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RUMEN METABOLITES OF YANKASA RAMS FED VARIOUS SUPPLEMENTATIONS WITH ENSILED COMPOSITE BASAL DIET MADE FROM CRUSHED GROUNDNUT SHELL, AFRICAN LOCUST BEAN PULP AND POULTRY LITTER

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ABSTRACT

Sixteen growing Yankasa rams weighing between 18-19kg were used to assess the utilization of ensiled crushed groundnut shell (CGNS), African locust bean pulp (ALBP) and poultry litter with various supplementations. The study was conducted at Abubakar Tafawa Balewa University Teaching and Research Farm, Bauchi. Twenty (20) growing Yankasa rams were used. Five diets plus a basal diet were formulated. The experiment was laid in a complete randomized design (CRD) consisting of five treatments with four replications per treatment. Rumen liquor samples were collected at 0 hours before and 4 hours after feeding to determine rumen pH, ammonia nitrogen and volatile fatty acids. The results on rumen pH, after feeding, rumen ammonia-nitrogen and total volatile fatty acids before and after feeding indicates significant difference ($P<0.05$) between the treatments. Feeding of the diets significantly ($P<0.05$) influenced rumen volatile fatty acid. The study concludes that; ensiling crushed groundnut shell with locust bean pulp and poultry litter fed to Yankasa rams did not affect the rumen metabolites of the experimental animals. It is recommended that 50% CGNS and 30% ALBP should be ensiled with 20% poultry litter waste as basal diet for sheep especially in the dry season. The study also recommends further studies using groundnut shell and African locust bean pulp to expand their potentials as feedstuffs.

Keywords: Groundnut shell; African locust bean; poultry litter; rumen VFAs

INTRODUCTION

Ruminant production in many developing countries is largely limited by unavailability and high cost of feeds (Lamidi *et al.,* 2014). The unavailability of feed is more persistent in the dry season when natural pastures mature and became highly fibrous and low in crude protein content (Oni *et al.,* 2010). It is in this respect that non-conventional energy and protein materials of farm and agro-industrial waste origin are being utilised for livestock production in Nigeria (Okonkwo *et al.,* 2008). Groundnut (*Arachis hypogea L*) consist of 21-29% external shell (Van Doosselaere, 2013; Davis *et al.*, 2016), which are the left-over products obtained after the removal of groundnut seed from its pod (Duc *et al.,* 2019).

Groundnut shell is an abundant agro-industrial waste product that is burnt or buried resulting in environmental pollution (Duc *et al.,* 2019). It contains various bioactive functional components that are beneficial to mankind. The African locust bean pulp (*Parkia biglobosa*) is yellow coloured substance that is sweet to taste when ripe, which indicates the presence of sugar and thus a potential energy source. The pulp also contains beta carotene a precursor of vitamin A, which is known to improve appetite and consequently the growth performance of livestock (Gernah *et al.,* 2007; Yakubu *et al.*, 2017). Poultry litter is an agricultural waste from poultry farms which often constitute health hazard due to inadequate means of disposal especially when not utilized as fertilizer (Lanyasunya *et al.*, 2006). The fertilizer value of poultry litter is well recognised, due to its high content of nitrogen and other organic materials. The nutrient concentration of poultry litter can be extremely variable, depending on a variety of factors (Tasistro *et al.,* 2004), and therefore a potential feed ingredient for ruminant animals.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the Abubakar Tafawa Balewa University Bauchi Teaching and Research Farm, located at Yelwa along Tafawa Balewa Road, Bauchi. Bauchi State occupies a land area of about 49,119km^2, approximately 5.3% of Nigerian's total land area. The average annual rainfall ranges from 700 mm in the north to 1300mm in the southwestern part of the state. The rain usually starts in April and ends in October. Minimum temperature of 22^{0}C is usually in December/January while maximum temperature of 40^{0}C is around March/April (BSOD, 2014).

Experimental Materials

The experimental materials were African locust bean pulp, groundnut shell, poultry litter, maize bran, cotton seed cake, urea, groundnut cake and haulms.

Ensiling Procedure

Crushed groundnut shell (CGNS), African locust bean pulp (ALBP) and poultry litter were mixed in the combinations as shown in Table 1 (Basal diet). Hundred (100) litres of water were sprinkled on the mixture of CGNS/ALBP/PL and ensiled for 21 days in a 300-litre capacity water reservoir as silo (Wilhelm and Wurm, 1999). Polyethene was used to further seal the silo after filling with feed materials and compressed.

Table 1: Composition of basal and supplemental diets

Basal diet	Supplements				
	A	B	C	D	E
CGNS/ALBP/PL	MB + GNC	MB +UREA	MB	MB +GNH	MB+CSC
(50:30:20)	(50:50)	(100:4)	(100)	(50:50)	(50:50)

CGS/ALBP= Crushed groundnut shell/African locust bean pulp/poultry litter, MB= maize bran, CSC= cotton seed cake, GNC= groundnut cake. GNH= groundnut haulms.

Experimental Animals and their Management

Twenty (20) growing Yankasa rams of approximately 12-18 months of age were purchased from livestock Markets (Durun and Mararraba) in Bauchi State. The rams were transported to Abubakar Tafawa Balewa University Teaching and Research Farm Bauchi. The rams were quarantined, dewormed with *albendazole* at the rate of 10mlg/kg body weight and injected against ectoparasites with *ivemectine*, a broad-spectrum antibiotic at the rate of 1ml/kg body weight administered subcutaneously.

The rams were group fed and managed intensively during a 2-week adaptation period prior to the commencement of the experiment.

Experimental Design and Feeding Procedure

Complete Randomised Design (CRD) was used in the experiment as outlined by Steel and Torrie (1980). Twenty (20) growing Yankasa rams were assigned to five (5) dietary treatments coded as Diets A, B, C, D and E respectively with four (4) animals per treatment. Crushed groundnut shell and African locust bean pulp ensiled with poultry litter were used as basal diet. Maize bran, cotton seed cake, urea, groundnut cake and groundnut haulms were used as a supplement at various proportions as shown in Table 1. The basal diet was given *ad libitum* to each animal and 300g of the supplements were given in the morning before the basal diet. Water was offered *ad-libitum.*

Data Collection

Proximate composition of the experimental diets was carried out to determine crude protein (CP), crude fibre (CF), ether extracts (EE) and total ash according to (AOAC, 2005). Fibre fraction such as neutral detergent fibre (NDF), acid detergent fibre (ADF) was analysed according to Van Soest *et al.* (1991).

Rumen liquor was collected from two (2) animals in each treatment. The liquor was collected in the morning during the last week of the experiment by restraining the animal with fore and rear legs on the ground in standing position. Fluid was collected using a stomach suction tube before and at four hours after feeding. About 20ml of the fluid was drawn and transferred into sample bottles. The pH was taken immediately by using a pye pH meter with pye gold combined glass reference electrode. Ten (10ml) of 0.05 sulphuric acid was poured into the bottle and taken to the laboratory for volatile fatty acid (VFA) and rumen ammonia nitrogen analysis. Total VFA was determined according to Luo *et al.* (2015) and ammonia nitrogen concentration according to Souza *et al.* (2013).

Data Analysis

Data generated in this study were subjected to analysis of variance (ANOVA) according to Steel and Torrie (1980) using SPSS version 20, and means were compared and separated using Duncan's Multiple Range Test.

RESULTS

The results on chemical composition are presented in Table 2 which shows that the basal diet has a lower dry matter content of (79.08%) compared to the dry matter content of the supplements which ranges from (92.08%) for treatment E to (90.44%) for treatment C. The crude protein content for the basal diet was also low (6.071%) in this experiment compared to the supplements which ranges from (20.91%) in treatment D to (11.67%) in treatment A. The crude fibre content was higher (13.13%) in treatment E with groundnut haulms supplement, and treatment C (12.84%) which is only maize bran. crude fibre for the basal diet was (12.54%). The lowest value (11.40%) for crude fibre was recorded in treatment D. The organic matter content in the basal diet was lower (90.27%) than those for the various supplements which ranges from 96.84% to 94.87%. Additionally, ash content in the basal diet was higher (9.73%) compared to the various supplements, treatment D had the lowest ash content of (3.16%) while treatment A had the highest (5.13%) among the supplements. The NDF and the ADF contents were 24.23% and 17.30% for the basal diet, while treatment A with GNC supplementation had the highest NDF (51.70%) while treatment C had the lowest (45.90%). Treatment A had the highest ADF value (48.30).

Table 2: Chemical composition of basal and supplemental diets (%)

Components	Treatments					
	Basal Diet	A	B	C	D	E
DM	79.08	90.98	91.76	90.44	90.52	92.08
CP	6.07	11.67	20.91	18.18	17.27	17.17
CF	12.54	12.48	11.53	12.82	11.40	13.13
OM	90.27	94.87	95.26	96.57	96.84	96.31
ASH	9.73	5.13	4.74	3.43	3.16	3.69
EE	1.70	2.44	4.60	5.90	2.94	4.45
NDF	24.23	51.70	47.80	45.90	46.50	44.50
ADF	17.30	48.30	40.70	33.01	40.70	31.32

DM= Dry matter, CP= crude protein, CF= crude fibre, OM= Organic matter, EE= Ether extract, NDF= Neutral detergent fibre, ADF= Acid detergent fibre.

Rumen pH, Ammonia-nitrogen and Volatile Fatty Acid of Growing Yankasa Rams fed Basal and Supplemental Diets

The results on rumen pH, ammonia-nitrogen and volatile fatty acid are shown in Table 3. The results indicate no significant difference between the treatments in term of (pre and post-feeding) of the diets on rumen pH. Treatment C in pre and post-feeding rumen liquor was recorded with the higher value of 6.76 and 7.35 while the lower value (6.01) pre-feeding was obtained in treatment B and that of post-feeding (7.05) was in treatment E. Pre-feeding of rumen ammonia nitrogen was significantly ($P<0.05$) affected by the treatment means, treatment B had the higher value (72.82mg/dl) rumen ammonia nitrogen while the lower value (33.10mg/dl) was recorded in treatment D, treatment A, C and E were recorded with the figures (35.65, 34.26 and 53.60mg/dl) respectively. Rumen ammonia nitrogen in post-feeding rumen liquor was significantly different ($P<0.05$) between the treatment means with the higher value (101.76mg/dl) recorded in treatment B, while the lower value (54.48mg/dl) recorded in treatment D. Individual volatile fatty acid, (acetic and propionic fatty acid) were significantly affected (P<0.05) by the treatment means in pre-feeding rumen liquor sample, the values ranges from (47.64Mmol/l) to 37.07Mmol/l) for acetic while (40.72Mmol/l) to (27.61Mmol/l) for propionic acid. Butyric acid pre-feeding was not affected by the treatment means. Total volatile fatty acid pre-feeding rumen liquor sample was significantly different (P<0.05) across the treatment means, treatment E was recorded with the higher value (101.79Mmol/l) and the lower value (76.40Mmol/l) was obtained in treatment C. Post feeding of the diets on rumen individual fatty acid (acetic, propionic and butyric fatty acid) was significantly different (P<0.05) across the treatment means, the higher value (53.16Mmol/l) for acetic acid was recorded in treatment E, while the higher value (45.94Mmol/l) for propionic acid was recorded in treatment B, lower values (46.10Mmol/l) and (36.87Mmol/l) for acetic and propionic fatty acid were recorded both in treatment A. Post-feeding butyric acid and the total volatile fatty acid were significantly (P<0.05) different between the treatment means, treatment E had the higher value (114.94Mmol/l) and the lower value (98.97Mmol/l) was recorded in treatment C.

Table 3: Rumen pH, Ammonia nitrogen and volatile fatty acid of growing Yankasa rams fed basal and supplemental diets

Parameters	Treatments					SEM
	A	B	C	D	E	
pH 0 hrs BF	6.49	6.01	6.76	6.51	6.63	0.16
pH 4 hrs AF	7.22	7.08	7.35	7.04	7.05	0.14
R.A.N BF (mg/dl)	35.65^{c}	72.82^{a}	34.26^{c}	33.10^{c}	53.60^{b}	1.22
R.A.N AF (mg/dl)	55.43^{c}	101.76^{a}	55.72^{c}	54.48^{c}	71.53^{b}	0.77
Acetic BF (Mmol/100)	37.07^{c}	42.71^{b}	39.86^{bc}	40.22^{bc}	47.64^{a}	1.04
Acetic AF (Mmol/100)	46.10^{b}	49.88^{ab}	49.74^{ab}	50.14^{ab}	53.16^{a}	0.97
Propionic BF (Mmol/l)	27.61^{c}	36.43^{ab}	28.24^{c}	31.88^{bc}	40.72^{a}	1.87
Propionic AF (Mmol/100)	36.87^{b}	45.94^{a}	36.90^{b}	41.54^{ab}	45.80^{a}	1.64
Butyric BF (Mmol/100)	11.72	12.70	12.32	13.80	13.43	0.86
Butyric AF (Mmol/100)	18.16^{a}	14.72^{ab}	12.33^{b}	13.25^{b}	15.97^{ab}	1.15
Total VFA BF (Mmol/100)	76.40^{c}	91.85^{b}	80.43^{c}	85.91^{bc}	101.79^{a}	1.87
Total VFA AF (Mmol/100)	101.13^{c}	110.54^{ab}	98.97^{c}	104.94^{bc}	114.94^{a}	1.55

Means within the same row with different superscript are significantly different (P<0.05)
R.A.N= rumen ammonia nitrogen, BF= before feeding, AF= after feeding and VFA= volatile fatty acid, SEM= standard error mean.

DISCUSSION

The dry matter content of the supplements was very high due to the low moisture content of the ingredients. This could be attributed to the high degree of dryness of the materials. The basal diet had lower DM content due to the supplemental moisture applied during the ensiling process. Yerima *et al*. (2020) reported lower DM in a basal diet made from cowpea shell and maize offal. The crude protein content in this study for the basal diet was low (6.07%) compared to that of Yerima *et al*. (2020) which reported CP content of (12.6%) for basal diet, CP content of the supplements ranges from (11.67 to 20.91%), which is higher than the CP contents (14.90 to 15.85%) reported by (Yahya *et al*., 2020) when graded levels of probiotics supplemented sugarcane bagasse was fed to red Sokoto Goats.

This could be attributed to the variation in the feed ingredients used during the supplementations. The high crude protein content of the supplements diet was adequate to meet the optimum microbial need in the rumen. The crude fibre contents for the basal diet (12.54%) and that of the supplements (11.40 to 13.13%) were lowered compared to the CF contents reported for ensiled sugarcane waste and poultry litter (Ashiru *et al*., 2017). The organic matter (OM) content of the basal diet was higher (90.27%) than that of the Yerima *et al*. (2020) which reported OM content of (82.63%), OM of the supplements ranges from (94.87 to 96.84%) which is comparable to the OM contents (92.50 to 94.60%) reported by (Abdullahi *et al*., 2020a) when the author fed urea ensiled sesame chaff supplemented with varying proportion of protein and energy source to growing Yankasa sheep. The Ash content (9.73%) of the basal diet in this present study was higher to that of Yerima *et al*. (2020) that reported (5.64%). The ether extracts (EE) in the present study (1.70 to 5.90%) were slightly comparable to the EE contents (2.90 to 4.79%) reported by Adebisi *et al*. (2020). Whose determine Nutritional potential of differently processed *Cajanus cajan* leaves on nutrient digestibility and nitrogen utilization of West African dwarf growing rams fed *Panicum maximum.* The neutral detergent fibre (NDF) and acid detergent fibre (ADF) contents (46.90 to 52.71%) and (43.21 to 48.20%) were higher than (33.20 to 51.00%) and 29.40 to 31.00%) by Adebisi *et al*. (2020), but comparable with NDF contents reported by (Abdullahi *et al*., 2020a).

The results indicate no significant variations between the treatment means in term of (pre and post-feeding) of the diets on rumen pH. The pre-feeding rumen pH in this study were recorded with values (6.01 to 6.76) which is comparable with the range (6.12 to 6.90) reported by Abdulazeez *et al*. (2020) when the authors substituted maize grain with maize cobs treated with urea and wood ash on sheep performance and rumen parameters. Post-feeding rumen pH (7.04 to 7.35) was higher than the pH (6.56 to 6.85) reported by Akinbode *et al*. (2020). The rumen pH (pre and post-feeding) in this were slightly acid to neutral which is ideal for the rumen microbes to thrive. Pre and post-feeding of rumen ammonia nitrogen were significantly (P<0.05) affected by the treatments, the values (33.10 to 72.82mg/dl) pre and (54.48-101.76mg/dl) post feeding recorded in the present study were higher than 23.55 to 24.00mg/l and 23.8 to 33.5mg/dl reported by Abdullazeez *et al*. (2020) and Abubakar *et al*. (2010) respectively. Generally higher rumen ammonia nitrogen post-feeding implies rapid fermentation of the basal feeds and the supplements. In addition, the basal feed was fed *ad libitum* and is hightly digestible (Ngele, 2007). Concentration of acetic and propionic fatty acids observed in the current study were comparable to 47.40Mmol/l for acetic and 28.38Mmol/l for propionic reported by Kanber *et al*. (2016). Butyric acid pre-feeding was not affected by the treatment means, the values (11.72 to 13.80mmol/l) were similar to (9.73 to 13.00mmol/l) obtained by (Akinbode *et al*., 2020). Total volatile fatty acid pre-feeding was significantly different (P<0.05) across the treatment means, the value (76.40 to 101.79Mmol/l) in this study were higher than the values (70.10 to 86.23mmol/100ml) by Adebayo *et al*. (2017) and comparable with the values (73.00 to 118.27mmol/l) reported by Dang *et al*. (2018). Post feeding of the diets on rumen individual fatty acid (acetic, propionic and butyric acid) were significantly different (P<0.05), the value (46.10 to 53.16Mmol/l) acetic and (36.87 to 45.80Mmol/l) propionic acid recorded were similar to that of Akinbode *et al*. (2020). Total volatile fatty acids were significantly (P<0.05) different between the treatment means, the values (98.97 to 110.54Mmol/l) were comparable with the values (99.90-105.90mmol/l) by Dang *et al*. (2018). This confirms the importance of energy and protein ratio in feeding supplements to low quality roughages (Oddoye *et al*., 2005; Ngele, 2007). The higher VFA observed in this study can be attributed to a high rate of degradation in the rumen.

CONCLUSION

Ensiling groundnut shell, locust bean pulp and poultry litter fed to Yankasa rams with supplementation did not affect the rumen metabolites of the experimental animals.

It is recommended that 50% CGNS and 30% ALBP should be ensiled with 20% poultry litter waste as feed for Yankasa rams and other ruminant animals. The experiment also recommends further studies using groundnut shell and African locust bean pulp to expand their potentials as feedstuffs.

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