Original Research Article

Effects of Dietary Levels of Rice Husk Supplemented with or without Commercial Enzymes on Performance, Nutrient Retention and Gastro-intestinal Tract Characteristics of Broilers

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ABSTRACT

Aims: This experiment was carried out to investigate the effects of dietary levels of rice husk with or without commercial enzyme on performance, nutrient retention and gastro-intestinal tract of chicken broilers.

Study design: The experimental design was a 2 × 4 factorial combination of dietary levels of rice husk with or without recommended levels of commercial enzymes.

Place and Duration of Study: The study was carried out at the Department of Animal Production, Faculty of Agriculture, University of Ilorin, Nigeria. The study lasted for eight weeks.

Methodology: One hundred and ninety-two (192) one-day old unsexed Arbor acre broilers were used. The experimental diet was a 2 × 4 factorial combination of dietary levels of rice husk with or without recommended levels of commercial enzymes. Rice husk was added at 0 or 25% at the expense of maize in the control diet each of the diet was tested without (0ppm) or with enzymes namely: Phytase (100ppm), Nutrase xyla (150ppm), or Grindazyme (350ppm) during a trial that lasted 8 weeks. Experimental diets and water were supplied *ad-libitum* to the birds from day old to eight weeks and were subjected to recommended routine vaccination programme. 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, killed by neck decapitation and eviscerated. The crop, proventriculus, gizzard, liver and pancreas were removed and weighed.

Results: The experiment showed that increase in dietary level of rice husk at the expense of maize without commercial enzyme supplementation caused significant ($P= .05$) decrease in weight gain, feed conversion ratio and nutrient digestibility. There were significant ($P= .05$) interactions between dietary levels of rice husk and commercial enzyme on performance, nutrient digestibility and gastro-intestinal tract characteristics of chicken broilers. Hypertrophies of the organs were observed in birds fed rice husk without enzyme supplementation. However, those birds fed rice husk supplemented with enzyme attenuated the increased function of the investigated organs. It was observed 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.

Conclusion: The use of commercial enzyme is advantageous in the utilization of high fibre

chicken diets. Commercial enzyme supplementation resulted in increased weight gain, better feed conversion ratio and improved nutrient digestibility with a beneficial reduction in cost of production.

Keywords: Broiler, Commercial Enzyme, Effect, 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]. 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. Hence, the need to investigate the effect of dietary levels of rice husk supplemented with or without enzyme on the performance, nutrient digestibility and gastro-intestinal tract characteristics of broilers.

2. MATERIAL AND METHODS

One hundred and ninety-two (192) one-day old mixed sex broilers of commercial strain (Arbor acre) were used for this experiment. The ambient temperatures during the period of study were 26.6^{o}C (morning), 33.1^{o}C (afternoon) and 30.7^{o}C (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 eight weeks. The experimental diet consisted of a 2 × 4 factorial combination of replacement of maize with rice husk and types of enzymes namely: Phytase (100ppm), Nutrase xyla (150ppm), or Grindazyme (350ppm), and without enzyme (0ppm). 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 recommended level. Thus, there were 8 treatments each with 3 replicate cages of 8 chicks (192birds). Experimental diets and water were supplied *ad-libitum*, to the birds and were subjected to routine vaccination programme. The birds were weighed at the beginning of the trial with an average weight of 54.85g and there after every week. Mortality was recorded daily. A nutrient digestibility trial was undertaken when the birds were 3 weeks

old. Weighed quantities of feed were supplied and excreta collected over a 72 hour using the total collection method. The excreta samples were weighed, oven dried at 70^0C 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 faeces

Diet and excreta samples were subjected to proximate analysis using method of AOAC [8]. Crude protein was determined using the Kjeldahl procedure. Ether extract was determined by subjecting the samples to petroleum ether (b.p 60 - 80^0C) extraction in a soxhlet apparatus. Crude fibre of the samples was determined by the method described by Cullison [9]. At the end of the feeding trial, 3 birds per replicate were randomly selected, killed by neck decapitation and eviscerated. The crop, proventriculus, gizzard, liver and pancreas were removed and weighed to determine the impact of enzyme usage on the gastro-intestinal tract. Data collected were subjected to statistical analysis using the model for 2 way factorial design [10], significant difference between treatments means were separated using the Duncan's Multiple Range Test [11].

Table 1: 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
Enzyme I	-	100ppm	-	-	-	100ppm	-	-
Enzyme II	-	-	150ppm	-	-	-	150ppm	-
Enzyme III	-	-	-	350ppm	-	-	-	350ppm
Analyzed nutrient content								
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

*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% .

- Treatment not included, Enzyme I- Nutrase xyla 100ppm, Enzyme II- Roxayzme G 150ppm, Enzyme III- Grindazyme 350ppm.

3. RESULTS AND DISCUSSION

The feed became bulky as 50% of the maize in the control diet was replaced with rice husk and there was an increase in feed intake by birds fed rice husk without enzyme supplementation 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). There was no significant effect of enzyme supplementation 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 there was significant interaction between rice husk level and type of enzyme on 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 [12]. 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 [13]. 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 monogastric 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 3a 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= .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. There were significant interaction between dietary level of rice husk and type of enzyme on protein and fibre digestibility, details as shown in Table 3b. Some authors [14;15;16] 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 monogastric animal [17]. 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 [18]. Table 4a 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. There were significant interactions between dietary levels of rice husk and type of enzymes on weight of crop, proventriculus, gizzard and liver (*P*= .05), details of which are shown in Table 4b. 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 [19]. 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 digesta and showed a marked improvement on the various morphological effects of feeding fibrous materials to chicken broilers. A viscous digesta 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.* [20] observed that addition of enzymes to monogastric feed reduced viscosity of the intestinal digesta 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 [21].

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 (ppm)	NS	*	NS
No enzyme (0ppm)	58.50	21.92[a]	2.67
Enzyme I (100ppm)	62.22	23.72[b]	2.62
Enzyme II(150ppm)	62.20	23.66[b]	2.63
Enzyme III(350ppm)	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.

	No enzyme	Enzyme I	Enzyme II	Enzyme III
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 3a: 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 (ppm)	NS	*	NS	*	NS
No enzyme (0ppm)	88.35	63.81	82.62	48.50	2.29
Enzyme I (100ppm)	88.44	68.30	84.20	56.00	2.27
Enzyme II(150ppm)	88.42	68.20	84.21	56.00	2.21
Enzyme III(350ppm)	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

241 **Table 3b: Details of interaction between levels of rice husk and commercial enzymes**
242 **on protein and fibre digestibility.**

	No enzyme	Enzyme I	Enzyme II	Enzyme III
Protein digestibility				
Rice husk (%)				
0	64.57[b]	66.01[b]	65.65[a]	66.14[a]
25	61.50[a]	65.52[a]	65.21[a]	67.20[b]
Fibre digestibility				
Rice husk (%)				
0	46.91[b]	54.47[a]	56.03[b]	56.19[b]
25	41.06[a]	54.45[a]	5b.10[a]	54.45[a]

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244 Different superscripts indicate significant differences (P= .05)

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Table 4a: 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 (ppm)	*	*	*	*	NS
No enzyme (0ppm)	0.57[a]	0.50[a]	2.20[a]	1.78[a]	0.20
Enzyme I (100ppm)	0.46[b]	0.43[b]	2.10[b]	1.66[b]	0.19
Enzyme II(150ppm)	0.45[b]	0.44[b]	2.11[b]	1.66[b]	0.20
Enzyme III(350ppm)	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 4b Details of interaction between dietary levels of rice husk and types of commercial enzyme on weight of crop, proventriculus, gizzard and liver

Organ	No enzyme	Enzyme I	Enzyme II	Enzyme III
Crop				
Rice husk (%)				
0	0.51^{b}	0.50^{a}	0.50^{a}	0.50^{a}
25	0.55^{c}	0.51^{b}	0.51^{b}	0.51^{b}
Proventriculus				
Rice husk (%)				
0	0.47^{b}	0.44^{a}	0.45^{a}	0.44^{a}
25	0.49^{b}	0.45^{a}	0.44^{a}	0.45^{a}
Gizzard				
Rice husk (%)				
0	2.21^{b}	2.16^{a}	2.16^{a}	2.15^{a}
25	2.30^{c}	2.15^{a}	2.15^{a}	2.16^{a}
Liver				
Rice husk (%)				
0	1.71^{b}	1.66^{a}	1.67^{a}	1.66^{a}
25	1.88^{c}	1.70^{b}	1.70^{b}	1.70^{b}

Different superscripts indicate significant differences (P= .05)

4. CONCLUSION

Increased level of rice husk and without commercial enzyme supplementation resulted in poor feed conversion, difficulty in feed digestibility. More so, increased level 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 the high fibre chicken diets were supplemented with the different types of commercial enzyme. Farmers could replace 50% of maize with rice husk in the diet of broilers with the rice husk supplemented with any of the commercial enzyme for better results at low cost of production. The use of commercial enzyme is advantageous in the utilization of high fibre chicken diets.

COMPETING INTERESTS

Authors declare that no competing interests exist.

AUTHORS' CONTRIBUTIONS

AOO and AJO designed the study and performed the statistical analysis. OPT handled the feeding trial. AOO wrote the first draft of the manuscript. AOO and AJO managed the analyses of the study while AOO managed the literature searches. All authors read and approved the final manuscript.

ETHICAL APPROVAL (WHERE EVER APPLICABLE)

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

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