, 1991). During the rest of the year the animals gain minimally, maintain or lose weight. It is therefore necessary to exploit locally available feed resources and to develop feeding strategies compatible with the local environment. However, in many instances, farmers relied on the use of crop residues and low-quality standing hay for feeding animals. Groundnut (*Arachis hypogaea*) is a vital leguminous crop in Nigeria, cultivated either as monoculture or intercropped with cereals (Dan abba *et al.*, 2021). This crop serve a dual purpose in the agricultural system; its grains are used for human consumption, while the haulms (residues) are used as livestock feed. The use of groundnut residues as supplements to cereal stover in animal production has been well-documented (Ashiru *et al.*, 2010). On the other hand, the productivity of ruminant animals in tropical regions like Nigeria is often limited by deficiencies in protein, energy, and minerals. These deficiencies impair microbial protein synthesis in the rumen and negatively affect animal performance (Asare-Agyapong *et al.*, 2019). Therefore, the livestock sub-sector in Nigeria faces significant challenges in maintaining productivity, particularly during the long dry season when forage quality and availability are severely limited (Asare-Agyapong *et al.*, 2019). Optimizing the use of these readily available legume residues, could contribute to improving the growth performance, nutrient intake, and overall economic efficiency of smallholder livestock production systems. The current study was therefore designed to evaluate the feed intake and growth performance, rumen metabolites as well as blood profile of growing *Yankasa* rams fed groundnut haulms based total mixed rations with different protein and energy sources

MATERIALS AND METHODS

Study Area

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. In contrast, the Northern tip of the State receiving a rain late June/July. Relative humidity ranges from about 12% in February to about 68% in August. At the beginning of the rainy season, relative humidity is about 37%. Bauchi state has an average temperature of 40.50c (around April) and 6.110c – 7.220c (around December and January) (Butswat *et al.*, 2000). The vegetation here is not uniform and grasses are shorter than is obtain further of the country. The South- West region of the state is mountainous as a result of spread in to region of Jos-Plateau while the Northern part is generally sandy. The soil is moderately deep, well drained and characteristically tropical sandy loam. The seasons in Bauchi are divided into four based on rainfall distribution pattern (Butswat, 1994): late dry season (January – March), early rainy season (April – June), late rainy season (July – September) and early dry season (October – December). The climatic conditions of Bauchi exhibit two marked seasons which are rainy season and dry season. During the rainy reason, there are abundance of pastures and green grasses for animals to graze. The dry season lasts for a period of about 7 months (October to April). The months of October to December are the period of harvest and there are a lot of animal feeds in form of crop residues.

SOURCING, COLLECTION AND PROCESSING OF EXPERIMENTAL FEED INGREDIENTS

Experimental feed ingredients including Cotton seed cake, groundnut cake (local) maize offal, wheat offal, groundnut haulms, 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.



Experimental Animals and their Management

About a month to the arrival of animals, the quarantine and experimental pens were cleaned, disinfected with Rambo (pimethrin 0.60%) and labelled. Sixteen (16) growing *Yankasa* rams were purchased from neighbouring village of Mararraban-Liman Katagum, a distance of about 20km away from Bauchi. On arrival, the animals ranging between 15.7 and 18.9kg in live weight (averaging 16.5kg) were identified with neckbands carrying number tags. The animals were quarantined for four weeks during which they were dewormed with Banminth-F or Albendazole (2.5% oral suspension) and dipped against ectoparasites using an acaricide (Diazintol or Diazinon) solution. They were then injected (intramuscularly) with Terramycin or Oxytetrin long acting broad-spectrum antibiotics. During the quarantine period the animals were fed chopped groundnut haulms *ad lib* and 200g maize offal per animal per day as maintenance ration. They were also provided with good clean drinking water *ad lib*. The quarantine treatments were repeated midway into the experiment. The animals were randomly divided into four groups of four animals each and kept in individual pens, which has been washed and disinfected with IZAL solution. The pens have concrete floors and are well ventilated with space of about 1.5m² each. 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

Four diets (16% crude protein) were formulated using Cotton seed cake, groundnut cake, wheat offal, maize offal, bone meal and common salt. All the ingredients were milled and mixed with chopped groundnut haulms 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 allowed 14 day period for adaptation to confinement. During the experiment, feeding was done every morning at about 0800hrs at approximately 10% in excess of individual consumption. Animals were provided fresh drinking water in graduated plastic buckets. The total daily allocation of the diets was adjusted on the basis of the previous day's intake. Total feed and water intake of each animal were estimated. The animals were weighed at the beginning of the experiment and weekly thereafter. The experiment lasted for 90 days.

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

Nutrients	GNH	GNC	CSC	WO	MO
Dry matter	95.48	92.70	94.65	93.50	94.87
Organic matter	76.10	93.79	84.20	89.40	79.81
Crude protein	15.89	44.34	34.70	16.20	10.89
Ash	23.90	6.21	15.80	10.60	20.19
NDF	69.10	32.45	79.61	11.58	46.90
ADF	38.30	19.46	48.30	3.70	26.79
Hemicellulose	30.80	12.99	31.31	7.88	20.11

GNH = Groundnut haulms, GNC = Groundnut cake, CSC=Cotton seed cake, WO= Wheat offal, MO= Maize offal

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

	INGREDIENTS			DIETS
	1 (CSC/WO)	2 (CSC/MO)	3 (GNC/WO)	4 (GNC/MO)
Cotton seed cake	15.40	28.98	0.00	0.00
Groundnut cake	0.00	0.00	17.52	24.04
Wheat offal	53.35	0.00	42.60	0.00
Maize offal	0.00	39.77	0.00	53.86
Groundnut haulms	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 the Animals (%)

	NUTRIENTS			DIETS
	1	2	3	4
Dry matter	96.20	92.80	93.87	93.56
Organic matter	81.20	84.50	88.78	87.51
Ash	15.00	1.50	11.22	12.49
Crude protein	15.60	16.20	15.89	16.10
N D F	42.79	39.46	40.69	39.70
A D F	22.56	21.42	25.10	21.42
Hemicellulose	20.23	18.04	15.59	18.28

NDF - Neutral detergent fibre, ADF – Acid detergent fibre

Experimental Design

The experiment was conducted in a completely randomized design (Steel and Torrie, 1980) with four (4) treatments of four (4) animals each.

DATA COLLECTION

Data were collected on the following parameters:

Feed intake

During the feeding trial, feed intake was determined by subtracting the left over from the original quantity provided on daily basis.

Weight measurements

Initial body weights of individual animals were measured at the beginning of the trial and on weekly basis in the morning around 8:00 am, before fresh feeds were offered to them using a very sensitive weighing scale. Feed Conversion Ratio was calculated using feed intake and body weight gain. Nutrient intakes were obtained from feed intake and chemical composition of the feed materials.

Blood profile studies

Blood samples were collected at the beginning of the experiment (0 week) and the seventh week of the experiment in order to establish the health status of the animals. Blood samples were collected via jugular veins from two animals each per treatment (total of 8) into an Ethylene Diamine Tetra 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 Magyar (2005). 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. Plasma protein was determined according to the method described by Uko *et al.*, (2000). Blood Urea Nitrogen was determined as described by Baker and Rege (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 Ziolecki and Kwiatkowski (1975) and Rumen ammonia-nitrogen concentration by the method of Mgheni *et al.* (1994).

Chemical Analysis of Feed Samples

The experimental diets and feed ingredients were dried at 65°C for 24 hours and analysed for dry matter (DM) and crude protein (CP) according to AOAC (2010) procedures. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were also determined according to procedure described by Van Soest *et al.* (1991). Urine samples were analysed for total nitrogen (Chen and Gomes, 1992).

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).

RESULTS AND DISCUSSION

Performance of Yankasa Rams

The performance of Yankasa Rams fed groundnut haulms based total mixed rations with different protein and energy sources is presented in Table 4. The results of the daily weight gain (DWG) of the animals revealed a significant ($P < 0.05$) difference across the treatments. The results of the daily weight gain (DWG) of animals obtained in the current study (60.00 - 102.50 g/day) is much higher than the values of 48.89 to 95.24 g/day reported by Adeola *et al.* (2021) for sheep fed diets with supplementation. Similarly, the ADG values of 63.8 g/d reported by Tesfaye (2007) in sheep fed teff straw basal diet supplemented with 350g concentrate mixture and 25 to 34 g/day observed by Abebe (2008). However, the ADG values in the current study were lower than the average daily weight gains of 131.43 g/day reported by Ali and Jabbar (2014) for sheep fed complete diets with 15% dry poultry litter. The ADG values in the current study are appreciably higher than 46.14 to 47.5 g/day reported by Adegun and Aye (2013) in their work with West African Dwarf Rams fed Moringa oleifera and cotton seed cake as protein supplements for Panicum maximum. All animals in the current study gained weight, which indicated that, the intake of energy and proteins were well above maintenance requirements. The daily feed intake (DFI) obtained in the current study (576.59 - 773.57g/day) were much lower than the 1110.90 g/day reported by Millam *et al.* (2021) for Yankasa sheep fed complete diets with varying levels of groundnut shell and cotton seed cake as protein source. The DFI value recorded in this study was also lower than the 907.70 g/day reported by Ashiru *et al.* (2018) in a feeding trial to assess the performance of Yankasa sheep fed ensiled sugarcane waste enhanced with non-protein nitrogen (urea and poultry litter) sources and soybean meal. The figures of DFI in this study were also lower than 819.42 g/day reported by Jokthan *et al.* (2013) for Yankasa rams fed concentrate and basal diets of maize husk. Better feed utilization was observed in animals on treatment 1 (7.28) and 4 (7.70) in this study compared to the others. Pond *et al.* (1995) reported that

improved feed conversion efficiency may be due to the relatively higher nutrient composition of diets and the consequent increase in body weight gain showing that diets that promote a high rate of gain will usually result in a greater efficiency than diets that do not allow rapid gain, since the rapidly gaining animals utilize less of the total feed intake for maintenance and more of it for live weight gain which was in accordance with the present study.

Table 4: Performance of *Yankasa* Rams Fed Groundnuts Haulms Based Total Mixed Rations with Different Protein and Energy Sources

Parameters	T1	T2	T3	T4	SEM
Initial weight gain (kg)	14.60	16.04	14.48	15.23	0.83NS
Final weight gain (kg)	21.60 ^a	21.93 ^a	18.98 ^b	22.66 ^a	0.99*
Total weight gain (kg)	7.00 ^{ab}	5.89 ^b	4.50 ^c	7.44 ^a	0.64*
Daily weight gain(g)	95.00 ^b	77.50 ^c	60.00 ^c	104.50 ^a	7.38*
Total feed intake (kg)	47.32 ^b	54.15 ^a	40.37 ^c	54.07 ^a	2.91*
Daily feed intake(g)	676.00 ^b	773.57 ^a	576.59 ^c	772.36 ^a	41.6*
Feed conversion ratio	7.28 ^a	10.04 ^b	9.74 ^b	7.70 ^a	1.07*

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 (22.10 - 32.20%) are within the normal physiological range of 21-35% (Njidda, 2014) and 27 – 45% (Jain, 1993) reported for sheep. This indicated the animals were in a healthy condition. Aikhuomobhogbe and Orhemata (2006) asserted that low PCV results in anaemia which causes reduced oxygen carrying capacity of the blood, increased pulse rate and consequently heart failure. The range of values of 10.60 to 13.20 g/dL recorded for haemoglobin in the current study was comparable to the standard values reported for sheep (Ukanwoko *et al.*, 2020). This is an indication that the diets were adequately capable of supporting oxygen transport within the animal cells and sheep (Njidda *et al.*, 2014). The range of White blood cell (WBC) values reported in this study (7.10 to 9.20 x10⁹/L) were in conformity with the values of the previous work of Njidda *et al.* (2014) who observed the haematological and biochemical indices of sheep in semi-arid environment of Northern Nigeria. The mean values for red blood cell (RBC) range (10.40 to 13.00 x10¹²/L) are within the normal range 3.5-13-5 (Ukanwoko *et al.*, 2020) thus lower values are indicative of susceptibility to anaemia related disorders. Age was a practical factor that has a significant effect on the RBC of small ruminants (Daramola *et al.*, 2005). The MCV range of values (17.13 - 30.96fl) were within the normal range of 23-48fl reported by Jain (1993). The MCV, MCH and MCHC are characteristics of RBC indicating average cell size, average cell haemoglobin content and average cell haemoglobin concentration, respectively (Russell and Rousell, 2007). 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 Groundnut Haulms based Total Mixed Rations with Different Protein and Energy Sources

Parameters	Treatments				*Standard values
	T1	T2	T3	T4	
PCV (%)	22.10	29.51	32.10	32.20	27–45
HGB (g/dL)	10.60	12.45	13.20	11.60	9–15
WBC (10 ⁹ /L)	7.10	7.50	8.10	9.20	4–12
RBC(10 ⁶ /μL)	12.90	10.95	13.00	10.40	9–15
MCV (fL)	17.13	26.95	24.69	30.96	28–40
MCH (g/dL)	8.22	11.37	10.15	11.15	8–12
MCHC (g/dL)	47.97	42.19	41.12	36.02	33–38

PCV=Packed Cell Volume, HGB= Heamoglobin, 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 groundnut haulms based total mixed rations with different protein and energy sources are shown in Table 6. Serum biochemical parameters are used to evaluate the level of heart attack, liver damage and to determine protein quality and to determine protein quality and amino requirements and availability in animals. The range of values for blood glucose of rams obtained in the current study (2.90 - 4.10 mmol/L) are comparable to the 3.96-4.35 g/mmol observed by Babale (2019) for West African Dwarf goats fed groundnut haulms and cowpea husk supplemented with Brewers dried grain. However, the range of values for blood glucose in both experiments fell within the normal values for healthy rams as reported by Jain (1993). This indicated that there was enough energy made available for the animals since serum glucose is an estimation of blood sugar content. The range of values for blood urea (8.50 – 10.70 g/mmol) was comparable to standard values for rams reported by Jain (1993). This could be due to improvement on CP intake and digestibility that was achieved, confirming the argument that high dietary protein is associated with increase in blood urea level. The similarity in urea levels across this study suggests stable nitrogen metabolism in the sheep across different dietary treatments, likely reflecting adequate protein intake and utilization. Cholesterol levels in this study varied from 1.50 to 2.10 mmol/L. Variation in cholesterol levels could be attributed to differences in dietary fat composition. However, the result in the current study suggests that varying the proportions of CS and GH does not significantly disrupt lipid metabolism. The Albumin levels in this study which ranged from 31.70 to 33.30 g/L fell within the standard range of 29-47 g/L (Jain, 1993). The consistency of albumin levels across this study indicates that the diet supports normal protein synthesis and liver function. The creatinine levels in this study ranged from 60.40 to 95.31 µmol/L and the values fell within the standard range of 28-100 µmol/L. These levels are consistent with the 86.50-97.00 µmol/L reported by Njidda *et al.* (2021). The findings suggest normal kidney functions across the dietary treatments, as indicated by the stable creatinine levels. Total protein is the sum of all serum proteins in the form of albumin and globulin whose function is osmotic regulations, immunity, coagulation and transportation of substances. Values for total protein (50.30 – 81.40 g/dl) in the current study indicates that the rams were not suffering from protein deficiency. The slight variation in total protein levels may be due to differences in the protein content of the diets in the different trials.

Table 6: Serum Biochemical Indices of Growing *Yankasa* Rams Fed Groundnut Haulms based total Mixed Rations with Different Protein and Energy Sources

Parameters	Treatments				
	T1	T2	T3	T4	*SV
Glucose (mmol/L)	4.10	2.90	2.95	3.25	2.6 - 5.0
Urea (mmol/L)	8.50	9.51	10.60	10.70	3.4 - 12.0
Cholesterol (mmol/L)	1.50	2.10	2.00	2.10	1.13 - 2.7
Albumin (g/L)	31.70	40.10	38.30	32.00	29 - 47
Creatine (µmol/L)	78.50	70.50	80.95	60.40	28 - 100
Total protein (g/L)	53.40	50.30	63.50	81.40	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 and energy sources are shown in Table 7. The rumen pH (BF and AF) feeding the diets (6.38 – 6.88 and 6.78 – 7.18) respectively are slightly above the range reported by (Njidda, 2014). (2013) for *Yankasa* sheep. The higher rumen pH showed that the diets increased rumination actively and salivary secretion flow into the rumen and this better the rumen pH. A rumen pH of less than 6.1 has been shown to inhibit cellulolysis (Mould and Orskov, 1983). The pH values increased across the treatments 5 hours after feeding. This is similar to

the observations of Adegbola (2002), who reported increased pH of rumen fluid of bulls 2 hours after feeding on rice straw supplemented with Urea, CSC or groundnut hay. The increased pH reported in the present study AF (6.78 - 7.18) was within the range reported to be suitable for fibre digestion and optimum microbial protein synthesis (Thomas *et al.*, 1994). RAN values obtained are much higher when compared to the range of 1.1-2.5mg/100ml observed by Adegbola *et al.* (1989) for sheep fed on basal hay or hay plus concentrates of varying protein contents. This is an indication that ruminal nitrogen degradation were adequate across the treatments for normal rumen function and forage digestion. Concentration of RAN varies greatly with the animal specie, nutritional status and age of animal and type of diet among others and may be between 2 to over 100mgRAN/100ml (Adegbola *et al.*, 1989). 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 5-25mg/100ml of rumen liquor (Preston and Leng 1987). The level of RAN obtained BF (10.78 -20.18 mg/100ml) and AF (20.18 - 25.15 mg/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). Similarly, ammonia is the nitrogen source of the main microbes in the rumen (and concentration is an indicator of degradation and utilization of nitrogen source by rumen microbes (Wang *et al.*, 2018). The levels of rumen total VFA obtained in this study indicated higher values post-feeding (7.98 - 9.25 vs 10.23 - 11.53 mmol/100ml). 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 Lee *et al.* (1995) that increased level of RAN results in an increased amount of energy from low quality hay or straw. Similar observation was also reported by Adegbola (2002) for bulls fed rice straw with or without supplements. Production of VFA is dependent on many factors including type and amount of plant material as well as the pH in the rumen.

Table 7: The pH, RAN and TVFA Concentrations of Rumen Liquor of Growing *Yankasa* Rams Fed Groundnut Haulms based total Mixed Rations with Different Protein and Energy Sources

Parameters		Periods			
		1	2	3	4
pH					
BF		6.58	6.38	6.83	6.88
5hrAF		6.88	6.88	7.18	6.78
RAN (mg/100ml)					
BF		10.78 ^d	12.78 ^c	20.18 ^a	14.55 ^b
5hrAF		20.18 ^c	23.38 ^b	25.05 ^a	25.15 ^a
TVFA (mmol/100ml)					
BF		7.98 ^d	8.68 ^b	9.25 ^a	8.55 ^c
5hrAF		10.23 ^d	10.78 ^b	11.53 ^a	10.63 ^c

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 showed no any deleterious effects on the feed intake, growth performance, rumen metabolites, as well as blood profile of growing *Yankasa* rams fed groundnut haulms based total mixed rations with different protein and energy sources. From the results of the current study, based on the higher weight gains of 104.50g/day and normal levels for most



haematological and serum biochemical parameters and adequate RAN and total VFA production, diet 4 (Groundnut cake/Maize offal) is recommended for growing *Yankasa* rams.

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