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Effects of Graded Levels of Xylanase-Treated Rice Husk on Nutrient Digestibility and Growth Performance of Broiler Chickens

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Abstract

This study investigated the feeding value of Aspergillus tubingensis xylanase-treated rice husk in broiler chickens. The objectives of the study are (I) to investigate the effect of xylanase treatment on the utilization of rice husk in broiler chickens and (II) to determine the optimum level of xylanase-treated rice husk that can be tolerated by broiler chickens. Xylanases are hydrolytic enzymes that degrade xylan and hemicelluloses located in plant cell walls, into xylose which is a reducing sugar and enhancing nutrient digestibility in animal feeds. The production of extracellular xylanase by a locally isolated Aspergillus tubingensis was conducted using solid-state fermentation. The selected isolate was identified by cultural techniques and verified by molecular identification. Conventional feed ingredients such as maize is the primary cereal as source of energy in broiler diet. High cost, availability and competition existing among man, industry and livestock has necessitated the need to find cheap and available alternative feedstuffs for maize in poultry diet. Rice husk is one of the alternative feedstuffs but characterized by high fibre content and Non-Starch Polysaccharide (NSP) (Dalibord, 2006). Thus, addition of the xylanase enzyme breaks the NSPs resulting in plant cell wall destruction after releasing the trapped nutrients such as starches and proteins within fibre-rich cell walls (Gade et al., 2017). Crude xylanase produced was used for enzymatic degradation of rice husk to improve its nutritional value. The rice husk was initially subjected to physical pre-treatment by soaking in water for 24 hours or ground to increase the surface area. Pre-treated rice husk was treated by spraying xylanase onto the rice husk at 100g/ 0.2mL representing the concentration level that recorded the best degradation of fibre content in the treated rice husk. Xylanase-treated rice husk (XTRH) was used with other ingredients in formulating a broiler chicken diet at different inclusion levels. The experiment was a complete randomized design with five experimental diets containing xylanase-treated rice husk at different inclusion levels 0, 5, 10, 15 and 20 kg/100kg. The control diet contained no xylanase-treated rice husk (XTRH). There were five (5) treatments each with three (3) replicate cages of eight (8) broiler chicks totalling 120 birds for the feeding trial. One hundred and twenty (120) day-old chicks with an average weight of 54.85g were randomly allotted to five dietary treatments formulated with 0 (control), 5%, 10%, 15% and 20% (XTRH), and fed for eight weeks. There were three replicates of eight (8) birds per treatment. Results showed that the performance of Broiler chickens such as feed intake, and weight gain feed fed diet containing a 20% inclusion level of xylanase-treated rice husk was significantly higher ($p<0.05$) compared to other treatment diets. This showed an improvement in the utilization of a high-fibre diet, nutrient digestibility, growth performance, and carcass characteristics which can be beneficial to farmers in reducing the cost of feed, and increasing savings and profit margin. Conclusively, the application of xylanase produced by Aspergillus tubingensis on rice husk may have enhanced efficient enzymatic hydrolysis of its fibre fractions and improved its nutritional values. Supplementation of rice husk treated with xylanase at 100g/0.2mL concentration level and included at 20% in broiler chicken may enhance nutrient digestion and utilization and improve the growth performance of broiler chickens.

Keywords: Aspergillus Tubingensis, Xylanase, Rice Husk, Fibre, Degradation

Introduction

High cost of conventional ingredients such as maize as source of energy, soybean, groundnut cake and fish meal as source of protein in broiler's diet has increased the cost of feed and consequently increased cost of production (Attia, 2015). The cost of feed represents about 75% of the total costs of animal production. Also, non-availability and competition existing among man, industry and livestock have necessitated the need to find cheap and available alternative feedstuffs for maize and other ingredients in poultry diet. Rice husk, a crop residue, is one of the alternative feedstuffs but, is characterized by high fibre content and Non-Starch Polysaccharide (NSP) (Dalibord, 2006, Onabanjo et al., 2021). Moreover, poultry digestive enzyme profiles are not modified to degrade NSP due to a lack of endogenous fibre-degrading enzymes. Hence, high fibre feedstuffs such as rice husk might impair growth responses (Abdollahi et al., 2016).

Essentially, fiber present in rice husk like other dietary fibre are lignin and polysaccharides that are not digested by endogenous enzymes or secretions of the digestive tract of non-ruminant animals. Dietary fiber has an important role in pig and poultry diets but a minimum level of it is required to maintain normal physiological function in the digestive tract (Wenk, 2001, Zhang et al., 2013). A major concern when including fiber in diets for monogastric animals is that high dietary fiber content is attributed to decreased nutrient utilization and low net energy values (Noblet et al., 2001, Agyekum & Nyachoti, 2017). Thus, the addition of enzymes to poultry diets has resulted to the breakdown of fibre content and consequently improves nutrient digestibility and utilization, thereby mitigating the excreta output and lowering nutrient excretion as reported by Rehman et al. (2017).

The addition of the xylanase enzyme breaks the NSPs resulting in plant cell wall destruction thereafter releasing the trapped nutrients such as starches and proteins within fibre-rich cell wall (Gade et al., 2017). This study, therefore, aimed to investigate the effect of xylanase-supplemented rice husk on the growth performance, and nutrient digestibility of thebroiler and to determine the optimum level the of xylanase-supplemented rice husk that can be tolerated by the broiler.

Materials and Methods

Housing and Experimental design

The experimental design was a complete randomized design with five experimental diets containing rice husk with different levels of inclusion (0, 5, 10, 15 and 20 kg/100kg) each supplemented with 0.02 ml/g of xylanase concentration (Pejman. Atrian et al., 2012) was used for the treatment of rice husk. The control diet contained no xylanase-supplemented rice husk (XTRH). There were five (5) treatments each with three (3) replicate cages of six (8) chicks (120 birds).

Feeding, Watering and Management

The experiment was carried out with One hundred and twenty (120) day old mixed sex Arbor acres commercial broiler chicks for a period of 56 days at Alfurqon poultry farm located at Fajeromi village, Tanke, Oke-Ode off University Road, Ilorin, Kwara state, Nigeria.

The enzyme xylanase (ß 1-4, endo-xylanase) supplemented in the dietary treatments was produced by fungi strain, Aspergillus tubingensis using corn cobs as substrate under solid state fermentation. Erlenmeyer flasks (250ml) containing 5g of wheat straw and 25ml of Mandels and Sternburg's (MS) medium (g/l): peptone, 1.0; (NH4)2SO4, 1.4; KH2PO4, 2.0; urea, 0.3; CaCl2, 0.3; MgSO47H2O, 0.3 and trace elements (mg/ l): FeSO47H2O, 5.0; MnSO4H2O, 1.6; ZnSO47H2O, 1.4; CoCl2, 2.0; Tween 80, 0.1% (v/v) pH 6.0) were autoclaved at 121 C for 30 min, cooled, inoculated with 2 9 106 spores/ml and incubated at 30 C for 10 days. The flasks were gently tapped intermittently to mix the content. At the desired intervals, the flasks were removed and the contents extracted with 50 mM sodium citrate buffer (pH 5.0). (Pandya & Gupte, 2012).

Experimental diets and clean drinking water were offered ad-libitum throughout the experiment. Vaccination and other routine practices were duly followed all through the experimental period.

Rice husk was collected from the rice milling centre in the Sango area, Ilorin, Kwara state. The rice husk was sun-dried for 3 days and milled. The best pre-treatment method of either soaking, grinding or in a raw state in experiment three (3) was used as a physical method for the pre-treatment of rice husk prior to the treatment using different levels of concentrations of xylanase. Other feed ingredients used in the present experiment were purchased and prepared at a commercial feed mill in Ilorin, Kwara state. The experimental diets included five different levels of inclusion of xylanase-supplemented rice husk at 0%, 5%, 10%, 15% and 20%. Diets were formulated to meet the nutritional recommendations (NRC, 1994) and fed in mashed form. The nutrients composition of broiler diets is shown in the Table 1.

Table 1. Composition of Experimental Diets of Broiler (kg/ 100kg)

Ingredients	Diet 1 (Control)	Diet 2	Diet 3	Diet 4	Diet 5
Maize	54	49	44	39	38
Groundnut Cake (GNC)	20	22	22	15	17
Soya bean cake	8	6	6	14	14
Fish Meal	2	2	2	2	2
Palm kernel cake (PKC)	10	10	10	9	3
Xylanase-Treated Rice husk (XTRH)	-	5	10	15	20
Limestone	3	3	3	3	3
Bone meal	2	2	2	2	2
Broiler premix	0.25	0.25	0.25	0.25	0.25
Salt	0.3	0.3	0.3	0.3	0.3
Lysine	0.2	0.2	0.2	0.2	0.2
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Nutritional Composition of the experimental Diet (Analysed)					
Crude Protein (%)	21.15	21.28	21.40	21.12	21.34
Crude Fiber (%)	6.10	5.80	6.50	5.90	6.10

Ether Extract (%)	5.60	5.67	5.43	5.87	5.98
Metabolizable Energy (Kcal./kg)	3109.77	3128.09	3146.40	3104.64	3136.98

Data collection

Birds were weighed at the beginning of the trial and thereafter on a weekly basis to determine weekly weight changes. Weight gain was calculated by subtracting the weight of the previous week from that of the current week. The feed intake was determined by subtracting the left-over feed from the feed offered. The feed conversion ratio was determined as average feed intake divided by average weight gain. Mortality was recorded daily and expressed as a percentage of mortality at the end of the experiment for the corresponding treatment group. A nutrient digestibility trial was carried out at three weeks of age using the (AOAC, 2000). The total feed offered and total excreta output of each treatment were quantitatively measured from day eighteen (18) to day twenty-one (21). Daily collections from each treatment were pooled, mixed and weighed over 72 hours. The weighed excreta samples were oven dried at 70oC for 24 hours and weighed again to determine their dry matter. Dried excreta were ground prior to chemical analyses.

At the expiration of the feeding trial, two birds were randomly selected per replicate, slaughtered and eviscerated. The live weight, weight at slaughtering and carcass weight were measured to determine the dressing percentage of broilers. The crop, proventriculus, gizzard, liver and pancreas were removed and weighed to determine the effect of dietary treatments on the gastrointestinal tract.

Chemical Analysis

Diet and excreta samples were subjected to proximate analysis using standard procedures of AOAC (2008) to determine the proximate composition.

Calculations

Nutrient digestibility was calculated using the following formula:

$$\text{Nutrient Digestibility (\%)} = \frac{\text{Nutrient in intake (g) - Nutrient in output (g)}}{\text{Nutrient in intake (g)}} \times 100$$

Where ND= Nutrient digestibility

Nutrient intake= weight of dry feed intake x coefficient of nutrient in the feed

Nutrient output= weight of dry excreta x coefficient of nutrient in faeces.

Feed Conversion Ratio (FCR) is the amount of feed ingested by an animal which can be converted into one kilogram of live weight.

FCR= Total weight of feed / Net production (Final weight- Initial weight)

Statistical Analysis

Data obtained were subjected to one-way analysis of variance (ANOVA) to determine the main effects (xylanase-treated rice husk inclusion) using the General Linear Models procedure of SAS (2008). Significant differences between treatments' means were determined by Duncan Multiple Range Test (Duncan, 1995).

Results and Discussion

The results in Table 2 showed that the average feed consumption of birds fed Diet 5 (20% XTRH level of inclusion) recorded the highest feed intake, followed by Diet 4 (15% XTRH level of inclusion), followed by Diet 3 (10% XTRH level of inclusion) and Diet 2 (5% XTRH level of inclusion) although similar (p>0.05) to values obtained in Diet 5. Birds fed on control (Diet 1) without XTRH inclusion level in the Diet recorded the lowest feed intake among the treatment diets.

The results in Table 2 showed a significant (p<0.05) difference in weight gain among birds fed on various dietary treatments. The average weight gain (WG) for the experimental period of 56 days showed that birds fed on diet five (5) containing a 20% level of inclusion of xylanase-treated rice husk (XTRH) had the highest weight gain, followed by birds fed diet four (4) with 15% and diet two (2) with 5% levels of inclusion. Broilers fed a 5% level of inclusion of XTRH recorded the lowest weight gain and closely followed by the birds fed on control diet with no supplementation of XTRH which was significantly different (p<0.05) from others.

The least feed conversion ratio was found in treatment diet 5 (1.73), followed by diet 4, diet 3 and diet 2. The highest feed conversion ratio (2.03) was found in treatment diet 1 (control). The result showed that feed conversion of broilers in high-fibre feed ingredients in the diet supplemented with XTRH was found to be better than that of the control diet.

The results in Table 2 show lower mortality in diets containing xylanase-treated rice husk (4.25%) recorded over a period of 56 days (8 weeks) except diet 2 having higher mortality when compared with the control diet. High mortality in diet 2 may be due to environmental and genetic factors.

Table 2. Effect of dietary level of xylanase treated rice husk on Performance Characteristics of Broiler

	Treatment						
Parameters	Diet 1 (ctrl)	Diet 2	Diet 3	Diet 4	Diet 5	SEM	P-value
FI (g/b/wk)	93.74^{d}	93.44^{d}	99.81^{c}	105.02^{b}	109.08^{a}	1.28	<.0001
Total FI (g)	3937.27^{d}	3924.43^{d}	4192.10^{c}	4410.63^{b}	4581.50^{a}	53.67	<.0001
WG g/b/2wks	46.24^{d}	54.95^{c}	56.03^{c}	59.21^{b}	63.08^{a}	0.69	<.0001
Total WG (g)	1942.00^{d}	2308.00^{c}	2353.33^{c}	2486.67^{b}	2649.33^{a}	29.24	<.0001
FCR	2.03^{a}	1.70^{c}	1.78^{b}	1.77^{b}	1.73^{bc}	0.03	<.0001
Mortality	0.86	1.67	0.00	0.86	0.86	NS	

Key: ^{a,b,c,d} means in the same column with different superscripts are significantly different (P < 0.0001), S.E.M= Standard Error Mean. FI-feed intake; WG- Weight gain; FCR- Feed conversion ratio

Table 3 showed the effect of treatments on the gastrointestinal tract characteristics of the broiler. An increase in the weight of the crop was observed in the diets with different levels of inclusion of xylanase-treated rice husk when compared with the control diet with no inclusion level of XTRH treatment. The result showed decrease (p<0.05) in weight of proventriculus in other diets which contained different inclusion levels of XTRH, except for diet 3 which recorded significant increase (p<0.05) in weight when compared with the control diet having no supplementation of xylanase treated rice husk. There were no significant differences in the weight of the gizzard and liver between the control diet with no level of XTRH inclusion and other diets with different levels of inclusion of XTRH.

Table 3. Effect of Dietary level of xylanase treated rice husk on the gastro- intestinal tract characteristics of Broiler

Weight of organs (g/100g body weight)	Treatment						
	Diet 1 (ctrl)	Diet 2	Diet 3	Diet 4	Diet 5	SEM	P-value

Crop	2.74^{c}	5.47^{a}	3.59^{bc}	3.68^{bc}	3.96^{b}	0.559	0.0020
Proventriculus	0.99^{b}	0.90^{b}	1.42^{a}	0.81^{b}	0.80^{b}	0.195	0.0164
Gizzard	4.74	4.31	4.37	4.67	4.57	0.819	0.9537
Liver	2.05	1.40	1.86	1.97	2.59	0.494	0.1364
Pancreas	0.71^{b}	1.30^{a}	1.79^{a}	1.54^{a}	1.71^{a}	0.265	0.0036

Key: Means in the same column with different superscripts are significantly different (P < 0.05). S.E.M= Standard Error Mean

Table 4 shows the effects of different levels of xylanase supplementation on nutrient retention. There was a significant increase (p<0.05) in fat retention for birds fed with xylanase-supplemented diets when compared with the control diet that has no xylanase-supplemented rice husk inclusion. An increase in the level of xylanase-treated rice husk included in the diets has resulted in a significant increase in protein and fibre digestibility. Lowest protein and fibre digestibility was recorded in the control diet with no xylanase-treated rice husk inclusion.

There is a significant difference (p<0.05) in the cost of feed for different inclusion levels of xylanase-treated rice husk. There were savings recorded in the cost of feed as the level of inclusion of xylanase treated rice husk increased in the diets. Diet 5 containing 20% XTRH inclusion level recorded the least cost of feed at ₦148.95. It was noticed that the cost of feed was more expensive in control diet and less expensive in diet 5 containing 20% XTRH.

There was a significant increase (p<0.05) in live weight of birds fed diet 5 compared with other dietary treatments. The lowest live weight was recorded in birds on diet 1 (control). These results tend to suggest that xylanase was able to degrade the fibre content of rice husk and consequently released the locked nutrients for animal utilization. This is in agreement with Fasuyi et al. (2012). There were significant differences (p<0.05) amongst the treatment means for eviscerated weight. The carcass weight of birds on diet 5 was the highest at 2218.00 g, followed by diet 4 at 2165.00 g while the control diet recorded the lowest at 1539.67 g.

There was a significant difference (p<0.05) in carcass weight of birds fed on dietary treatments when compared with those on the control diet. Birds on diet 5 had the highest eviscerated weight of 2518.67 g and there were significant differences from other dietary treatments. It was followed by birds on diet 4 with the eviscerated weight of 2398.33 g. Birds on diet 1 (control diet) recorded the lowest eviscerated weight of 1789.67 g. There was no significant difference in the eviscerated weight of birds fed treatment diets 2 and 3.

The economics of broiler production from the experimental treatments is shown in Table 4. The cost of production includes the cost of day-old chicks, feed, vaccination and medication programme and other overhead costs. The costs of diets were calculated using the current prices of the feed ingredients and other items.

The cost of the finished feed showed that the control diet was the most expensive, while diet 5 had the lowest cost. Followed by Diet 4, diet 3 and diet 2 respectively. The cost of feed per kilogram decreased as the level of inclusion of xylanase-treated rice husk (XTRH) increased. The cost per weight gain was lowest for birds on diet 5 (₦ 477.32) followed by diet 4 (₦ 498.81), diet 2 (₦ 525.94), diet 3 (₦ 568.94) and highest for birds on diet 1 (₦ 621.54). It showed from the table above that broiler on diet 5 had the least cost of feed per weight gain and those on diet 1 recorded the highest cost of feed.

Table 4. Effect of levels of xylanase enzyme on Nutrient Retention

Parameters	Levels of XTRH Inclusion						
	0.00	0.01	0.02	0.03	0.04	SEM	P-value
CP (%)	72.97^{c}	80.11^{b}	82.06^{b}	86.78^{a}	82.23^{b}	2.639	<.0001
CF (%)	65.63^{d}	79.03^{b}	80.91^{a}	74.67^{c}	80.73^{a}	1.277	<.0001
EE (%)	67.67^{b}	78.12^{a}	75.63^{a}	76.45^{a}	78.16^{a}	4.667	<.0009

Key: Means in the same column with different superscripts are significantly different (P < 0.05). SEM= Standard Error of Mean. CP- Crude protein; CF- Crude fibre; EE-Ether extract

The result of feed consumption recorded in Table 2 may be due to the xylanase supplementation in the diet containing rice husk which aided the breaking down of indigestible fibre of rice husk thereby releasing the trapped nutrients. The inclusion of highly fibrous feedstuff like rice husk affects feed intake and energy utilization of birds. Density of diets decreases as a result of increase in fibre content of the diet which dilutes energy concentration of diets (Alabi et al., 2014). Thus, birds tend to increase their feed intake because of the variation that occurs in energy density of the feed to maintain a constant energy level. The result of this study corroborates the findings of Cowieson et al. (2010) that enzyme treatment reduces the variation in digestibility which in turn increases the growth of birds and improves the utilization of nutrient present in poor quality feedstuffs. Anuradha and Roy, (2015) also reported an increased feed consumption by broilers fed on high fibre de-oiled rice bran supplemented with enzyme. Atteh (2000) reported that enhanced nutrient utilization by birds was as a result of an increased intestinal transit time in the presence of enzyme nutrase xyla, a xylanase enzyme. In addition, the observed improvements in the broilers fed diet supplemented with enzymes may be as a result of the activities of the enzymes in enhancing the birds to utilize the dietary fibre and other nutrients in the feed (Aderibigbe et al., 2018). It was observed that the inclusion of high fibre feed ingredient dilutes energy concentration and decreases the density of diets (Sriver et al., 2003). Therefore, birds change their feed intake as the energy density of the feed changes to maintain a constant energy level. Hence, need for increase feed intake (Alabi et al., 2014).

The result of weight gain obtained in Table 2 implied that the improvement in body weight of broilers was due to the efficient degradation of fibre content by the action of xylanase supplementation (Gade et al., 2017) on rice husk at different levels. Supplementation of xylanase break down fiber, starch and alleviate the negative effects of NSP and the anti-nutritional factors, thus improving nutrients digestibility and feeding value of rice husk allowing the release of entrapped nutrients for effective utilization by birds and consequently improve the weight gain of broilers. Birds on dietary treatments gained more weight as they consumed more feeds. It was reported that the addition of enzymes to broiler diet with fibre content improved weight gain in broilers when compared to diet without enzyme supplementation (Raza et. al., 2009). Similar report showed that addition of enzyme improved the weight gain of birds and efficiently breaks down the structural arabinoxylan in feed which invariably decrease intestinal viscosity and made available the entrapped nutrients (Alabi et al., 2014). Nikam et al. (2016) reported an improved body weight gain of broilers fed xylanase treated diet than control diet without enzyme supplementation. Kiarie et al. (2014) reported that xylanase supplementation improved growth performance, nutrient and energy utilization in both wheat-and corn-based diets.

The result showed that the feed conversion ratio of broilers fed xylanase treated rice husk was better than the control group. Birds placed on experimental diets were able to utilize the feed well and convert to flesh resulting from improved digestibility xylanase-treated rice husk. Supplementation of xylanase may have broken down the soluble fibres that dissolve in the gut of monogastric animals, creating viscous gels that trap nutrients and reduce rates of digestion, passage of feed through the gut, reducing feed intake and growth performance.

Beauchemin et al., (2000) reported 11% improvement in feed conversion ratio resulting from a 5% decrease in feed intake with enzyme treated diet associated with 6% increase in body weight gain. The result of mortality suggested that xylanase treated rice husk (XTRH) supplemented in dietary treatment as a feed ingredient, is not harmful to birds. Najafabadi et al. (2007) reported that xylanase supplementation resulted to significant decrease in the mortality rates.

The result obtained in Table 3 showed a significant increase in the weight of crop, proventriculus and pancrease ($p<0.05$). There was no significant effect of treatments on the weight of gizzard and liver. The increased in weight of crop recorded may be due to the quantity of bulky nature of rice husk stored after rapid ingestion. This is in agreement with the report of Alabi et al. (2014) who observed that increase in weights of crop, proventriculus, gizzard and liver is due to the increased activity of these organs. There was a significant increase in the weight of the pancreas of birds fed control diet with no xylanase-treated rice husk inclusion when compared with other experimental diets with different levels of XTRH inclusion. This may be as a result of the action of the enzyme xylanase on bulky rice husk treatments thereby reducing the activity of the organ which contains pancreatic juice known to produce the digestive enzyme. An increase in the size of proventriculus may be attributed to the need to produce more enzymes.

This result of nutrient retention in Table 4 appears to be the effect of the action of xylanase on fibre content of the dietary treatments. Fibre reduces the rate of digestion of protein, fat and their nutrients and an increase in fibre digestion lead to increase in other nutrients. Similar reports showed that enzyme supplementation in the diet containing cheap low-quality carbohydrate sources improved animal performance (Vander et al., 2004). The positive carcass characteristics observed in birds on diet 5 might be due to the successful breakdown and conversion of fibre in the supplemented xylanase-treated rice husk in the diet which in turn released the trapped nutrient for animal utilization. This is in agreement with Fasuyi et al. (2012) who reported that enzyme supplementation has a beneficial effect on the performance of animals.

The result of cost of feed recorded in Table 6 showed that xylanase treated rice husk supplementation significantly influenced the weight gain, feed intake and FCR which lead to the reduction in the cost of production and consequently improved profit margin. BIS (2007) inferred that supplementation of xylanase enzyme in a high-fibre diet may have a better cost-benefit ratio than that of low-fibre diet without an enzyme.

Table 5. Effect of Dietary level of xylanase treated rice husk on, live weight and Weight at Slaughtering, Carcass weight

Parameters	Treatment						
	Diet 1 (ctrl)	Diet 2	Diet 3	Diet 4	Diet 5	SEM	P-value
Live Weight (g)	1931.33^{d}	2288.67^{d}	2334.33^{c}	2473.33^{b}	2635.33^{a}	29.10	<.0001
Eviscerated Weight(g)	1789.67^{d}	2205.33^{c}	2259.33^{c}	2398.33^{b}	2518.67^{a}	59.97	<.0001
Carcass Weight (g)	1539.67^{d}	1858.67^{c}	1842.67^{c}	2165.00^{b}	2218.67^{a}	68.83	<.0001

Key: Means in the same column with different superscripts are significantly different (P < 0.05). SEM= Standard Error Mean

Table 6. Cost of Production of broilers fed xylanase treated rice husk

Parameters	Diet 1(ctrl)	Diet 2	Diet 3	Diet 4	Diet 5
Total feed intake/ bird (kg)	3.45	3.57	3.68	4.08	4.23
Cost of feed (₦/ kg)	174.75	165.00	156.15	151.60	148.95
Total cost of feed intake/ bird (₦)	602.89	589.05	574.63	618.53	630.06
Weight gain/ bird (kg)	0.97	1.12	1.01	1.24	1.32
Cost of feed intake/weight gain/bird (₦)	621.54	525.94	568.94	498.81	477.32

Conclusion

Pre-treatment of rice husk by physical method which involved grinding, followed by xylanase treatment at 0.02 ml/g level of concentration incorporated into broiler diets had an appreciable increase in nutrient digestibility, improved utilization of high fibre diet, enhanced growth performance and a better cost-benefit ratio of production. Xylanase-treated rice husk (XTRH) could be used in the diet of broilers up to 20% level of inclusion with no harmful effects on growth performance.

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