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Effect of Dietary Inclusion of Rice Husk Supplemented with Commercial Enzymes on Performance, Nutrient Retention and Gastro-intestinal Tract Characteristics of Arbor Acres Broilers

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Authors' contributions

Authors OOA and JOA designed the study and performed the statistical analysis. Author PTO handled the feeding trial. Author OOA wrote the first draft of the manuscript. Authors OOA and JOA managed the analyses of the study while author OOA managed the literature searches. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aims: This experiment was carried out to assess the effect of dietary inclusion of rice husk supplemented with commercial enzyme on performance, nutrient retention and gastro-intestinal tract characteristics of chicken broilers. The experimental design was a 2×4 factorial combination of two dietary level of rice husk (0 or 25%) with four levels of different commercial enzymes 0E (without enzyme 0ppm), 100E (100ppm of Phytase), 150E (150 ppm of Nutrase xyla), or 350E (350ppm of Grindazyme). Rice husk was added at the expense of maize in the control diet, and each experimental diet was tested during a 56-day feeding trial in triplicate. One hundred and ninety-two (192) one-day old unsexed Arbor acres chicks were used in the trial. Experimental diets and water were supplied *ad-libitum* to the birds from day the first day to day 56 and chicks were subjected to the recommended routine vaccination programmed. A nutrient digestibility trial was undertaken when the birds were 3 weeks old. At the end of the feeding trial, 3 birds per replicate were randomly selected, euthanatized by neck decapitation, then eviscerated, and the crop,

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proventriculus, gizzard, liver and pancreas weights were determined. The results showed that an increase in the dietary level of rice husk without commercial enzyme supplementation significantly decreased (*P<0.05*) weight gain, feed conversion ratio and nutrient digestibility. There were significant (*P<0.05*) interactions between dietary levels of rice husk and the inclusion of commercial enzymes on performance, nutrient digestibility and gastro-intestinal tract characteristics of chicks. Hypertrophy of the digestive organs was observed in birds fed rice husk without enzyme supplementation. However, this effect was attenuated with the inclusion of commercial enzymes. Results obtained showed that birds fed rice husk diets supplemented with commercial enzymes performed better in all parameters tested than those fed rice husk diets without commercial enzyme. The use of commercial enzyme is advantageous in the utilization of high-fibre diets for chicks. The dietary supplementation with commercial enzymes increased the weight gain, feed conversion ratio and improved nutrient digestibility in broilers, which supposes a beneficial reduction in the production costs.

Keywords: Broiler; commercial enzyme; digestive organ; rice husk; supplementation.

1. INTRODUCTION

Cost of production of poultry is associated with the cost of feed. The cost of feed is also related to the cost of ingredients. Maize is a major ingredient in the poultry diets. Its availability and price are influenced by competition between man, industry and livestock. Hence, it makes economic sense to find cheap alternatives for maize in poultry diets. Most of the alternative feed ingredients for maize contain Non-Starch Polysaccharide {NSP} [1]. However, the broilers digestive enzyme profiles are not designed to digest NSP thereby limiting the broilers ability to utilize high fibre feedstuffs. This intolerable high fibre content causes digestive inefficiency of the gastro-intestinal tract thereby reducing the effect of digestive enzymes and absorption of nutrients [2]. Efforts to extract more nutrients from feedstuffs (both conventional and non-conventional) have been a focus for research for decades [3]. In recent times more effort has been directed towards harnessing and utilizing by-products and wastes which are not directly utilizable by man, and take advantage of the convertible mechanism of animal organ to convert what is seen as a waste into wholesome animal product for human consumption [4]. Rice husk is a common by-product of rice milling that is high in crude fibre of about 12% [5]. Birds are known to require a minimal amount of fibre in the diet for proper functioning of the digestive organs. Dietary fibre has been observed as a diluent of the diet and, often, an anti-nutritional factor. Nonetheless, moderate amount of fiber has the ability to improve the development of organs, enzyme production, and nutrient digestibility in poultry. However, the potential benefits depend on the physicochemical characteristics of the fiber source. Fibre utilization by monogastric livestock has recently gained interest for various reasons, primarily to promote constant passage of materials through the gut and to stimulate growth [6]. The nutritional functions of fibre in the animal body include keeping the digestive system healthy for proper function, aiding and speeding up the excretion of waste and toxic materials from the animal body. Dietary fibre components undergo a limited conversion to substance available for absorption in poultry and could be degraded only by exogenous enzymes [7]. The addition of enzymes to address NSP viscosity can improve gut health, feed efficiency, improve fecal quality and facilitate the use of lower cost feed ingredients. The benefits of using livestock feed enzymes is to increase the availability of starches and proteins which are enclosed within fibre-rich cell walls and to increase the availability of phosphorus from phytate. Nutra

Xyla has been reported to improve apparent nitrogen and fiber absorption as well as feed transit time in pullet chicks fed boiled castor seed meal-based diets supplemented with β-xylanase [8]. Nutrase Xyla has been shown to efficiently break down the arabinoxylan fraction in feed, thereby resulting in a fast decrease of intestinal viscosity, improved availability of nutrients and energy, increased energetic value of the ration and reduction of digestive problems. Phytases are known to be phosphor hydrolytic enzymes which initiate stepwise of phosphate from phytate. The major form of phosphorus in plant-based feeds is phytate, which requires phytase to digest. Hence, the need to investigate the effect of dietary levels of rice husk supplemented with enzymes on the performance, nutrient digestibility and gastro-intestinal tract characteristics of broilers.

2. MATERIALS AND METHODS

One hundred and ninety-two (192) one-day old mixed sex broilers of commercial strain (Arbor acres) were used for this experiment. The temperature during the period of study was 26.6ºC (morning), 33.1ºC (afternoon) and 30.7ºC (evening) with corresponding relative humidity of 72%, 40% and 52% respectively. The birds were housed in an electrically heated battery cage and were fed the experimental diets Table 1 from one-day old to 56 days. The experimental design was a completely randomized design with a 2×4 factorial arrangement of replacement of maize with rice husk and types of enzymes namely: 0E (without enzyme) 100E (100ppm Phytase), 150E (150 ppm Nutrase xyla), 350E (350ppm Grindazyme). Rice husk which comprised of the pericarp, the aleurone layer, the germ and some of the endosperm of rice was added at 0 or 25% inclusion level at the expense of maize in the control diet. Each of these was undertaken in the presence of no enzyme or with different commercial enzymes at levels recommended by the provider. Thus, there were 8 treatments each with 3 replicate cages of 8 chicks (192 birds). Experimental diets and water were supplied *ad-libitum* and birds were subjected to a routine vaccination programmed. The birds were weighed at the beginning of the trial (54.85 g) and after every week. Mortality was recorded daily. A nutrient digestibility trial was undertaken when the birds were 3 weeks old. Total feed offered and collected excreta were weighed over a 72 hour using the total collection method. The excreta samples were weighed, oven dried at 70ºC and weighed again to determine their dry matter. Dried excreta were ground prior to chemical analyses. Nutrient digestibility was calculated using the formula:

$$NR = \frac{Nutrient\ intake - Nutrient\ output}{Nutrient\ intake} \times 100$$

NR= Nutrient digestibility
Nutrient intake = weight of dry feed intake × coefficient of nutrient in the feed
Nutrient output = weight of dry excreta ×coefficient of nutrient in feces

Diet and excreta samples were subjected to proximate analysis using methods of AOAC [9]. Crude protein was determined using the Kjeldahl procedure. Ether extract was determined by subjecting the samples to petroleum ether (b.p 60-80ºC) extraction in a soxhlet apparatus. Crude fibre of the samples was determined by the method described by Cullison [10]. At the end of the feeding trial, 3 birds per replicate were randomly selected, euthanatized by neck decapitation and eviscerated. The crop, proventriculus, gizzard, liver and pancreas were removed and weighed to determine effect of dietary treatments on the gastro-intestinal tract. Data collected were subjected to statistical analysis using the model for 2 way factorial design [11], significant difference between treatments means were separated using the Duncan's Multiple Range Test [12].

Table 1. Ingredient and chemical composition of experimental diets

Ingredients (%)	1	2	3	4	5	6	7	8
Basal *	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Maize	50.00	50.00	50.00	50.00	25.00	25.00	25.00	25.00
Rice husk	-	-	-	-	25.00	25.00	25.00	25.00
0E	-	-	-	-	-	-	-	-
100E	-	100ppm	-	-	-	100ppm	-	-
150E	-	-	150ppm	-	-	-	150ppm	-
350E	-	-	-	350ppm	-	-	-	350ppm
Analyzed nutrient content (% of dry matter)								
Dry matter	88.21	89.45	89.86	89.63	86.75	87.65	87.72	87.92
Crude protein(%)	19.42	19.46	19.56	19.91	20.65	20.70	20.77	20.76
Crude fat (%)	9.20	9.25	8.35	8.40	10.25	10.33	10.65	10.77
Crude fibre (%)	6.05	5.95	5.91	5.85	10.05	10.10	10.07	10.12
ME (MJ/Kg)	14.15	14.21	14.25	14.22	11.25	11.30	11.35	11.31
Lysine	0.91	0.92	0.91	0.93	0.82	0.83	0.83	0.82
Methionine	0.73	0.74	0.73	0.73	0.65	0.69	0.69	0.68

**Made up of groundnut cake 26.80%, blood meal 3.00%, palm kernel cake 3.00%,fish meal 2.00%, maize milling waste 10.00%, bone meal 2.35%, oyster shell 0.25%, salt 0.25%, palm oil 2.00%, Di-methonine 0.10%, premix 0.25(provided per Kg) Vit.A 4,000IU; Vit.D 8000IU; Vit.E 4,000mg; Vit.K 900mg; Vit.B_1 500mg; Vit.B_2 2000mg; Vit.B_3 5,500mg; choline chloride 15,000mg; Antioxidant (BHT) 0.05%;iron 1.8%; copper 0.2%; manganese 2.4%; cobalt 0.05%; zinc 2.8%; iodine 0.04%; selenium 0.18%; calcium 12.8% . 0E -without enzyme, 100E- Phytase, 150E- Nutrase xyla, 350E- Grindazyme*

3. RESULTS AND DISCUSSION

The feed became bulky as 50% of the maize in the control diet was replaced with rice husk an increase in feed intake by birds fed rice husk without enzyme supplementation was observed as shown in Table 2a. Increase in dietary level of rice husk supplemented with commercial enzyme increased weight gain and improved feed gain ratio (*P*=.05). No significant effect of enzyme supplementation was observed on feed intake and feed/gain ratio. There was also no significant interaction between levels of rice husk and enzyme supplementation on feed intake and feed/gain ratio. However significant interaction between rice husk level and type of enzyme was recorded for weight gain, details of which are shown in Table 2b. Rice husk is a high fibre feed ingredient, fibre affects feed intake and energy utilization of birds. The primary factor in the voluntary feed intake of chicks appears to be the need for energy [13]. Birds will ordinarily eat to satisfy their energy requirement. As fibre content of diets increases, density of the diets decreases. The inclusion of fibre in feed dilutes energy concentration of diets [14]. Hence, for birds to keep a constant energy level they have to change their feed intake as the energy density of the feed changes, hence the need for increase feed intake. Fibre has been included in experimental diets for mono gastric animals for many years primarily to promote constant passage of materials through gut; fibre reduces the digestibility time of feed in the gut not allowing intestinal secretions to act on the feed. Table 3 showed the effects of the dietary treatment on nutrient digestibility. There was no significant effect of treatments on fat digestibility. Increase in dietary level of rice husk at the expense of maize caused a significant increase in feed intestinal transit time ($P<0.05$), however there was no significant effect of the type of enzyme on this parameter. Increase in dietary level of rice husk in the absence of supplemented enzyme caused significant decrease in protein and fibre digestibility. Some authors [15-17] reported that increasing fibre concentration of feed causes decreased digestibility of all nutrients, reduced weight and increased faecal bulk as observed in this experiment, there was reduced weight gain, fibre act as a diluents agent which lower nutrient concentration and the effect of this indigestible fraction of carbohydrates can be observed on the anatomy of the digestive tract, the transit time, water losses bringing about poor digestion in mono gastric animal [18]. However, this experiment showed that addition of enzyme does enhanced the performance of the birds in terms of weight gain. Enzyme supplementations efficiently break down the arabinoxylan in feed, thereby resulting in a decrease in intestinal viscosity, improved availability of nutrients. Enzyme allows improved performance or a more efficient use of cheap low quality carbohydrate-sources without adversely affecting animal performance [19]. Table 4 showed that there was increase in the weight of crop, proventriculus, gizzard and liver when 50% of maize in the control diet was replaced with rice husk without enzyme supplementation. There was no significant effect of treatments on the size of the pancreas. Table 5 showed detail interactions between dietary levels of rice husk and type of enzymes on significant digestibility, weight of crop, proventriculus, gizzard and liver ($P<0.05$). Increase in the weight of the crop, proventriculus, gizzard and liver in the birds fed diet without enzyme supplementation may be as a result of increased activity of these organs. Increased viscosity of the intestinal contents decrease the rate of diffusion of substrates and digestive enzymes and hinders their effective interaction leading to significant modification of the structure and function of the digestive organs. To adapt to these changes, the activities of the intestinal secreting mechanism may be enhanced possibly leading to hypertrophy of the digestive organs. The increased weight of the crop is thought to be due to a need to store more feed as a result of the bulky nature of rice husk, while increase proventriculus size was associated with the need to produce more enzyme and increased gizzard size was due to the need for more grinding activities resulting in increased musculature consequent on increased fibre content of the diet. The liver equally increase in size in the birds fed rice husk without enzyme supplementation, liver plays a major role in metabolism, it produces bile an alkaline compound which aids in digestion via emulsification of lipids. The liver's highly specialized tissues regulate a wide variety of high volume biochemical reactions, including the synthesis and breakdown of small and complex molecules [20]. The various functions of the liver are carried out by the liver cells; these cells can differentiate and probably increase with the need for more work. With enzyme supplementation a greater proportion of non-starch polysaccharide (NSP) was digested thereby attenuating the increased function of the responding organs. NSP enzymes acting on the feed carbohydrate fraction are widely used for the capacity to increase feed digestibility and to decrease the anti-nutritional effects of certain carbohydrates. Enzyme supplementation irrespective of the type reduces the workload of the organs investigated. Addition of enzyme to broiler's feed reduced viscosity of the intestinal digest and showed a marked improvement on the various morphological effects of feeding fibrous materials to chicken broilers. A viscous digest slows down digestion processes and encapsulates nutrients, making them inaccessible to digestive enzymes, supplementation of feed with enzyme help to address NSP viscosity. Mclean et al. [21] observed that addition of enzymes to mono gastric feed reduced viscosity of the intestinal digest and showed a marked improvement on the various morphological effects of feeding fibrous materials to non-ruminants. Enzyme supplementation has a beneficial effect on the performance of animals [22].

Table 2a. Effects of dietary levels of rice husk supplemented with enzyme on bird performance

Dietary treatment	Feed intake g/bird/day	Weight gain g/bird/day	Feed/gain
Level of rice husk (%)	*	*	*
0	65.30^{a}	23.71^{b}	2.75^{a}
25	58.20^{b}	18.33^{a}	2.78^{b}
Types of enzyme	NS	*	NS
0E	58.50	21.92^{a}	2.67
100E	62.22	23.72^{b}	2.62
150E	62.20	23.66^{b}	2.63
350E	62.30	23.76^{b}	2.62
Rice husk × enzyme	*	*	*
S.E.M	3.30	0.70	0.33

*NS: Non-significant; *Means within the same column followed by different subscripts are significantly different (P= .05), S.E.M=Standard Error Mean*

Table 2b. Details of Interaction between dietary levels of rice husk and commercial enzymes on feed intake, weight gain and feed conversion ratio

	0E	100E	150E	350E
Feed intake: Rice husk (%)				
0	60.01^{b}	58.41^{a}	58.40^{a}	58.43^{a}
25	67.18^{c}	63.54^{b}	63.50^{b}	63.52^{b}
Weight gain: Rice husk (%)				
0	22.31^{b}	25.50^{c}	25.51^{c}	25.51^{c}
25	19.42^{a}	23.81^{b}	23.80^{b}	23.80^{b}
Feed/gain ratio: Rice husk (%)				
0	2.69^{b}	2.51^{a}	2.50^{a}	2.50^{a}
25	2.70^{b}	2.53^{a}	2.52^{a}	2.53^{a}

Different superscripts indicate significant differences (P= .05)

Table 3. Effect of dietary level of rice husk with or without commercial enzyme supplementation on nutrient digestibility and feed intestinal transit time (FITT)

Dietary treatment	Dry matter (%)	Protein (%)	Fat (%)	Fibre (%)	FITT (hrs)
Level of rice husk (%)		*	*	*	*
0	88.34	64.80	84.00	43.70	2.25
25	89.34	60.42	83.20	35.60	2.40
Types of enzyme	NS	*	NS	*	NS
0E	88.35	63.81	82.62	48.50	2.29
100E	88.44	68.30	84.20	56.00	2.27
150E	88.42	68.20	84.21	56.00	2.21
350E	88.44	68.30	84.20	56.21	2.22
Rice husk × enzyme	NS	*	NS	*	NS
S.E.M	0.77	1.50	0.82	1.56	0.14

**Means within the same column followed by different subscript are significantly different (P= .05); NS: Non-significant*

Table 4. Effect of dietary level of rice husk with or without commercial enzyme supplementation on the gastro-intestinal tract characteristics of broiler

Dietary treatment	g/100g body weight				
	Crop	Proventriculus	Gizzard	Liver	Pancreas
Level of rice husk (%)	*	*	*	*	*
0	0.58^a	0.44^a	2.35^a	1.72^a	0.14^a
25	0.72^b	0.66^b	3.66^b	2.90^b	0.30^b
Types of enzyme	*	*	*	*	NS
0E	0.57^a	0.50^a	2.20^a	1.78^a	0.20
100E	0.46^b	0.43^b	2.10^b	1.66^b	0.19
150E	0.45^b	0.44^b	2.11^b	1.66^b	0.20
350E	0.45^b	0.44^b	2.10^b	1.65^b	0.19
Rice husk × enzyme	*	*	*	*	NS
S.E.M	0.05	0.03	0.04	0.02	0.01

**Means within the same column followed by different subscript are significantly different (P= .05)*

Table 5. Details of interaction between dietary levels of rice husk and types of commercial enzyme on digestibility and gastro intestinal tract characteristics of broilers

Digestibility	0E		100E		150E		350E	
	0	25	0	25	0	25	0	25
Protein digestibility	64.57^b	61.50^a	66.01^c	65.52^b	65.65^b	65.21^b	66.14^c	67.20^c
Fibre digestibility	46.91^b	41.06^a	54.47^b	54.45^b	56.03^c	54.10^b	56.19^c	54.45^b
Organ weight								
Weight of crop	0.51^b	0.55^c	0.50^a	0.51^b	0.50^a	0.51^b	0.50^a	0.51^b
Weight of proventriculus	0.47^b	0.49^b	0.44^a	0.45^a	0.45^a	0.44^a	0.44^a	0.44^a
Weight of gizzard	2.21^b	2.30^c	2.16^a	2.15^a	2.16^a	2.15^a	2.15^a	2.15^a
Weight of liver	0.71^b	1.88^c	1.66^a	1.70^b	1.69^a	1.70^b	1.66^a	1.70^b

**Means within the same row followed by different subscript are significantly different (P=.05)*

4. CONCLUSION

Increased level of rice husk without commercial enzyme supplementation resulted in poor feed conversion and feed digestibility. More so, utilization of rice husk without commercial enzyme supplementation resulted in modification of the structure and function of the crop, proventriculus, gizzard and liver. Nutrient digestibility appreciably improved when rice husk-diets were supplemented with commercial enzyme. Farmers could replace 50% of maize with rice husk in practical diet for broilers but after supplementation with any of the commercial enzymes used in this work. The use of commercial enzymes is advantageous in the utilization of high fibre chicken diets with a low cost of production.

ETHICAL APPROVAL

Principles of laboratory animal care were followed, as well as specific national laws where applicable.

COMPETING INTERESTS

Authors declare that no competing interests exist.

REFERENCES

1. Dalibord, Enzyme update on targeting the Vegetable Cell wall. Feed International. Watt publication; 2006.
2. Jozefiak D, Rutkowski A, Martin S. The effects of dietary fibre fraction from different cereals and microbial enzyme supplementation on performance, feed viscosity and short chain fatty acid concentration in caeca of broiler chickens. Anim. Feed Sci. 2004;(13):487-496.
3. Peter R, Hoffman D. Effect of enzyme in poultry feed. Watt publication; 2002.
4. Atteh J. Principles and practices of livestock feed and manufacturing.1st ed. Ilorin: Adlek Printer; 2002.
5. Aduku A. Tropical feedstuff table. Department of Animal Science, Ahmadu Bello University, Samaru, Zaria; 1993.
6. Grieshop C, Reese D, Fahey G. Non-starch polysaccharides and oligosaccharides in swine nutrition. Pg.107 in swine nutrition A.J. Lewis and L.L Southern Eds. CRC Press, Boca Raton FL; 2001.
7. Selle J, Ravindran V. Microbial phytase enzyme in poultry nutrition. A Review Anim. Feed Sci. Technol. 2007;(35):1-41.
8. Babalola TOO, Apata DF, Atteh JO. Effect of β-xylanase supplementation of boiled castor seed meal-based diets on the performance, nutrient absorbability and some blood constituents of pullet chicks. Tropical science. 2006;46(4):216-223.
9. Association of Official Analytical and Applied Chemists. Official Methods of Analysis 18th edition: Washington D.C, U.S.A; 2008.
10. Cullison AE. Feeds and feeding 3rd ed. Reston Publishing Company Inc., Reston, Virginia, 22090; 1982.
11. Steel RG, Torrie JH. Principle and procedure of a statistics biometrical approach (3rd edition). New McGraw-York: Hill; 1990.
12. Duncan DE. Multiple Ranges and Multiple F-tests Biometrics. 1955;(11):1-42.
13. Fernando R, Paulo R. The quest for improved fibre utilization, feed industry network. Com/Feed international; 2008.

14. Sriver JC, Carter SD, Sutton BT, Petty LA. Effects of adding fibre sources to reduced crude protein, growth performance and carcass traits of finishing pigs. J. Anim. Sci. 2003;(81):492-502.
15. Atteh JO. Use of enzyme to improve the nutrient value of wheat inclusion. A paper presented on 2-day seminar on array of tailor made biotechnical improver for flour milling and baking industry. Sheraton Hotel Lagos, Nigeria; 2000.
16. Lee JJ, Sally AR, Jerry S. Feeding by-products high in concentration of fibre to non-ruminants. A paper presented at the third National Symposium on alternative feeds for livestock and poultry held in Kansas City MO; 2003.
17. Carre M. Features of feed enzymes. Feed international, Watt; 2002.
18. Jorgensen HZ, XinQuan KE, Krudse BO, Zhao XQ. The influence of dietary fibre source and level on development of the gastrointestinal tract digestibility and energy metabolism in broiler chickens. Br. J. Nutr. 1996;(75):379-395.
19. Vander M, Dikken G. Duck keeping in the tropics, 2nd ed. Macmillan Netherlands; 2004.
20. Suzuki K, Tanaka M, Watanbe N, Saito S, Nonaka H, Miyajima A. P75 Neurotrophin receptor is a marker for precursors of stellate cells and fibroblasts in mouse fetal liver' Gastroenterology. 2008;135(1):270-281.
21. Mclean JA, Acamanic T, Brown D, Nelson M. The influence of various enzymes mixtures on the growth, feed intake, feed conversion and intestinal viscosity of broilers fed maize, soya beans diet. World Poultry Conf; 2000.
22. Fasuyi AO. Effect of cellulase/glucanase/xylanase enzymes combination on nutrients utilization of vegetable meal (*Amaranthus cruentus*) fed as sole dietary protein source in rat assay. International Journal of Food Science and Technology. 2010;45:683-689.

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