Response of finishing broiler chickens to diets containing rumen liquor fermented rice husk meal.

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Abstract

One hundred and fifty Arbor acres broiler chickens aged four weeks were used in determining the effect of fermented rice husk meal diets on the performance and nutrient digestibility of finisher broiler chickens. They were allotted into five dietary treatments containing 0, 5, 10, 15 and 20 % rumen liquor fermented rice husk (RLFRH) meal, respectively. Each treatment was replicated three times with ten chickens each. The experiment was carried out using the completely randomized design. Feed and clean water were supplied ad libitum through the five weeks experimental period. Routine and standard management practices were strictly observed. Data on weight changes, feed intake and mortality were collected while feed conversion ratio was calculated. The results showed no significant ($p>0.05$) differences in live weight, feed intake, feed conversion ratio and mortality. However, the growth rate was influenced ($p<0.05$) by the dietary treatments with broiler chickens on dietary treatments containing 15% RLFRH and 20% RLFRH having higher ($p<0.05$) growth rate than those on 5% RLFRH and 10% RLFRH . Apparent digestibility results showed that dry matter, crude protein, crude fibre and ether extract digestibility were influenced ($p<0.05$) by dietary treatments. They were optimized at rumen liquor fermented rice husk levels of 9.10, 9.29, 12.03, and 12.31 g/kg DM intake. However, nitrogen free extract was not significantly ($p>0.05$) influenced by the dietary treatments. The results from this study showed that diets containing RLFRH had no adverse effect on broiler chickens performance and nutrient digestibility at the finisher phase; as most of the performance parameters were not significantly different from the control diet. Twenty percent RLFRH inclusion level is recommended at this phase for improved growth rate.

Keywords: Performance, rumen liquor, fermented, digestibility

Introduction

Poultry production is an important source of animal protein for human population. Poultry products are widely accepted for human consumption and also have quick returns on capital investments. However, broiler chicken production in many tropical and sub-tropical countries is affected by scarcity and high cost of conventional feed ingredients (El-Deek *et al.,* 2008). Feed constitute 65-75 % of the total cost of broiler chicken production. Convectional ingredients are expensive because of competition between man and animal (Dairo *et al.*, 2005). The main ingredient used as energy source in formulating feed for poultry is maize; it accounts for about 60 % of the total amount of feed ingredient required in poultry diets (Afolayan, 2012). There is therefore, urgent need for alternative locally available and cheap source of feed ingredient which is not directly consumed by human. One of the cheap sources is rice husk which is a by-product of paddy rice processing, Over 90 % of the world's rice is produced and consumed in this part of the world. The average yield of rice production in the world is estimated to be 3.69 kg/ hectare in 1996 and between 1990 and 1995 it was calculated to be 37 kg/ha/year (FAO, 2012). According to FAO (2012) rice production increased from 4.2 million tonnes in year 2013 to 72.9 million tonnes in year 2015. The husk (outer covering of rice) produced from this rice is either burn away or heap up as waste. This is because of its higher fibre (28 %) content (Oyawoye and Nelson, 1998). The high fibre content of this by-product has limited it usage by chicken because they the enzyme capable of breaking down this cellulose cell wall, thus making the nutrient present in this by-product unavailable. One possible way of overcoming this problem is by fermentation. Fermentation procedure has been used to improve the nutritive quality of waste of many farm products by reducing the fibre content while increasing protein proportion therefore making raw substances rich in non-digestible carbohydrates a major functional livestock feed (Dairo and Egbeyemi, 2012). Furthermore rumen liquor has proven to be an excellent solvent for fermentation high fibre by products (Adeyemi and Familade, 2003; Abasiekong, 1991). Rumen liquor is the filtrate of the rumen content. These fluids contain large amount of microbial enzymes which ruminants utilize for fibre (cellulose, hemicelluloses and phenolic polymers) degradation. The microbes are able to synthesis beta-glucanases, which are used for the breakdown cellulose, hemicelluloses and phenolic polymers (Hungate, 1966). Adeyemi and Familade (2003) report that fermentation enhanced the nutrition value of maize cob. Their study showed that replacement of maize with rumen filtrate (liquor) fermented corn-cob in layer diets increased the crude protein content three folds while crude fibre decreased from 42.46% to 28.94. However, there are no studies on the effect of rumen liquor fermented rice husk meal diets on the performance and nutrient digestibility of finisher broiler chickens. Therefore, this study was carried out to determine the effect of rumen liquor fermented rice husk meal diets on the performance and nutrient digestibility of finisher broiler chickens.

Materials and Methods

This experiment was conducted at the Teaching and Research Farm of the School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State. Minna lies within latitude 9° 37′ North and longitude 6° 32′ East. The average temperature in Minna is between 19 to 37 °C with an annual rainfall of 1312 mm. The mean annual relative humidity is between 21 to 73 % (Climatemp, 2011).

Rice husk fermentation and diet preparation

Bovine rumen liquor was collected from carcasses of animals slaughtered at a Minna abattoir. The rumen content of the slaughtered cattle was taken into a well cleaned room and was immediately poured into fine mesh (mesh size). Solid material in the liquor was discarded while the fluid (liquor) part of the content transferred to airtight nylon bags. The whole process took approximately 10-15 minutes.

The fresh rumen liquor was sprayed on rice husk at 300ml/kg using procedure of Muhannad (2010). After spraying, the rice husk was stirred and packed in polyethylene bags which were made airtight to secure anaerobic fermentation for 30 hours according to the procedures of Muhannad (2010). The rumen liquor fermented rice husk meal were air dried for three days. Samples from dried rumen liquor fermented rice husk meal were taken for chemical analysis according to the AOAC (2012) procedure.

Five diets were formulated (Table 1) to represent five treatments and the diets were made by replacing maize meal. Ingredients and nutrient composition of the experimental diets are presented in Table 1. Zero percent (RLFRH 0) replacement was the control diet while 5, 10, 15 and 20 % replacements of maize with rumen liquor fermented rice husk respectively were tagged diets RLFRH 5, RLFRH 10, RLFRH 15 and RLFRH 20, respectively.

Management of birds and data collection

One hundred and fifty Arbor acres broiler chickens aged four weeks were randomly allocated to the five experimental dietary treatments, each treatment had three replicates and each replicate had ten chickens. A completely randomized design was used. Feed, water and light were provided 24 hours. Standard management practices were observed. The birds were reared in a deep litter house; feed and water were provided *ad libitum*. Prior to this experiment, the chickens had been fed a 220 g CP/kg DM and 12.14 MJ of ME/kg DM diet to meet their nutritional requirements according to NRC (1994).

Each broiler chicken was weighed at the inception of experiment and weekly throughout the experimental period. The body weight gain was obtained by subtracting the initial weight from the final weight of the broiler chickens at the end of the experiment. The daily weight gain of each bird was determined by dividing the total weight gain by total number of days.

A known quantity of the feed that will allow for *ad libitum* intake was given to the chickens daily for a period of four weeks with the left over collected every morning throughout the experimental period. The daily feed intake was gotten by subtracting the left over from the amount of feed offered the previous days. The feed was weighed using weighing balance. The feed conversion ratio (FCR) was calculated as dry matter intake per unit weight gain.

Table 1: Ingredients composition of experimental diets

Ingredient (%)	RLFRH0	RLFRH5	RLFRH10	RLFRH15	RLFRH20
Maize	62.18	59.07	55.96	52.85	49.74
Rice husk	0.00	3.11	6.22	9.33	12.44
Groundnut cake	28.82	28.82	28.82	28.82	28.82
Fish meal	4.00	4.00	4.00	4.00	4.00
Palm oil	1.00	1.00	1.00	1.00	1.00
Oyster shell	1.00	1.00	1.00	1.00	1.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25
Vit/min premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Determined analysis					
Dry matter	88.48	88.21	88.64	88.55	88.35
Ash	6.43	6.57	6.52	6.45	6.55
Crude protein	17.99	17.96	17.81	17.88	17.78
Ether extract	3.49	3.44	3.51	3.64	3.69
Crude fiber	3.17	3.40	3.48	3.47	3.51
Calcium	10.05	10.06	10.08	10.08	10.14
Phosphorus	5.50	5.52	5.57	5.61	5.70
ME (MJ/kg)	12.49	11.79	11.78	11.87	11.88

On day 21 after the commencement of the study, digestibility trial was carried out. This involves feeding the animals daily with known quantity of feed. A three-day acclimatization period was allowed prior to a four-day collection period. Droppings voided by each bird were collected on a daily basis at 09.00 hours. Care was taken to avoid contamination from feathers, scales, debris and feeds. Total faeces voided by each replicate were collected using a collection tray. The faeces was weighed (wet basis) and oven dried at 85 °C until a constant weight was obtained. At the end of the faecal collection the total dry faeces for each replicate was bulked, thoroughly mixed and 30 % of it was weighed and ground to a size that could pass through a 2 mm sieve for proximate analysis. The difference between the nutrients in the feed consumed and the faeces or nutrients in the faeces voided multiply by 100 gives the apparent digestibility coefficient of the feed.

The data on performance (body weight gain, feed intake, and feed conversion ratio) and nutrient digestibility was subjected to statistical analysis using one way analysis of variance (ANOVA), where differences occurred, they were separated using the least significant difference (LSD). SAS (2011) statistical package was used.

Results

The results of the proximate composition of the unfermented and fermented rice husk meal are presented in Table 2. The dry matter, crude protein, ether extract, crude protein and nitrogen free extract increased with fermentation, while the crude fibre and ash contents reduced.

Effects of fermented rice husk meal diets on growth rate, live weight, feed intake, feed conversion ratio and mortality are presented in Table 3. Dietary treatments significantly ($p<0.05$) affected growth rate (measured as Average daily weight gain). Live weight change, feed intake, feed conversion ratio and mortality were, however, not influenced ($p>0.05$) by dietary treatments.

Chickens on dietary treatments with 0, 15

Table 2: Proximate composition of unfermented, fermented rice husk and their percentage (%) change

Parameters	Unfermented rice husk	Fermented rice husk	% change
Dry matter	87.00	90.30	3.65
Crude protein	6.04	7.87	23.25
Ether extract	2.21	5.00	55.80
Ash	13.90	2.54	-447.24
Crude fibre	46.12	29.33	-57.25
Nitrogen free extract	27.10	43.74	38.04

Table 3: Effects of fermented rice husk on growth (g/day), live weight (g), feed intake (g/day), feed conversion ratio and mortality of broiler chickens

Parameter	RLFRH0	RLFRH5	RLFRH10	RLFRH15	RLFRH20	SEM
Jnital weight	231.12	234.11	231.14	233.21	233.14	1.121
Growth	13.87^{ab}	11.76^{b}	14.50^{b}	14.68^{a}	14.80^{a}	17.143
Live weight	631.91	558.58	661.24	614.94	654.26	0.418
Feed intake	45.62	48.73	53.11	50.98	60.13	2.012
FCR	3.37	4.16	3.68	3.68	4.07	0.167
Mortality	0.00	0.00	0.00	0.00	0.00	0.00

Means with different letter along the same row are significantly different ($p<0.05$).

SEM: Standard error mean

and 20 RLFRH inclusion levels had similar (p>0.05) growth rate. Similarly, chickens on dietary treatments with 0, 5 and 20 RLFRH inclusion levels had similar (p>0.05) growth rate. However, broiler chickens on dietary treatmentswith 15 and 20 RLFRH inlusion had higher (p<0.05) growth rate than those on treatments with 5 and 10 RLFRH inclusion levels.

The effects of rumen liquor fermented rice husk meal inclusion in diets on nutrient digestibilities are presented in Table 4. The results show that dietary treatments had effect (p<0.05) on dry matter, crude protein, crude fibre and ether extract digestibility. However, nitrogen free extract digestibility was not influenced (p>0.05) by dietary treatments. Chickens on dietary treatments RLFRH 0, 5, 10, and 15 had similar (p>0.05) dry matter and crude protein digestibility. Similarly, chickens on dietary treatments RLFRH 0, 5 and 20 had similar (p>0.05) dry matter and crude protein digestibility. However, those on treatments RLFRH 10 and 15 had higher (p<0.05) dry matter and crude protein digestibility than those on RLFRH 20. Crude fibre digestibility of chickens on treatments RLFRH 5, 10 and 15 were similar (p>0.05). Crude fibre digestibility of chickens on RLFRH 10, 15 and 20 were also similar (p>0.05). However, chickens on dietary treatment RLFRH 15 had higher (p<0.05) crude fibre digestibility than those on RLFRH 20 and 5. Furthermore, crude fibre digestibility of chickens on treatment RLFRH 20 was also higher (p<0.05) those on treatment RLFRH 0. Results of the ether extract digestibility showed that chickens on dietary treatments RLFRH 0, 5, 10 and 15 had similar ether extract digestibility, their digestibility were, however, higher than those chickens on dietary RLFRH 20.

Presented in Table 5 are the results of rumen liquor fermented rice husk for optimal dry matter, crude protein, crude fibre and ether extract digestibility. These results showed that dry matter, crude protein, crude fibre and ether extract digestibility were optimized at rumen liquor fermented rice husk levels of 9.10, 9.29, 12.03, and 12.31 g/kg DM.

Discussion

The proximate composition showed that fermentation improved the nutrient values in rice husk. Dry matter, crude protein, ether extract and nitrogen free extract increased with fermentation while ash and crude fibre reduced. In line with the present study, Akinwolere and Tsado (2014) reported that rumen filtrate of shea nut meal increased dry matter, crude protein and it reduced crude fibre and ash. Adeyemi and Familade (2003) indicated that fermentation with rumen filtrate increased the crude protein content three folds while crude fibre

Table 4: Effects of rumen liquor fermented rice husk diets on percentage dry matter, crude protein, crude fibre, ether extract and nitrogen free extract (NFE) digestibility of broiler chickens

Parameters	RLFRH0	RLFRH5	RLFRH10	RLFRH15	RLFRH20	SEM
Dry matter	91.00^{ab}	91.33^{ab}	92.33^{a}	92.67^{a}	89.33^{b}	0.443
Crude protein	88.67^{ab}	88.67^{ab}	90.67^{a}	90.67^{a}	86.67^{b}	0.573
Crude fibre	66.00^{c}	77.00^{ab}	80.33^{ab}	83.67^{a}	74.33^{b}	1.850
Ether extract	90.33^{a}	91.67^{a}	93.67^{a}	93.00^{a}	84.33^{b}	0.985
NFE	96.33	96.00	95.67	96.67	95.67	0.182

Means with different letter along the same row are significantly different (p<0.05).

SEM: Standard error mean

NFE: Nitrogen free extract

Table 5: Rumen liquor fermented rice husk levels (X) for optimal dry matter, crude protein, crude fibre and ether extract digestibility of broiler chickens

Trait	Formula	r^2 values	X	Y- value
Dry matter	$Y = 90.589 + 0.417X - 0.0229X^2$	0.72	9.10	92.49
Crude protein	$Y = 88.041 + 0.5314X - 0.0286X^2$	0.67	9.29	90.51
Crude fibre	$Y = 65.790 + 2.79X - 0.116X^2$	0.95	12.03	82.57
Ether extract	$Y = 90.164 + 0.502X - 0.020X^2$	0.91	12.55	93.31

decreased from 42.46% to 28.94%. This can be attributed to presence of microbes present in the rumen liquor which are able to synthesis beta-glucanases used for the breakdown cellulose, hemicelluloses and phenolic polymers as reported by Hungate (1966). However, contrary to the present study, Akinwolere and Tsado (2014) reported an increase in crude fibre when shea nut was fermented with rumen filtrate. The reason(s) for this is not known, but may be due to the nature of the test ingredient used.

Rice husk fermented rumen liquor had significant influence on the growth rate of broiler chickens. Chickens on dietary treatments 15 and 20 % inclusion level had higher growth rate at the 5 and 10 % inclusion levels. This may implies that at lower inclusion levels, rumen fermented rice husk meal do not have enough nutrient to make significant improvement in the growth rate as evidence in the digestibility trial results where diet with 15 % RLFRH inclusion level had better CP, ether extract had digestibilities. The growth results obtained in the present study is contrary to those of Adeyemi *et al.* (2008) who recorded the highest average daily growth at 0 % cassava enhanced with dried cage layer waste and fermented with rumen filtrate. Similarly, Muhannad (2010) did not observed any differences in the growth rate of broiler chickens fed rumen filterate fermented wheat bran based diets

The result obtained from the digestibility trial revealed that dietary treatments had significant influence in dry matter, crude protein, crude fibre and ether extract digestibilities. These parameters increased with increase of the inclusion levels until they were optimized. This reveals the concept of optimization of nutrient in poultry diets. Law of diminishing returns stated that " as more investment in an area is made, overall return on the investment increases until it get to a peak (optimal level) when additional investment will lead to a decrease in output assuming all other variable remains fixed". The dry matter, crude protein, crude fibre and ether extract digestibility were optimized at different inclusion levels. This showed that different levels of inclusion are required for different nutrient digestibilities (NRC, 1994; Mbajiorgu *et al.*, 2011). This might be the reason why some of the performance parameters were not significantly affected by the dietary treatments. NRC (1994), Mbajiorgu *et al.* (2011) and (Alabi *et al.* (2013) reported that different growth parameters were optimized at different nutritional inclusion levels. Akinwolere and Tsado (2014) observed that rumen filtrate fermented Shea nut influenced crude protein, crude fibre and ether extract digestibilities. They, however, did not determine the optimal levels.

Conclusion

The results from this study showed that in all the performance characteristics measured only growth rate was influenced by dietary treatment. Whereas the digestibility study showed that dry matter, crude protein, crude fibre and ether extract were influenced by dietary treatments and were optimized at dietary treatment levels of 9.10, 9.29, 12.03, and 12.31 g/kg DM intake. Furthermore, rumen liquor fermented rice husk meal had no adverse effect on broiler chickens performance and nutrient digestibility at the finisher phase as most were of the performance parameters were not significantly different from the control diet. For improved growth rate, CP and ether extract digestibilies, 15 % RLFRH inclusion level is recommended.

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