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EFFECTS OF FEEDING DIET CONTAINING RAW OR PARBOILED RICE OFFAL ON RUMEN METABOLITE OF BUNAJI BULLS

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ABSTRACT

Twenty Bunaji bulls aged 2-3 years with an average weight of 230kg were assigned to five dietary treatments with four bulls per treatment in a 2x2 factorial configuration with common control to determine the effect of feeding diet containing varying inclusion of raw or parboiled rice offal on bull rumen metabolites which lasted for 90 days. Rumen fluid was collected at 0, 2, 4, and 6 hr intervals to assess rumen pH, rumen ammonia nitrogen (RAN), and rumen total volatile fatty acid (TVFA). Digitaria smutsii concentrate and basal diet were provided at 2% bogy weight. Crude Protein content of the experimental diets ranged from 19.69- 20.44%, while Metabolizable Energy content ranged from 10.86-11.16MJ/kg DM. Rice offal type had no effect on rumen parameters (P>0.05). Rumen pH six hours after feeding at 0% (6.63) and 30% (6.76) inclusion levels was similar (P>0.05), but differed considerably (P<0.05) from the 20% (6.93) inclusion level. The highest and lowest TVFA values were found in bulls fed diets with 20% (44.70 mol) and 30% (23.49 mol) inclusion levels. Effects of varying RRO and PRO inclusion levels on rumen pH and TVFA at different sample times were not significant (P>0.05). Bulls fed 30%PRO had the highest value (22.41g/100g), while bulls fed 20% PRO had the lowest value (14.80g/100g). This study indicated that RRO or PRO can be utilized to replace up to 30% of maize offal as a source of energy in the diet of Bunaji bulls with no negative effects on the bulls' rumen metabolite.

Keywords: Bunaji bull, Parboiled rice offal, Raw rice offal, Rumen metabolite

INTRODUCTION

Cattle are ungulates with a complex stomach system developed for rumination, they are raised as livestock for the production of meat, dairy animals for the production of milk, and draft animals (Kudo *et al.*, 1995; Marcus and Jurgen, 2017). The rumen is a complex anaerobic microbial ecosystem in which bacteria, archaea, protozoa, fungi, and viruses interact in ways that affect ruminant health (Denman McSweeney, 2006; Kamra, 2005; Hua, *et al.*, 2022). Fermentation takes place under anaerobic circumstances. As a result, carbohydrates are primarily converted to volatile fatty acids (VFAs). Other prominent products include lactic acid, carbon dioxide, and methane (Ozutsumi *et al.*, 2005; Pei *et al.*, 2010; Oskoueian *et al*., 2021). VFAs are an important result of fermentation from the standpoint of the host animal.These small lipids perform several functions, but the most important role of VFAs in herbivores is that they are ingested and act as the animal's primary fuel for energy synthesis, much like glucose does in humans (Ozutsumi *et al.*, 2005; Njokweni *et al*., 2021).

One of the parameters for determining animal well-being is the health status of animals kept under various feeding settings (Scamell, 2006). Because the rumen is the first and largest compartment where continuous anaerobic fermentation takes place by a complex consortium of microorganisms (Kudo et al., 1995; Debi et al., 2022), it is critical to monitor housing and feeding conditions because they directly influence growth performance and determine the animal's homeostasis or maintenance (Ahmad et al., 2003).

Rice offal is a by-product of rice processing obtained from rice mills and it contains husks, bran, and small quantities of broken grain. Because rice offal accounts for a significant portion of rice production (more than 40%), Nigeria has the potential to produce thousands of metric tonnes of rice each year. Despite its abundance, rice offal has been overlooked by animal nutritionists because it is high in fibre but low in protein and energy (Tiough et al., 2020). Rice offal contains a lot of silica and fiber (Dafwang, 2006; Tiough et al., 2020). Rice offal has a proximate chemical composition of 94.42% dry matter, 5.09% crude protein, 30.39% crude fiber, 3.40% ether-extract, 16.67% ash, and 46.1% nitrogen free-extract (Maikano, 2007). Research into the evaluation of additional agricultural wastes for use as livestock feeds in Nigeria has increased as a result of the notion that employing abundant feed materials that are easily accessible will increase ruminant animal production (Millam *et al.*, 2020). Thus, including rice milling waste in beef cattle diet may not have any negative effects on rumen metabolite. This study was conducted against this backdrop to explore the effect of using rice offals as an energy source on the rumen metabolites of Bunaji bulls.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the experimental pens of the Beef Research Programme of the National Animal Production Research Institute, Shika, Zaria, Nigeria. The study area falls within latitudes 11° 8' 19.56" N and longitudes 7° 45' 51.22" E, with an altitude of 640m above sea level (Google Earth, 2021). Shika is located within the Northern Guinea Savannah ecological zone with an average annual rainfall of 1,100mm which starts from late April/early May and ends mid-October, the temperature ranges from 27-35°C depending on the season, while the mean relative humidity during the harmattan and wet seasons are 21-72%, respectively (IAR, 2021).

Feeding Trial

A feeding trial was conducted using 20 Bunaji bulls with a live weight range of 210-249kg and average weight of 220kg with an age range of 2-3 years. The bulls were allotted to five dietary treatments in a 2x2 factorial arrangement with a common control to compare the effect of 2 levels of inclusion (20 and30%) of raw and parboiled rice offal on the fattening performance of Bunaji bulls. In the control diet (NRO), maize offal served as the main energy source and therefore had no rice offal. It contains 60% maize offal, 19.5% cotton seed cake, 19.5% poultry litter, 1% salt. The four test diets designated RRO contain 20 and 30 percent raw rice offal and PRO contain 20 and 30 percent parboiled rice offal. The TDN (%), ME (Kcal/Kg DM) and feed cost per Kg were calculated. There were four animals per treatment; the experimental diets were formulated to be isonitrogenous and isocaloric (Table 1). The trial lasted for 90 days.

Table 1: Percentfeed composition of concentrate diets.

Ingredient %	Inclusion level				
	0	20RRO	30RRO	20PRO	30PRO
Maize offal	60.00	45.00	39.00	45.00	39.00
Rice offal	0.00	12.00	18.00	12.00	18.00
Cotton seed cake	19.50	24.90	29.70	24.00	29.00
Poultry litter	19.50	17.60	12.80	18.50	13.40
Salt	1	1	1	1	1
Total	100.0	100.0	100.0	100.0	100.0
Calculated analysis					
Crude protein(%)	15.16	15.15	15.11	15.17	15.15
TDN(%)	71.73	66.85	64.56	62.84	58.52
ME(Kcal/Kg DM)	2238	2090	2045	2145	2129
Feed cost (₦/Kg)	34.66	32.09	32.09	31.34	31.22

Animal Management

The bulls were housed in individual pens and weighed every forth night. They were fed concentrate and hay (*Digitaria smutsii*) at 2% of their body weight each. The ration was adjusted at regular intervals of 2 weeks along with changes in live weight.

Rumen Fluid Sampling

Rumen fluid samples were collected from the bulls at the end of the feeding trial at 0hr, 2hrs, 4hrs and 6hrs after feeding. About 50mls of the rumen fluid was drawn from two bulls in each treatment using stomach tube. The tube which is about 150cm with a metallic strainer attached to the end was passed through a pipe placed in the mouth of the bulls into the rumen and a suction pump which was used to draw out the rumen fluid was attached to the other end of the tube. The fluid was collected into a plastic bottle containing equal quantity of 0.1N H_2SO_4 to trap ammonia. The samples were frozen until analysed. Rumen ammonia concentration was determined by steam distillation into boric acid and back titrated with 0.01N hydrochloric acid, according to the procedure described by (Whitehead *et al.,* 1976). Rumen pH was determined using Philips digital pH meter (model 9409).

Chemical analysis

Analysis of individual feed ingredients (raw and parboiled rice offal, cotton seed cake, poultry litters, and hay)was carried out by AOAC (2000) procedure. Also, Acid Detergent Fiber (ADF) and Neutral Detergent Fiber (NDF) were determined in all the feed ingredients according to Van Soest, J.P. (1991) at the central laboratory of the National Animal Production Research Institute (NAPRI), Shika, Zaria. Metabolizable energy (ME) was determined by the equation of Alderman and Cottrill (1985). ME (MJ/Kg DM) = 11.78 + 0.0064 CP + (0.000665EE)2 - CF (0.00414EE) - 0.0118A. Where ME = DM = Dry matter, CP = Crude protein, EE = Ether Extract, CF = Crude fiber and A = Ash. Moreover, Silica and other major oxide analysis were carried out for raw and parboiled rice offal (using X-fluorescence (XRF) techniques). The inner electronic structure of atoms was probed. The resultant spectrum generated the qualitative estimation of elements. Also, a quantitative estimate of chemical elements was established using a duly calibrated method with standard conditions at Multi-User Science Research Laboratory (MUSRL), Ahmadu Bello University, Zaria.

Data analysis

The data from the rumen metabolite was analyzed using the General Linear Model procedure of SAS (2002) to see the response of the animals to measured parameters. Significant levels of difference among treatment means were separated using Duncan Multiple Range Test (DMRT) in the SAS package.

The Model used is as follow:

$Yijk = \mu + Pi + Gj + (PG)ij + Eijk$

Where Yijk= kth observation of jth graded level of rice offal inclusion and ith type of rice offal. μ=overall mean Pi = effect of ith type of rice offal on performance Gj = effect of j th graded level of rice offal on performance (PG)ij = effect of interaction between ith type of rice offal and jth graded level of rice offal inclusion Eijk = random error.

RESULTS AND DISCUSSION

Chemical Analysis

Percent and Chemical composition of experimental diets are shown in Table 1 and 2 while the mineral content of raw and parboiled rice offal is shown in Table 3. Silica content is very high in both raw (24.86 %) and parboiled rice offal (36.91 %) compared to other oxides (Table 3). Also, peak of silicon is high when compared with other chemical elements (Fig 1 and 2). Qualitatively, silicon (Si) had the highest peak with high intensity in parboiled (over 6500 count per seconds-cps) and raw (about 3500 cps) within Kα line energy (1.5-2.0 KeV) for parboiled and Kα to Kβ line energy (1.8-3.0 KeV) for raw rice offal (See Fig I and 2). Quantitatively silica is very high for raw (24.86%) and parboiled (36.91%) relative to other mineral elements.

Table 2: Chemical composition of individual feed ingredient and hay.

Parameters	**Ingredient**					
	D. smutsii	**MO**	**CSC**	**LL**	**RRO**	**PRO**
Dry matter	93.10	89.46	89.94	93.11	91.34	93.36
Crude protein	8.06	11.88	23.69	19.00	7.69	4.38
Crude fibre	41.28	8.28	38.49	24.91	33.99	34.73
Ether extract	8.39	16.07	17.84	8.63	15.74	10.75
Ash	9.95	5.41	3.87	21.28	14.40	24.21
Acid detergent fibre	50.59	10.33	47.31	42.45	46.85	55.12
Neutral detergent fibre	63.42	21.61	55.37	60.15	53.49	61.22
Hemicellulose	12.83	11.28	8.06	17.7	6.64	6.10
Metabolizable energy(MJ/KgDM)	10.52	11.37	9.14	11.27	9.76	10.57

CSC = Cotton seed cake, MO = Maize offal, LL = Layer litter, RRO = Raw rice offal, PRO = Parboiled rice offal, *D.smutsii* = *Digitariasmutsii*. ME for the feed ingredients was determined by equation of Alderman and Cottrill, 1985. ME (MJ/Kg DM) = 11.78 + 0.0064 CP + $(0.000665EE)^2$ - CF (0.00414EE) - 0.0118A. Where ME = DM = Dry matter, CP = Crude protein, EE = Ether Extract, CF = Crude fiber and A = Ash.

Valchev *et al.,* (2009) and Zainal *et al.,* (2018) reported (17.9%) and (42%) silica content respectively from rice hulls. Ambreen *et al*., (2006) worked on chemical composition of rice polishing from several sources and reported a range (2.5-11% SiO2). Since rice offal contains approximately 60% hull, 35% bran and 5% polishing (Duru, 2010). Higher content of SiO_2 in the present study probably result from SiO_2 contents rice bran. The calcium (Ca) content of the raw (0.03%) is less than parboiled (0.10%) rice offal. This observation differs from the value for raw (0.09%) and parboiled (0.02%) by Duru (2010) where higher Ca content was documented in the raw rice offal. The Phosphorus (P) content of parboiled (0.304%) is greater than raw (0.26%) rice offal. These values are close to contents of raw (0.29%) and parboiled (0.32%) of Duru (2010). These values are lower than those reported by Obeka (1985) and Aduku, (1993). Both reported 0.49% P in their samples. Parboiled rice offal gave higher values of Sodium (0.04%), Aluminium (0.004%) than raw with Sodium (0.02%), Aluminium (0.002%) except Magnesium (0.07%-RRO, 0.02%-PRO). EE normally has an inverse significant correlation with crude fiber, calcium, and phosphorus (Ambreen et *al*., 2006). This trend was confirmed in raw and parboiled rice offal of the present study. The EE (15.74%) in raw is higher than parboiled (10.75%) hence an anticipated inverse proportional relationship with CF in raw (33.99%) to parboiled (34.73%), P in raw (0.26%) to parboiled (0.30%) and Ca in raw (0.03%) to parboiled (0.10%) was noted in the present study.

Table 3: Mineral composition of raw and parboiled rice offal

Analyte	**Raw rice offal (%)**	**Parboiled rice offal (%)**
SiO_2	24.860	36.910
Na_2O	0.023	0.057
CaO	0.141	0.043
MgO	0.118	0.040
Al_2O_3	0.004	0.008
P_2O_5	0.337	0.393

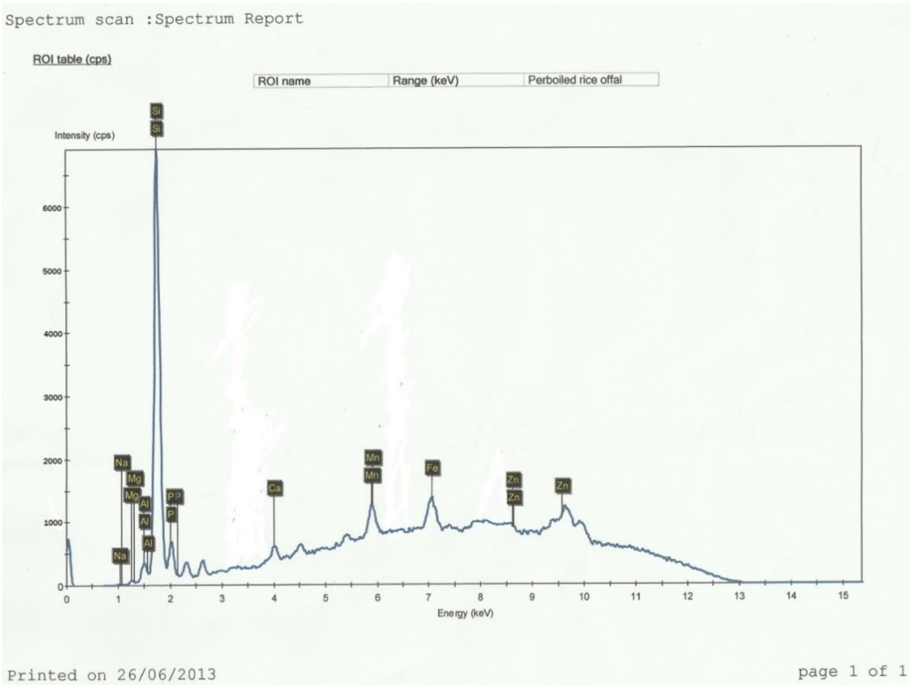

Figure 1: Spectrum of mineral elements in Parboiled rice offal with Silicon having the highest peak and intensity (cps) with K_α line energy

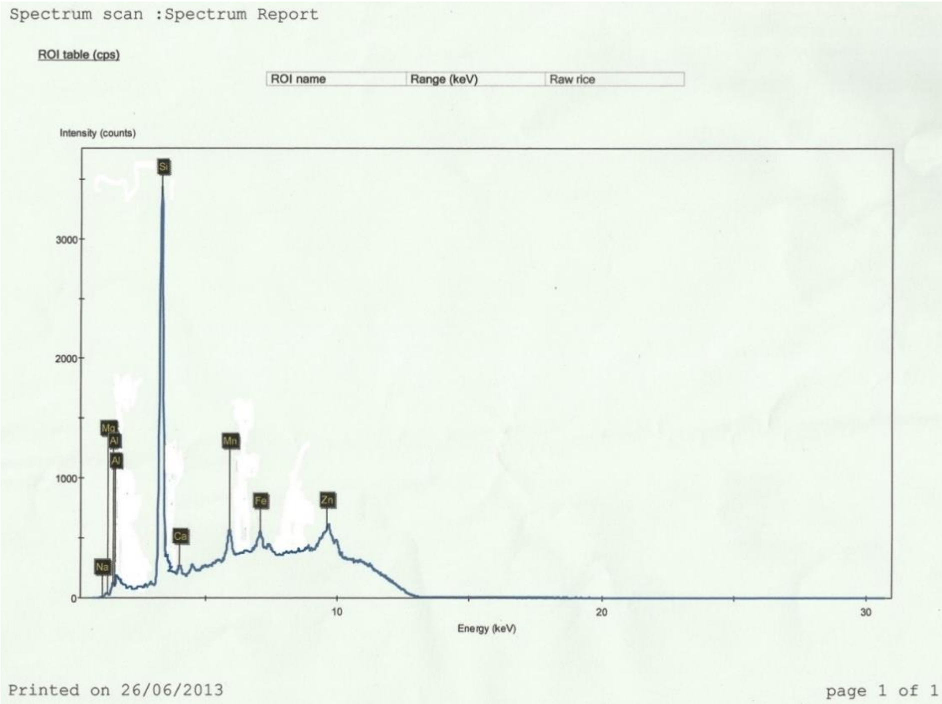

Figure 2: Spectrum of mineral elements in raw rice offal with Silicon having the highest peak and intensity (cps) with $K_{\alpha} – K_{\beta}$ line energy

Chemical composition of experimental diets

Chemical Composition of concentrate Diets is presented in Table 4. The ME of the diets ranged between 10.85 - 11.16MJ/Kg DM. It falls within the range 10 - 11.6MJ/Kg DM recommended for Bulls (Rutherglen, 1995). The Crude Protein (CP) of the diets range from 22.44% to 19.69%. These fall within the range of (19.00 to 22.91%) reported by Lamidi, *et al*. (2007) but higher than 13% and 13 - 15% reported by Rutherglen (1995) and Aduku (1993) respectively. The CF range between 14.59% to 17.84%. The CF the control diet (NRO) and 30% RRO inclusion were lower than the minimum level of 17% required for beef cattle (NRC,2000) The EE of all the diets also exceeded the maximum recommended level of 6% for matured cattle Parish and Rhinehart (2008). This increase might have resulted due to the presence of cotton seed cake in all the diets. The high fat level did not have a negative effect on the performance of the animals vis a vis feed intake or diarrhea, this could be due to the type of fats in the diets and the form it was supplied to the animal as a similar trend was observed by Idowu (2011).

Table 4: Chemical compositions of concentrate diets containing varying levels of raw or parboiled rice offal fed to fattening Bunaji bulls.

Parameters	Level of inclusion				
	0	**20RRO**	**30RRO**	**20PRO**	**30PRO**
Dry matter	90.05	89.77	88.77	89.85	89.17
Crude protein	19.94	19.69	22.44	21.38	20.56
Crude fibre	14.59	17.84	14.91	16.77	17.40
Ether extract	16.28	16.21	14.22	17.05	16.22
Ash	10.19	13.02	9.81	10.74	9.12
Acid detergent fibre (ADF)	20.56	21.89	21.32	24.13	21.09
Neutral detergent fibre (NDF)	36.44	40.81	39.87	43.96	42.41
Hemicellulose	15.88	18.92	18.50	19.83	19.32
Metabolizable energy(MJ/KgDM)	11.05	10.87	11.16	10.86	10.85

RRO = Raw rice offal, PRO = Parboiled rice offal, ME for the feed ingredients was determined by equation of Alderman and Cottrill, 1985. ME (MJ/Kg DM) = 11.78 + 0.0064 CP + $(0.000665EE)^2$ - CF (0.00414EE) - 0.0118A. Where ME = DM = Dry matter, CP = Crude protein, EE = Ether Extract, CF = Crude fiber and A = Ash.

Effect of Diet containing Raw and Parboiled Rice Offal on the Rumen Metabolites of Bunaji Bulls.

Figures 3, 4, and 5 show the effect of Experimental Diets on Rumen Metabolites of Bunaji Bulls. The rumen fluid pH obtained in this study was not significant (P>0.05) based on rice offal type (6.46-7.16), inclusion level (6.46-7.16),and interaction between rice offal type and inclusion level (6.46-7.24) irrespective of sampling time except at 6hrs post feeding which was significant (P<0.05) with inclusion level.

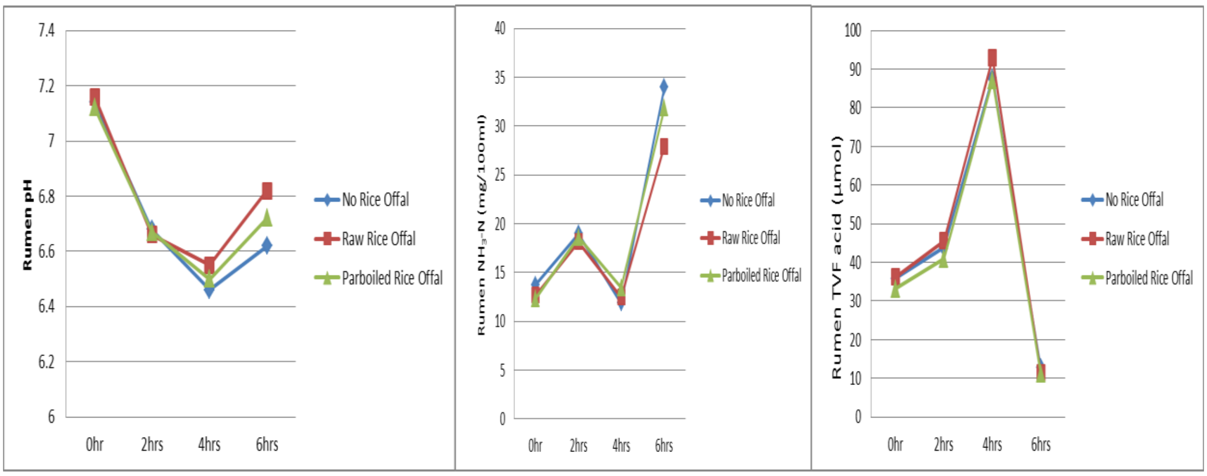

Figure 3: The effect of a diet containing a graded levels of raw or parboiled rice offal on the rumen pH, rumen ammonia nitrogen, and rumen total volatile fatty acid levels of fattened Bunaji bulls

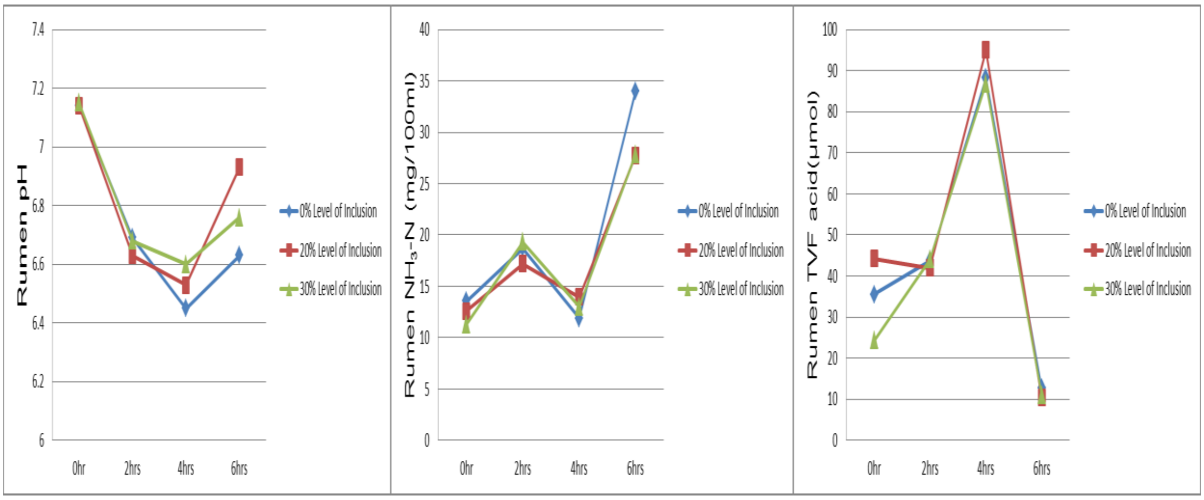

Figure 4: The effect of diet containing graded levels of rice offal on rumen pH, rumen ammonia nitrogen, and rumen total volatile fatty acid of fattened Bunaji bulls

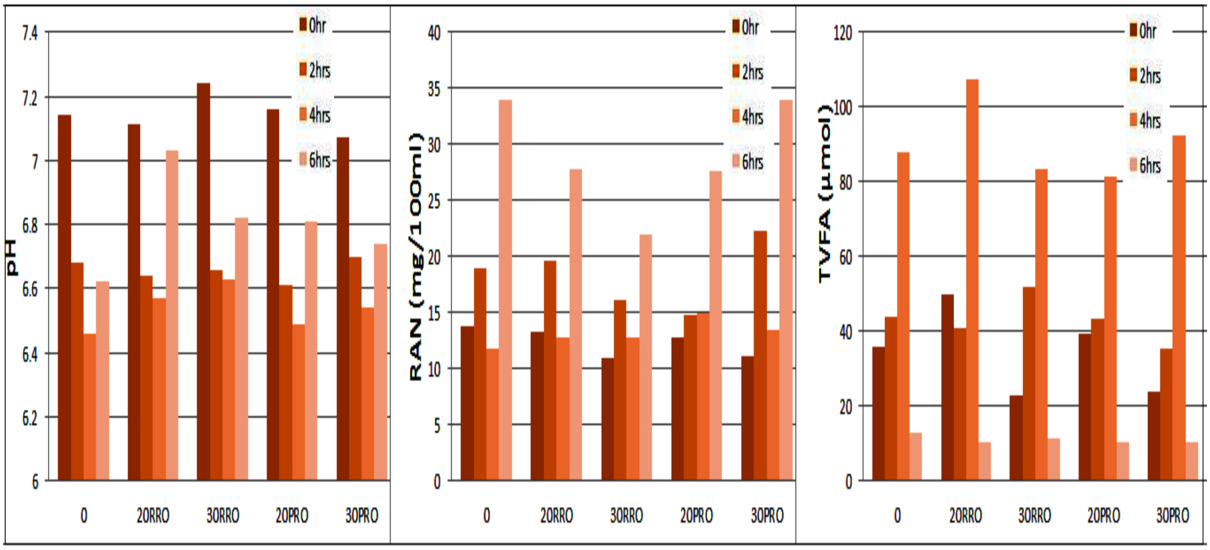

Figure 5: The effect of raw or parboiled rice offal type and level of inclusion on rumen pH, rumen ammonia nitrogen, and rumen total volatile fatty acid of fattened Bunaji bulls

At 0hr the pH of the rumen fluid was slightly above the normal range of 6.0-7.0 Mould and Orskov (1984). This could be due to the conditioned reflex displayed by much salivation into the buccal cavity in expectation of the morning feeding regime. At 2hrs, 4hrs and 6hrs after feeding, the pH values were above the minimum of 6.0 below which cellulolytic digestion in the rumen could be inhibited but it falls within the normal range of 6-7 (Lamidi, 2005).This finding is also in agreement with the report of Lamidi (2005)with rumen pH that ranged between 6.49 to 6.67. The Rumen Ammonia Nitrogen (RAN) obtained in this study was not significant (P>0.05) based on rice offal type (12.31-33.95mg/100ml), inclusion level (10.98-33.95mg/100ml) and interaction between rice offal type and inclusion level (10.93-33.95mg/100ml) irrespective of sampling time except at 6hrs post feeding which was significant (P<0.05) based on the interaction between rice offal type and inclusion level. These values are higher than 6.36-21.95 mg/100ml reported by Lamidi (2005) but it is mainly within the normal range of 5-20mg/100ml (Leng and Nolan 1984) for optimum RAN level required for maximum rumen function except for the values obtained at 6hrs post feeding which was above this value. The values obtained at 4hrs post-feeding fall within the range of 11.42 -14.43mg/100ml reported by Jonas and Vilma (2007) except for 20% parboiled rice offal inclusion which was slightly above this value. The high values obtained in this study could be due to low fermentable energy content of the diets. It could also be due to the fact that the poultry litter present in the diets is quite soluble in the rumen and rapidly converted to ammonia (Wohlt *et al.*,1976). However, there was no adverse effect on the performance of the animals. The Total volatile fatty acid (TVFA) obtained in this study was not significant (P>0.05) based on rice offal type (11.19-92.87Mmol/L), inclusion level (10.38-94.36Mmol/L) and interaction between rice offal type and inclusion level (10.33-107.45Mmol/L) irrespective of sampling time except at 0hr which was significant (P<0.05) with inclusion level. These concentrations gave an indication of the energy value. The amounts and proportions of the TVFA produced are variable, depending on the nature of the diet, the time after feeding, and the age of the animals (Stewart *et al.*, 1958). The range of TVFA in this study at 0hr before feeding is within the value of 19.57- 36.57Mmol/L reported by Jokthan (2006) when pigeon pea forage was supplemented in sheep diets except for 20% level of inclusion of raw and parboiled rice offal which were higher than these values. All the values obtained in this study is lower than 96.1 - 111.9Mmol/L reported by Jonas and Vilma (2007)except for the value of 107.90Mmol/L obtained for animals fed 20% raw rice offal at 4hrs post feeding which falls within this range,it was lowest at 0hr before feeding, then increases at 2hrs post feeding, it reaches its peak at 4hrs after feeding for rice offal type, inclusion level and interaction between rice offal type and inclusion level probably due to increase in digestibility of the feed, then it drastically reduced at 6hrs post-feeding. This is in line with the observation of Stewart *et al.* (1958).

CONCLUSION

The study was conducted to see the impact of raw and parboiled rice offal on the rumen metabolite of Bunaji bull. The beef cattle population has been increasing day by day and there is an extra demand of feed for the increased population. This extra demand of feed for livestock can be minimized by means of using unconventional feed like rice offal as a source of energy. This study revealed that diets containing raw and parboiled rice offal have no adverse effect on rumen metabolites. Therefore, it can be utilized by farmers for increased productivity.

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