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BIO-ECONOMICS AND GROWTH PERFORMANCE OF FEEDING BROILERS WITH RICE WASTE, PALM KERNEL CAKE AND SPENT GRAIN DIETS FERMENTED WITH LIQUID SPENT BREWER'S YEAST

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Abstract

Eight (8) weeks research was carried out to determine the effect of feeding broilers rice waste, palm kernel cake and spent grain fermented with liquid spent brewer's yeast (LSBY) on growth performance and cost benefit. One hundred and eight (108) day-old Agritted broiler birds were brooded and fed commercial diet at the starter phase for 2 weeks. At 3 weeks old, they were weighed and assigned randomly to 4 treatment of 27 birds each in a completely randomized design (CRD). Each group was randomly assigned to one of the 4 starter diets (0kg fermented diet for control and 21.07kg of rice waste, palm kernel cake and spent grain fermented with LSBY; 21.56-23.20% CP) and 4 finisher diets (0kg fermented diet for control and 24.15kg of rice waste, palm kernel cake and spent grain fermented with LSBY; 19.07-19.92% CP). Each treatment was replicated thrice with 9 birds each; feed and water were provided ad-libitum. Result on growth performance showed significant ($P<0.05$) differences in final body weight, weight gain, feed intake and feed conversion ratio. The result showed that the final body weight of the broilers ranged from 1.84-2.00kg, total weight gain (1.35-1.51kg), average daily weight gain (32.24-35.99g), total feed intake (8.28-8.95kg), average daily feed intake (192.63-208.35g) and feed conversion ratio (5.53-6.47) across the treatments, respectively. Results on feed cost per kg gain showed significant ($P<0.05$) differences; indicating that T_3 had the lowest value of 98.76₦/kg followed by T_2 (114.11₦/kg), T_1 (123.01₦/kg) and the control with the highest value of 146.06 ₦/kg. Fermentation of rice waste, PKC and spent grain with LSBY positively improved the nutritive value of the diet which will lead to increase in poultry farmers' income.

Keywords: Spent brewer's yeast, Broiler performance, Rice waste, Palm kernel cake, Spent grain.

Introduction

Broiler farming is undertaken at all levels, from small-scale backyard to large-scale commercial ventures. According to USDA (2013), Nigeria's commercial broiler production ranks 4th in Africa, and it contributes about 9 - 10 percent of the Nigerian economy's agricultural domestic products as reported by Food and Agriculture Organization (2006). Furthermore, Nigeria's bird population is estimated to be 150.682 million, with 25 percent being economically reared, 15% semi-commercially reared, and

60% being raised in backyards or small scale. As a result, livestock is a significant source of animal protein, accounting for about 36.5 % of Nigerians' total protein consumption (Food and Agriculture Organization, 2006; Agriculture Nigeria, 2019).

Farming of broiler birds is gaining popularity in developing nations due to its function in bridging protein deficiency in their diets and providing economic prosperity to the vulnerable or plebeians in the society (FEE, 2019). It has the most potential for escalating animal protein quantity and consistency. Human diets must include poultry meat as a source of animal protein. Its composition makes it a crucial part of healthy and balanced meals, despite being somewhat cheap and frequently available (Abdulla *et al*., 2015).

The high cost of feed and feed ingredients, particularly conventional energy and protein feed items like soybean cake, groundnut cake, is a key deterrent to Nigeria's intensive animal farming (Ani *et al*., 2012). There is need to further engage the study of the bioeconomics of broilers in order to proffer cheaper ways of increasing and improving the economic fortunes of the Nigerian farmers in general; such to elevate the per capita consumption of protein from broiler meat and to reduce malnutrition.

According to El-Boushy and Van-der-Poel (2000), the use of industrial by-products in animal feeding is a beneficial way to produce food from industrial by-products in an indirect manner. Thus, the search for alternative protein source that could be used to fortify feed ingredients. Brewer's yeast (*Saccharomyces cerevicea*) has been found as a component with a number of beneficial properties (Paryad and Mahmoudi, 2008). *S. cerevisiae* has a protein content of 45 percent, a lipid content of 1 percent, and a crude fibre content of 2.7 percent. It has an excellent amino acid profile, although it suffers from a lack of sulphur-containing amino acids like cysteine and methionine, as well as a high lysine concentration (Raven and Walker, 1980; Huige, 2006). Furthermore, Vasso and Constantina (2007) also reported that brewer's yeast products are valuable source of ME, CP, B-vitamins, phosphorus although relatively low in calcium. Brewers' yeast was adopted as a biological feed supplements in broiler birds' diet by Kotrbaceki *et al*. (1994). Supplementation with yeast has been reported in broiler bird's diet toward FCR reduction (Onifade and Babatunde, 1996) whereas (Adejumo *et al*., 2005) reported that supplementation with yeast is best for feeding starters than finisher broilers. It was also reported in rabbit that cultured *S. cerevisiae* improved feed conversion and haematological parameters (Raju *et al*., 2006).

As the number of brewery plants increases, more liquid brewer's yeasts are released as by-product (Murray and O'Neill, 2012). This yeast has no direct primary value at the moment. There is therefore the urgent need for animal nutritionists in the country to investigate mechanisms that can efficiently deploy this product into the food chain of broilers. One of such approaches is to utilize the liquid brewer's yeast in the fermentation of some agricultural by-products such as rice waste, palm kernel cake and spent grain. The resultant effect of the fermentation process is the improvement on the nutritive values of these agricultural by-products. This will help produce a quality and affordable feed for broilers, thus helping the farmer to maximize profit.

Therefore, the aim of this research is to investigate bioeconomics and growth performance of broiler birds fed diets containing rice waste, palm kernel cake, spent grain fermented with liquids spent brewer's yeast.

Materials and Methods

Site and Duration of the Study

The experiment was conducted at the University of Nigeria, Nsukka's Poultry Unit of the Department of Animal Science Teaching and Research Farm. Nsukka is located at an altitude of 430 meters above sea level in the derived savannah area, at longitude 6°25°N and latitude 7°24°E (Ofomata, 1975; Breinholt *et al*., 1981). The average day-length in the study region is between 13 and 14 hours; average total weekly indoor and outdoor temperatures were 27.9°C to 29.2°C and 26.8°C to 30.5°C, respectively; mean minimum weekly indoor and outdoor temperatures were 20.5°C to 22.3°C and 20.0°C and 23.60°C, respectively; relative humidity was 73.1 percent to 76.6 percent; and average monthly rainfall was 781.33mm (Breinholt *et al*., 1981; Okonkwo and Akubuo, 2007; Energy Centre UNN, 2008). This research lasted for 8 weeks.

Management of Experimental Birds

This research was carried out taking into cognizance the guidelines reported by the University of Nigeria, Nsukka (2013) on research ethics involving animal subjects. One hundred and eight (108) day-old *Agritted* broiler birds were used in the research, which were acquired from an *Agritted* supplier in Nsukka, Enugu State. Brooding of chicks lasted for 2 weeks before assigning them randomly to 4 treatments of 27 birds each at the 3rd week of study in a completely randomized design (CRD). Each group was replicated thrice, with each replicate containing 9 birds. Throughout the research, the birds had unlimited access to water and diet.

Procurement and Processing of Experimental Materials

The liquid spent brewer's yeast (LSBY) was procured from the Nigerian Brewery Industry at 9th Mile, Enugu State. Rice waste, spent grain, palm kernel cake were purchased from the market in Nsukka, Enugu State as well. The LSBY was mixed with rice waste, palm kernel cake and spent grain and ensiled for 2 weeks using polythene bags in the ratio of 1:3; that is, 1 litre of LSBY in 3kg of rice waste, palm kernel cake and spent grain. Therefore, 7.5 litres LSBY of was mixed with 21.07kg each of the treatments of rice waste, palm kernel cake and spent grain for the starter diet while 8.5 litres of LSBY was mixed with 24.15kg each of the treatments of rice waste, palm kernel cake and spent grain for the finisher diet. After 2 weeks of fermentation in ensilage, the end products were all gathered separately for drying which helped to reduce the moisture content. The fermented meal was incorporated into the broiler starter and finisher rations.

Experimental Diets

Table 1 presents the percentage proportion of the compounded rations at different phases of development (starter and finisher mashes).

Table 1: Percentage proportion of the experimental diets

Starter feedstuff (%)	Control	T_1	T_2	T_3
Maize	42.14	21.07	21.07	21.07
Wheat offal	17.89	18.05	21.86	30.86
Soybean meal	31.97	31.81	30.00	21.00
Fish meal	4.00	4.00	2.00	2.00
Bone meal	3.00	3.00	3.00	3.00
Salt	0.50	0.50	0.50	0.50
Vitamin-mineral premix®	0.50	0.50	0.50	0.50
FRW	0.00	21.07	0.00	0.00

FPKC	0.00	0.00	21.07	0.00
FSG	0.00	0.00	0.00	21.07
Total	100.00	100.00	100.00	100.00
Calculated composition				
Crude protein (%)	23.20	21.69	22.14	21.56
Crude fiber (%)	11.00	11.00	6.50	9.50
Fat (%)	1.00	1.00	2.50	0.50
Energy (MJ/kg ME)	2324.15	2378.16	2767.43	2479.53
Finisher Feedstuff (%)	**Control**	**T_1**	**T_2**	**T_3**
Maize	48.29	24.14	24.14	24.14
Wheat offal	20.70	20.70	24.71	35.40
Soybean meal	23.01	23.01	21.00	11.31
Fish meal	4.00	4.00	2.00	1.00
Bone meal	3.00	3.00	3.00	3.00
Salt	0.50	0.50	0.50	0.50
Vitamin-mineral premix®	0.50	0.50	0.50	0.50
FRW	0.00	24.15	0.00	0.00
FPKC	0.00	0.00	24.15	0.00
FSG	0.00	0.00	0.00	24.15
Total	100.00	100.00	100.00	100.00
Calculated composition				
Crude protein (%)	19.31	19.92	19.48	19.07
Crude fiber (%)	5.00	9.50	6.50	9.50
Fat (%)	1.50	3.50	2.50	0.50
Energy (MJ/kg ME)	2296.85	2494.04	2767.43	2479.53

T_1: Rice waste; T_2: Palm kernel cake; T_3: Spent grain; FRW: fermented rice waste; FPKC: fermented palm kernel cake; FSG: fermented spent grain; Vit-min-premix used in this research: vit A: 106 (IU); vit D_2: 500,000 (IU): vit E: 2000 (IU); vit B_1: 1000 (mg); vit B_2: 1500 (mg); vit B_6: 1000 (mg); vit B_{12}: 10,000 (mg); Ca Pantothenate: 3000 (mg); biotin: 5000 (mg); niacin-amide: 10,000 (mg); folic acid: 100 (mg); Na bicarbonate: 250,000 (mg); NaCl: 10,000 (mg); KCl: 20,000 (mg).

Data Collection

Data collected on growth performance indices were based on feed intake, feed conversion ratio (FCR), body weight and body weight gain. Feed given to the birds were weighed before being fed. Daily feed intake was calculated as the difference between feed supplied the previous day and feed left the next morning. To calculate the average daily feed intake, the daily consumption values were summed and divided by the number of days and birds. The birds were weighed at the beginning of the study and also daily. The weight gained for the day was calculated by subtracting the weight measured at the end of the previous day from the weight gained in the present day. A weighing balance was used to obtain the weight of birds. The average daily body weight gain per bird per group was calculated by dividing the daily body weight gain by the number of birds in each group. By dividing the daily feed intake value by the respective weight gains of the groups, the FCR was determined from feed consumed over weight gained for each treatment.

Experimental Design and Data Analysis

Data obtained from this research were subjected to statistical analysis using analysis of variance (ANOVA) ascribed for CRD to obtained if statistical differences exist among the treatment means (Steel and Torrie, 1980).

However, according to Duncan (1955), differences among treatment means are separated using Duncan's New Multiple Range Test, which was applied in this research.

Results and Discussion

Proximate composition of the ensiled rice waste, palm kernel cake and spent grain using LSBY is presented in Table 2, whereas Table 3 presents the growth performance of broiler birds fed rice waste, palm kernel cake and spent grain fermented with LSBY

Table 2: Proximate composition of the ensiled rice waste, spent grain and palm kernel cake using liquid spent brewer's yeast (LSBY)

Samples (%)	Protein	Ash	Moisture	Fat	Fiber
Fermented rice waste, ratio 1:3	9.19	17.00	12.00	2.06	17.00
Fermented spent grain, ratio 1:3	30.65	7.50	20.00	3.50	19.00
Fermented palm kernel cake, ratio 1:3	15.76	14.00	23.00	10.00	20.50

The result of the chemical analysis of the ensiled ingredients using LSBY showed that spent grain recorded the highest numerical value for crude protein, while the fermented rice waste had the least numerical figure. The ensiled palm kernel cake had more moisture content than the other groups, with the fermented rice waste having the least content of moisture. The fermented palm kernel cake and spent grain had higher crude fibre contents than the value recorded for fermented rice waste. However, the ash content was highest in the fermented rice waste and lowest in the fermented spent grain. The ether portion of the fermented test materials was highest in the palm kernel cake and lowest in the rice waste.

Table 3: Growth performance of broiler birds fed rice waste, palm kernel cake and spent grain fermented with liquid spent brewer's yeast (LSBY)

Parameter	Control	T_1	T_2	T_3	P. Value
IBW (kg)	0.44±0.05	0.49±0.05	0.49±0.03	0.44±0.05	0.101^{NS}
FBW (kg)	$1.92±0.05^{b}$	$1.84±0.02^{c}$	$2.00±0.05^{a}$	$1.90±0.02^{b}$	0.000**
TWG (kg)	$1.48±0.05^{a}$	$1.35±0.02^{b}$	$1.51±0.03^{a}$	$1.46±0.02^{a}$	0.000**
ADWG (g)	$35.05±0.19^{a}$	$32.24±0.52^{b}$	$35.99±0.69^{a}$	$34.68±0.52^{a}$	0.000**
TFI (kg)	$8.31±0.14^{b}$	$8.95±0.89^{a}$	$8.55±0.14^{b}$	$8.28±0.09^{b}$	0.002**
ADFI (g)	$193.25±3.16^{b}$	$208.35±2.01^{a}$	$198.91±3.27^{b}$	$192.63±2.14^{b}$	0.002**
FCR	$5.51±0.08^{b}$	$6.47±0.16^{a}$	$5.53±0.10^{b}$	$5.56±0.14^{b}$	0.000**

^{abc}: Means with different superscripts on the same row vary statistically (**P ≤ 0.05); IBW= Initial Body Weight; FBW= Final Body Weight; TWG= Total Weight Gain; ADWG= Average Daily Weight Gain; TFI= Total Feed Intake; ADFI= Average Daily Feed Intake; FCR= Feed Conversion Ratio; T_1= Fermented Rice Waste; T_2= Fermented Palm Kernel Cake; T_3= Fermented Spent Grain; NS= Non-significant difference at 1% and 5% probability level.

Table 3 presents the outcome of the experimental birds on performance with respect to growth after feeding the test ingredients with significant ($P<0.05$) results in all parameters except in IBW. It evinced that birds on T_2 had statistical ($P<0.05$) increased FBW which differed significantly from birds on control, T_1 and T_3. For weight gain (TWG and ADWG), control, T_2 and T_3 had similar significant values though they are statistically different from T_1. Feed intake (TFI and ADFI) of broilers in T_1 were observed to be highest among the study groups and statistically differed from the reported values for control, T_2 and T_3, respectively. More so, the FCR of birds on T_1 was found to be high when compared to other groups which are statistically the same.

This research found that birds fed fermented PKC and spent grain performed similarly to those fed a control diet, implying that fermentation increases product digestibility. More degradable fiber and nitrogen retention result from increased digestibility which leads to more weight gain (Rizal *et al*., 2013; Mirnawati *et al*., 2018). Values for body weights in this research were similar to those reported by Mahanta et *al*. (2017) ranging from 1.83 - 2.06 kg. Furthermore, Borah *et al*. (2015) and Vidyarthi *et al*. (2010) also obtained similar findings. Our findings also showed that adding fermented PKC and spent grain to broiler feed will result in weight gain comparable to broilers fed a control diet. However, since fermentation can boost digestibility, the body weight gain of birds on fermented PKC and spent grain did not differ, which is consistent with the findings of Dairo and Fasuyi (2008), Sukaryana *et al*. (2010) and Mirnawati *et al*. (2013), who indicated that fermented materials have better nutritional content.

The usage of PKC and spent grain fermented with LSBY had no substantial (P>0.05) effect on broiler intake as compared to the control diet. This could be as a result of a better aroma and palatability attached to the fermented ingredients in the ration leading to an increased uptake (Rizal *et al*., 2013; Mirnawati *et al*., 2017). The fermentation also can alter the feed content, making it easier to digest and remove contaminants from the original ration (Sukaryana *et al*., 2010). The findings of this research are similar to those of Sinurat *et al*. (2014) and Mirnawati *et al*. (2017), who reported that using fermented palm oil sludge in poultry ration improved feed intake. In this research, the mean FCR of broilers was greater than that of Mirnawati *et al*. (2011), who recorded a feed conversion of 1.78 for broilers. Furthermore, Ezhienshi and Olomu (2008) reported a feed conversion ratio of 1.89 - 2.33, while Ugwu *et al*. (2008) obtained a FCR of 2.61 - 3.46.

Table 4: Economic efficiency of broilers fed rice waste, palm kernel cake and spent grain fermented with liquid spent brewer's yeast (LSBY)

Parameters	Control	T_1	T_2	T_3	P. value
Cost/kg of feed(₦)	146.06 ± 0.00^a	123.01 ± 0.00^b	114.11 ± 0.00^c	98.76 ± 0.00^d	0.000**
Total feed intake/bird (kg)	8.31 ± 0.14^b	8.95 ± 0.89^a	8.55 ± 0.14^b	8.28 ± 0.09^b	0.002**
Cost of feed consumed/bird (₦)	1213.80 ± 19.89^a	1102.06 ± 10.67^b	976.06 ± 16.08^c	818.10 ± 9.12^d	0.000**
Sale of birds (₦)	1300.00	1200.00	1400.00	1300.00	
Gross margin (₦)	86.20	97.94	423.94	481.90	

abc: Means with different superscripts on the same row vary statistically (**P ≤ 0.05); T_1= Fermented Rice Waste; T_2= Fermented Palm Kernel Cake; T_3= Fermented Spent Grain.

Results of the cost benefit analysis of broiler birds fed rice waste, palm kernel cake and spent grain fermented with LSBY is presented in Table 4. Cost of feed/kg of diet were statistically (P<0.05) distinct. Control ration had the highest per-kilogram cost, followed by diets containing fermented rice waste (T_1) which was also statistically (P<0.05) greater than diet containing fermented palm kernel cake (T_2). Diets containing fermented spent grain (T_3) had the least cost per kg diet representing 32.6% reduction in cost and 31.73% in cost per kg weight gain of the finisher broilers compared to the control, whereas T_1 and T_2 saved 21.59% and 1.07% in cost/kg/gain, respectively. However, with respect to cost of feed per kg benefit ratio, T_3 had the best result which is statistically ($P<0.05$) different from other groups. The control diet showed the highest ratio of the cost per gain.

The inclusion of fermented PKC and spent grain could provide a better cost benefit than the control because the amount of money spent differed between the experimental groups and variations in feed intake and fermented ingredients cost per kg were the key causes of these changes. The findings of Srivastava *et al*. (2005) and Jawale *et al*. (2006) who documented lower feed costs and increased feed utilization in broilers fed enzyme-supplemented high fiber diets, were in agreement with the findings of the current study. Comparably, adding Roxazyme G2G to a rice waste-based diet decreased the feed cost per kilogram of live weight gain (Oladunoye and Ojebiyi, 2010).

Conclusion

Based on this research, it can be concluded that using liquid spent brewer's yeast (LSBY) to ferment rice waste, palm kernel cake, and spent grain may not only enhance feed nutritive value but also increase poultry farmers' income. The fermented feeds had positive effects on the growth performance and bioeconomics.

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