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Performance of Bunaji Bulls Fed Pleurotus *tuber regium* Biodegraded Rice Offal Incorporated Diets

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ABSTRACT

The nutritive potential of rice offal biodegraded using pleurotus tuber –regium (PTRO) as a feedstuff for growing Bunaji bulls was investigated in this study. The study which lasted for 90 days was carried out using a total of twelve bulls with average weight of 153 kg. The animals were allotted to four (4) treatments groups (T1, T2, T3 and T4) of three (3) bulls each and each animal was a replicate in a Completely Randomized Design. A basal diet of elephant grass was offered ad libitum and concentrates in which the PTRO was included at 0.0%, 5.0%, 10.0% and 15.0% for T1, T2, T3 and T4 respectively were offered at 3.0% body weight of the bulls while drinking water was offered ad libitum. The experimental diet was formulated using palm kernel cake, brewers dried grain, Shea nut cake, maize offal, treated rice offal, untreated rice offal, bone ash and table salt. Results obtained at the end of the study for growth performance indices including average daily concentrate intake, average daily forage intake, average daily total feed intake, average daily water intake, average daily weight gain and feed conversion ratio for T1, T2, T3 and T4 were: 1.24, 1.05, 1.19 and 1.19 kg; 8.23, 8.53, 9.04 and 8.38 kg; 9.51, 9.59, 9.99 and 9.30 kg; 7.10, 6.16, 6.86 and 6.00 litres; 0.23, 0.2, 0.29 and 0.44 kg, and 43.35, 37.40, 34.27 and 20.73 respectively. There were significant differences ($P<0.05$) in the average daily concentrate intake and average daily water intake while the average daily forage intake, average daily total feed intake, average daily weight gain and feed conversion ratio showed no significant differences ($P>0.05$). It was concluded, based on the results obtained, that the Pleurotus tuber regium biodegraded rice offal included diets were safe in feeding feedlot Bunaji bulls.

Keywords: *Performance; Pleurotus- tuber-regium; biodegraded; rice- by product; feedlot; Bunaji bulls;*

INTRODUCTION

Use of fungi in biodegrading fibrous materials to useful feed inputs has gained prominence in animal nutrition research due to the advantages of environmental preservation and feed production. The fungi perform this function by secreting digestive enzymes. According to Mehdi *et al.* (2010), the breakdown of lignocellulosic biomass involves formation of long chain polysaccharides, mainly cellulose and hemicellulose and the subsequent hydrolysis of these polysaccharides into their component 5- and 6- carbon chain sugars. The authors added that lignin, the most recalcitrant component of lignocellulosic material acts as a barrier for any solutions or enzymes by linking to both hemicellulose and cellulose and prevents penetration of lignocellulotic enzymes to the interior lignocellulotic structure; however, many white rot fungi simultaneously attack lignin, hemicellulose and cellulose. The use of fungal biodegraded lignocellulosic materials in feeds has been reported to improve performance of sheep (Sabry, 2007; Gurbuz and Davies 2007) and goats (Wuanor et al., (2017).0.06% methionine and 1319 Metabolizable energy 0.06% methionine and 1319 Kcal/kg Metabolizabe energy.

Rice offal, a by-product of rice milling makes up about 40% of the parboiled rice and contains husk, bran polishing and small quantities of broken rice; Nigeria was also reported to have the potential to produce 200,000 metric tons of rice offal from the 500,000 tonnes of rice produced annually (Wudiri, 1991). The nutrient composition of rice offal has been reported as 94.42% dry matter, 5.09% crude protein, 5.6% crude fat, 33.0 - 30.39% crude fibre, 16.67% ash and 46.10% nitrogen free extracts. 0.17% calcium, 0.49% phosphorus 0.16% lysine, goats (Wuanor et al., 2017) 0.06% methionine and 1319 Metabolizable energy (Aduku, 2005; Maikano,2007). Its' high crude fibre, mainly lignin and low crude protein have resulted in reduced voluntary feed intake and low utilization when fed to animals (Onu *et al.*, 2015; Gurbuz 2010). It has a laxative effect and promotes water absorption in the digestive tract of non – ruminant animals (Emeruah, 1999). It is reasoned that fungal biodegradation of rice offal which abounds in the country and is usually disposed by burning will improve feed availability and also reduce environmental hazard caused by the burning.

The increasing global human population needs to be fed meat, which in Nigeria is locally produced by many farm animals including the Bunaji (White Fulani) cattle breed. The breed is commonly utilized for meat, milk and draught and its dung used as manure. Its notable adaptability to all regions of the country emphasizes the need of researching on its nutrition though other indigenous cattle breeds have been reported to fatten in feedlot better than the Bunaji (Madziga *et al.*, 2013).

Supplementation of suckling Bunaji cows with lablab was reported to improve performance of the animals and income of the farmers (Eduvie *et al.*, 2018). Additionally, globally, there has been an increased awareness of the importance of indigenous animal breeds and the need to properly manage and utilize these resources (Kaanai *et al.*, 2013). The aim of this study was to evaluate the performance of feedlot Bunaji bulls supplemented diets made of graded levels of *Pleurotus tuber regium* biodegraded rice offal

Materials and Methods

Experimental Site

The experiment was conducted at the Cattle Unit of the Livestock Teaching and Research Farm of the University of Agriculture Makurdi in Benue State. Makurdi is located at latitude $7^0 43^{'}$N and longitude $8^0 3^{'}$E and lies within the Southern Guinea Savanna Region of Nigeria. It has a temperature range of 17.3 to 35^0c with an annual rainfall ranging between 508 mm and 1016 mm. The relative humidity varies from 47 to 85% (TAC, 2002). The area is warm with a minimum temperature range of 24.20 ± 1.40^0C and a maximum temperature range of 36.33 ± 3.70^0C (TAC, 2009).

Experimental Diets

The experimental materials; Shea nut cake, Maize offal, Brewers Dried Grain, Palm Kernel Cake, Bone Ash, Common Salt were bought at various locations in Makurdi.Four experimental diets were formulated containing 0%, 5%, 10%, and 15% *pleurotus tuber-regium* treated rice offal which replaced untreated rice offal alongside other feedstuff and the diets were designated T1, T2, T3 and T4 as shown in Table 1.

Acquisition of Rice Offal and Pleurotus Tuber Regium

Rice offal was collected from rice mills across Makurdi and cleaned by manual removal of foreign materials after which it was packed in sacks and stored for later use. Tubers of *Pleurotus tuber-regium* were bought from markets in Makurdi, Benue state**.**

Composting of Rice Offal

The rice offal was wetted with water at the rate of 1.0 kg offal to 1.5 litres of water and thoroughly mixed to enable complete wetness of the material, and then heaped in one place and covered with polythene sheets to create an air tight environment suitable for composting (Oei, 1996). Turning of the heaped offal at three days interval was done to ensure uniform composting until the material was properly composted.

Inoculation of Rice Offal with Pleurotus Tuber-Regium (PTR)

Tubers of PTR were washed thoroughly to remove the dirt, after which they were immersed in water for one hour and then removed and put in a transparent bucket and properly covered for three days to enable spore formation of the tubers. After the third day, PTR was then removed and dissected into smaller bits carrying the spores. The composted rice offal was loaded on a three step wooden tray constructed using 2 x 2 wood and wire mash base. The base of the wooden tray was covered with white polythene sheet disinfected with methylated spirit soaked in a cotton wool after which the composted rice offal was then spread on the polythene. Spores harvested from the PTR were inoculated into the composed rice offal at the rate of 1kg of spores to 10kg of rice offal. The end of the polythene sheet were brought together and then sealed to create an airtight environment. This was left in the inoculation room for 21 days to ensure that the mass of the composted rice offal was completely colonized by the fungus showing whitish growth which was then taken out of the inoculation room and sun dried to terminate growth of spores. The material was sun dried and then properly kept until it was required for use (Plates I, II and III).

Chemical Evaluation of Treatment Diets

Chemical evaluation of treatment diets was done by subjecting their samples to proximate analysis for crude protein (CP), crude fibre (CF), ether extract (EE) and Ash according to AOAC (1990). Neutral Detergent Fibre (NDF), acid detergent fibre (ADF) and Acid Detergent Lignin (ADL) were also determined using Van Soest *et al.* (1999) method.

Plate I

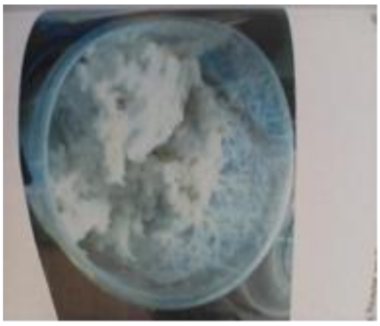

Plate II.

Plate III

Plate I. *Sample of Rice Offal,*

Plate II. *Water Soaked Tubers of Pleurotus tuber-regium Showing Spore Formation,*

Plate III. *Close View of Pleurotus tuber-regium Degraded rice offal*

Table1. *Composition of Experimental Diets Containing Pleurotus tuber regium Treated Rice Offal Fed to Bunaji bulls (%)*

Ingredient	Experimental Diets			
	1	2	3	4
Brewers Dried Grain	31	31	31	31
Palm kernel cake	30	30	30	30
Maize offal	15	15	15	15
Shea nut cake	5	5	5	5
Untreated rice offal	15	10	5	0
Treated rice offal	0	5	10	15
Bone ash	3	3	3	3
Table salt	1	1	1	1

T1 = 0% Treated rice offal, T2 = 5% Treated rice offal, T3 = 10% Treated rice offal,

T4 = 15% Treated rice offal

Experimental Animals and Management

The animal house (shed) was made of wooden materials. The wall was basically strong pillars made of roof, supported by other wooden materials properly arranged to confine the animals. The roof was made of zinc sheets to protect the animal from inclement weather condition. The house was divided into individual stalls measuring 3.6 m x 2.5 m x 6.2 m (length, weight and height) so that each animal was accommodated in a single stall. Twelve (12) Bunaji Bulls with average weight of 153 kg were used for the experiment. Two weeks to the arrival of the animals, the experimental stalls were thoroughly washed and disinfected, feeding and drinking troughs were washed and allowed to dry. On arrival the animals were treated against Trypanosomiasis using Samorin and dewormed using albendazole at the rate of 10 mg/kg intramuscularly and 10 mg/kg body weight orally respectively.

The animals were quarantined for a period of 30 days, thereafter, they were weighed using weighing band and randomly allotted into four

treatment groups with three (3) animals each and each animal served as a replicate. The animals were housed in individual pens and each animal was given on a daily basis, concentrate at three percent of body weight while forage (Elephant grass) and drinking water were offered *ad libitum*. The left over concentrate, forage and water were weighed the next morning so as to determine the feed and water consumed by subtracting the remnants from the quantity served. Animals were weighed weekly to determine their body weight gain throughout the feeding trial. The experiment lasted for 90 days. Final weights of bulls were taken on the last day of the experimental period with the aid of a weighing band. Feed conversion ratio was calculated using the formula;

$$FCR = \frac{\text{Total feed intake}}{\text{Total body weight gain}}$$

RESULTS

Chemical Composition and Fibre Fractions of Experimental Diets containing Varying Levels of Treated Rice Offal Fed to Feedlot Bunaji Bulls

The proximate composition, fibre fractions and Metabolizable energy of the experimental diets fed to the experimental animals are presented in Table 2. The dry matter ranged from 94.27 to 95.27% with the highest value observed in T1 followed by T2 and then T3 while the lowest value was recorded for T4.The crude protein content ranged between 13.13 and 17.94% with the highest value recorded in T4 and T3 and then T2 while the least value was recorded for T1. Crude fibre values ranged from 10.40 to 10.74 % with the highest value observed in T1 followed by T2 and then T3 while the lowest value was recorded for T4. The ether extracts values ranged from 4.72 to 5.85% with the highest being T1, followed by T4, then T2 while T3 was the lowest. The ash content ranged from 11.12 to 11.70% and was highest in T3, followed by T1, then T2 while T4 had the lowest value. The nitrogen free extracts values ranged from 46.61 to 50.63%; the highest value was in T1, followed by T2, then T3 and lastly T4. The neutral detergent fibre (NDF) ranged from 39.66 to 46.47 % and the acid detergent fibre ranged from 20.87 to 25.36%, both parameters exhibiting the same pattern as nitrogen free extracts. The acid detergent lignin values ranged from 9.50 to 13.19%, being highest in T2, followed by T1, then T4 and lastly T3. Hemicellulose content of the treatment diets ranged from 36.94 to 40.40 % with the highest observed in T1 followed by T3 and then T2 while the least value was recorded for T4. The cellulose values ranged from 11.25 % to 12.36 % with the highest value observed in T1 followed by T4 and then T3 while the lowest value was observed for T2. The ME (Kcal/Kg) ranged from 2730.33 to 2765.65 ME/Kcal/Kg with the highest value observed in T1 followed by T2 and then T4 while the least value was observed for T3.

Table2. *Chemical Composition of Experimental Diets Containing Varying Levels of Pleurotus tuber regium Treated Rice Offal Fed to Feedlot Bunaji bulls.*

Parameter	Dietary treatments			
	T1	T2	T3	T4
Dry matter (%)	95.27	95.25	95.19	94.27
Crude protein (%)	13.13	17.15	17.94	17.94
Ether extract (%)	5.85	4.99	4.72	5.32
Ash (%)	11.60	11.12	11.70	11.21
Nitrogen free extract (%)	50.63	48.41	47.43	46.61
Neutral detergent fibre (%)	46.47	42.81	41.42	39.66
Acid detergent fibre (%)	25.36	23.36	22.05	20.87
Acid detergent lignin (%)	11.96	13.12	9.50	10.50
Hemicellulose (%)	40.40	38.52	39.70	36.90
Cellulose (%)	12.36	11.25	11.48	11.99
ME (Kcal/kg)	2765.67	2757.79	2730.33	2749.83

ME: Metabolizable energy (37 x%CP+81.1x%EE+35.5x%NFE). (Pauzenga, 1985)

T1= contained 0% treated rice offal, T2= contained 5% treated rice offal

T3= contained 10% treated rice offal, T4= contained 15% treated rice offal

Performance of Bunaji bulls Fed Diets Containing Graded Levels of pleurotus tuber – regium Treaded Rice Offal (PTRO)

The performance of the Bunaji bulls fed diets containing graded levels of *pleurotus tuber – regium* treated rice offal is presented in table 3. There were no significant differences (P>0.05) in average daily weight gain, average daily forage intake, average daily total feed intake and feed conversion ratio while average daily concentrate intake and average daily water intake differed significantly (P<0.05). The average daily weight gain ranged between 0.23kg/day to 0.44kg/day, the highest value was recorded in T4 followed by T3, then T2 while the lowest value was recorded in T1. Average daily forage intake ranged from 8.26 to 9.04 kg. The highest value was observed in T3, followed by T2, then T4 with the least value observed in T1. The average daily concentrate intake ranged from 1.05 kg to 1.24 kg with the highest value observed in T1 followed by values of T3 and T4 which were similar while the least value was observed in T2.The average daily feed intake ranged from 9.30 kg to 9.99 kg with the highest value observed in T3 followed by T2 and then T1 while the lowest value was recorded for T4. Average daily water intake values ranged from 6.00 - 7.01 litres with the highest value recorded in T1 followed by T3 and then T2 while the least value was recorded for T4. Feed conversion ratio ranged from 20.79 to 43.35 with the highest value observed in T1 followed by T2, then that of T3 while the lowest value was observed in T4.

Table3. *Performance of Bunaji bulls fed diets containing graded levels of pleurotus tuber – regium treated rice offal*

Parameter	Dietary treatments				SEM	LOS
	T1	T2	T3	T4		
Initial weight (kg)	153.33	153.67	153.67	156	24.75	NS
Final weight (kg)	174.03	176.17	179.77	195.60	25.39	NS
Average daily weight gain(kg)	0.23	0.25	0.29	0.44	0.06	NS
Average daily forage intake (kg)	8.26	8.53	9.04	8.38	0.39	NS
Average daily concentrate intake (kg)	1.24^{a}	1.05^{b}	1.19^{a}	1.19^{a}	0.01	*
Average daily total feed intake (kg)	9.51	9.59	9.99	9.30	0.45	NS
Average daily water intake	7.01	6.16	6.86	6.00	0.21	*
Feed conversion ratio	43.35	37.40	34.27	20.79	19.32	NS

*T1 = contained 0% Treated rice offal; T2 = contained 5% Treated rice offal; T3 = contained 10% Treated rice offal; T4 = contained 15% Treated rice offal. SEM = standard error of mean. LOS=levels of significance. * = significantly different (P< 0.05). NS = not significantly different (P >0.05).*

DISCUSSION

The proximate composition of the treatment diets containing untreated rice offal (UTRO) and fungal treated rice offal (PTRO) revealed the potentials of the diets containing fungal treated rice offal as good feed materials for bulls. The dry matter (DM) content of the treatment diets showed that the feeds were dried. This indicates that the experimental diet will have long shelf life. The higher DM is advantageous, meaning less moisture and more nutrients. According to Mowlem (1992), dry matter is the portion of the feed that contains the nutrients. These values are comparable to 94.15 – 95.30 % reported by Ochepo *et al.* (2016) for enhancement of the nutritive value of cassava peal treated with white rot fungi. Differences in the DM may be as a result of the composition of the diets. The crude protein (CP) of the treatment diets increased with increase in inclusion levels of PTRO. The variation in the crude protein content is a reflection of the level of *pleurotus tuber-regium* treated rice offal (PTRO) in the diets. The PTRO contained 7.45 % CP while the untreated rice offal crude protein value was 5.90%; thus, increased inclusion of PTRO resulted in increased CP in the diets. The CP values of the treatment diets were within the recommended range of 13 – 15 % for bulls with live weight of 150 kg – 300 kg (Aduku, 2005) and also within the range of 12.31 – 16.91 % reported by Jokthan *et al.* (2013), who fed diets containing different energy sources to white Fulani cattle. However, these values were lower than 19.94 - 22.44% reported by Sani, (2014) when Bunaji bulls were fattened with raw or parboiled rice offal as energy source and (19.00%-22.91%) reported by Lamidi *et al*. (2007) for diets for fattening bulls. The crude fibre (CF) being highest in T1 than in the other treatment diets was attributed to the higher percentage of untreated rice offal (15 %). The CF content on the other hand decreased with increased proportion of PTRO in the diets. Reduction in CF content of the feed containing biologically treated rice offal has been attributed to the ligninolytic enzymes which degrade the lignin and other fibre components thereby rendering the residue less fibrous. The Ether Extract values (4.72 – 5.85%) of all the diets were within the recommended level of 6% for matured cattle (Parish and Rhinehart, 2006 as cited by Sani, 2014). The variation could be as a result of the varying inclusion levels of the test ingredient (PTRO). Ash values (11.12 – 11.70) was comparable to 10.93 – 11.50 reported by Jokthan (2013) when White Fulani bulls were fattened with diets containing maize offal as the energy source. The nitrogen free extracts content is a reflection of the other proximate components of the diets.

The NDF of the treatment diet varied. This variation could be attributed to the influence of graded level of biodegraded and untreated rice offal in the diets. NDF values of treatment diets showed decrease with increasing amount of PTRO. This could be ascribed to the varying levels of the test ingredient in the treatment diets. David, (2012) reported that in order to maintain optimal roughage digestion, ruminant diets should contain a minimum of 20 % NDF on a dry matter basis. The NDF fraction is made up of hemicellulose, cellulose and lignin resulting in improved fibre that is effective in stimulating rumen motility. The effect of lignin disruption is seen in the values of ADF and ADL in this study, which shows a potential for improvement of rice offal in the fermented diets. A diet with lower values of ADF is an indication of good nutritional quality as inferred by David (2012).The Metabolizable energy values (2730.33 – 2765.67 kcal/kg) for the diets were within the range value of 2388 - 2770kcal/kg reported for bulls with live weights of 150-300 kg (Rutherglen, 1995).

The pattern of daily body weight gain showed that the increasing inclusion levels of PTRO in the different diets offered the animals in different treatments proportionately increased the body weight, though there was no significant difference (P>0.05). This range of body weight gain (0.23-0.44 kg/day) compares with results of Jokthan (2013) who reported 0.40 kg/day when white Fulani bulls were fattened with rice offal based diet. The increased body weight of bulls fed diets containing increased inclusion level of PTRO can be said to be as a result of availability of more nutrients and especially protein which would have caused greater deposition of the nutrients in the growing animals (Webster *et al*., 1986). Additionally the numerical superiority of the average daily body weight values of the bulls fed the diet with the highest PTRO inclusion further buttresses advantage of the PTRO inclusion which may have acted synergistically with the forage intake creating a much more comfortable environment for the rumen microorganisms to break down the scabrous forage thereby liberating the encapsulated nutrients which became available for usage by the bulls (Moran, 2005). It is reasoned that the non-significance of the body weight may be due to the availability of abundant forages. However, the weight gain of bulls in all the treatments were lower than values obtained in fattening trial conducted by Lamidi *et al.* (2007) with higher gains of 0.87kg/day and those of Ayoade et al. (2015), Oyewole and Olorunju (2015) and Wuanor *et al*. (2015) whose values ranged from 0.74 to 1.45 Kg, 0.83 1.08 Kg and 0.34 to 0.58 Kg respectively in studies involving Bunaji bulls in the country. The final body weight is a cumulative of daily body weight gain; it is normal that it followed the pattern of daily body weight gain.

The statistical variation ($P < 0.05$) among the treatments for average daily concentrate intake which did not show a definite pattern can be explained to be caused by the feeding behaviour of the Bunaji bulls, where some animals have been reported to prefer eating concentrates while others prefer eating forages (Madziga *et al*., 2013). The average daily concentrate values showed that inclusion of PTRO in the diet lowered concentrate intake. The values are also lower than those reported by Wuanor *et al*. (2015) for Bunaji bulls in the same environment.

The forage intake showed that treatment had no effect on it. The forage intake values are lower compared to the 16.81 to 17.15 Kg reported by Wuanor *et al*. (2015) who fed varying levels of an agricultural by products based diet to feedlot Bunaji bulls in the same environment. Despite the lack of significant difference in the forage intake, the picture showed that concentrate and forage intake were balanced for each other i.e. the higher concentrate intake resulted in lower forage intake and vice versa (Madziga *et al*., 2013). The values of average daily total feed intake which is a summation of the daily concentrate intake and the daily forage intake are comparable with values obtained by Madziga *et al*. (2013) when concentrate mixture and *digitaria smutsii* hay fed to four Nigerian indigenous breeds of cattle in feedlot assessment. The values are however lower than those reported by Wuanor *et al.* (2015). This lower average daily total feed intake is reasoned to be the main reason for the lower average daily body weight gain values.

The average daily water intake values displayed a pattern where the highest intake (T1) corresponded to the highest concentrate intake. The water intake values are lower than those reported by Wuanor *et al.* (2015) and are reasoned to be caused by the season of the year corresponding with highest rainfall during which forages contain high moisture. Thus where the bulls harvest some water from the forages they would need to derive the remaining portion of water needed to satisfy their water requirement from drinking. Requirements for water vary with the environment, the type of feed on offered and the animal itself (Wilkinson and Stark, 1987).

The feed conversion ratio values are higher than those reported by Wuanor *et al*. (2015) for Bunaji bulls in the same environment and are attributed to the lower feed intake. The pattern of the FCR however showed that inclusion of PTRO in the diet improved the feed conversion by Bunaji bulls.

Conclusion

It was concluded that incorporation of PTRO up to 15% improved the growth performance of the bulls.

Recommendation

It was recommended that cattle farmers could replace rice offal with PTRO up to 15% in the diets of their Bunaji bulls to enhance growth performance

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