

Original Research Article

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

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ABSTRACT

Aims: This experiment was carried out to assess investigate the effects of dietary inclusion of levels of rice husk supplemented 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 two dietary levels of rice husk (0 or 25%) with four or without levels of different recommended levels of commercial enzymes (without enzyme (0 ppm), 100 ppm of Phytase, 150 ppm of Nutrase xyla, or 350 ppm of Grindazyme).

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 design was a completely randomized design with a 2 × 4 factorial arrangement 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, and each experimental of the diet was tested during without (0ppm) or with enzymes namely: Phytase (100ppm), Nutrase xyla (150ppm), or Grindazyme (350ppm) during a 56-day feeding trial in triplicate that lasted 8 weeks. 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 dayold to day 56eight weeks, and chicks were subjected to the 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, euthanatizedkilled by neck decapitation, thenand eviscerated, and -tThe crop, proventriculus, gizzard, liver and pancreas weights wereer determinede removed and weighed.

Results:- The resultsexperiment showed that an increase in the dietary level of rice husk at the expense of maize without commercial enzyme supplementation significantly decreased caused significant ($P \leq 0.05$) decrease in weight gain, feed conversion ratio and nutrient digestibility. There were significant ($P \leq 0.05$) interactions between dietary levels of rice husk and the inclusion of commercial enzymes on performance, nutrient digestibility and gastro-intestinal tract characteristics of chicksen broilers. Hypertrophyies of the digestive organs waswere observed in birds fed rice husk without enzyme supplementation. However, this effect was those birds fed rice husk supplemented with enzyme attenuated with the inclusion of commercial enzymes the increased function of the investigated organs. Results obtained showed 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 for chicks. The dietary sCommercial enzyme supplementation with commercial enzymes resulted in increased the weight gain, better feed conversion ratio and improved nutrient digestibility in broilers, which supposes ith a beneficial reduction in the production costs of production.

Keywords: Broiler, Commercial Enzyme, Effect, Digestive oOrgan, 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 Polysaccharides {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 fibreer in the diet for proper functioning of the digestive organs. Dietary fibreer has been observed as a diluent of the diet and, often, an anti-nutritional factor. Nonetheless, moderate

amount of fibre 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 fibre 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. Hence, the need to investigate the effect of dietary levels of rice husk supplemented with ~~or without commercial~~ enzymes 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 acres) were used for this experiment. The ambient temperatures during the period of study were 26.6°C (morning), 33.1°C (afternoon) and 30.7°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 56 dayseight-weeks. 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: 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~~ recommended by the provider. Thus, there were 8 dietary treatments each with 3 replicate cages of 8 chicks (192 birds). Experimental diets and water were supplied *ad-libitum*, ~~to the birds and~~ birds were subjected to a routine vaccination programme. The birds were weighed at the beginning of the trial (with an average weight of 54.85 g), and ~~after there after~~ every week. Mortality was recorded daily. A nutrient digestibility trial was undertaken when the birds were 3 weeks old. ~~Total Weighed quantities of feed offered were supplied and collected excreta were weighed/collected~~ over a 72 hour using the total collection method. The excreta samples were weighed, oven dried at 70°C and weighed again to determine their dry matter. Dried excreta were ground prior to chemical analyses. Nutrient digestibility was calculated using the formula:

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

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 methods 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°C) extraction in a soxhlet apparatus. Crude fibre of the samples was determined by the method described by Cullison

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[9]. At the end of the feeding trial, 3 birds per replicate were randomly selected, ~~euthanatized~~killed by neck decapitation and eviscerated. The crop, proventriculus, gizzard, liver and pancreas were removed and weighed to determine the effect of dietary treatments 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: Ingredient and chemical cComposition 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
<u>Nutrase</u> <u>XylaEnzyme-I</u>	-	100ppm	-	-	-	100ppm	-	-
<u>Enzyme</u> <u>II-Roxazyme</u>	-	-	150ppm	-	-	-	150ppm	-
<u>Enzyme</u> <u>III-Grindazyme</u>	-	-	-	350ppm	-	-	-	350ppm
Analyzed nutrient content <u>(% dry matter)</u>								
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%, Dimethionine 0.10%, premix 0.25(provided per Kg) Vit.A 4,000IU; Vit.D 8000IU; Vit.E 4,000mg; Vit.K 900mg; Vit.B₁ 500mg; Vit.B₂ 2000mg; Vit.B₃ 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.

KEY POINT TO BE DETAILED:

-AUTHORS MUST INCLUDE THE PROVIDERS OF THESE ENZYMES.

-WHICH TYPES OF ENZYMES INCLUDE EACH COMMERCIAL ENZYME PREPARATION?

3. RESULTS AND DISCUSSION

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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 ($P \leq 0.05$). 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 ($P \leq 0.05$), 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. 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 ($P \leq 0.05$), 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

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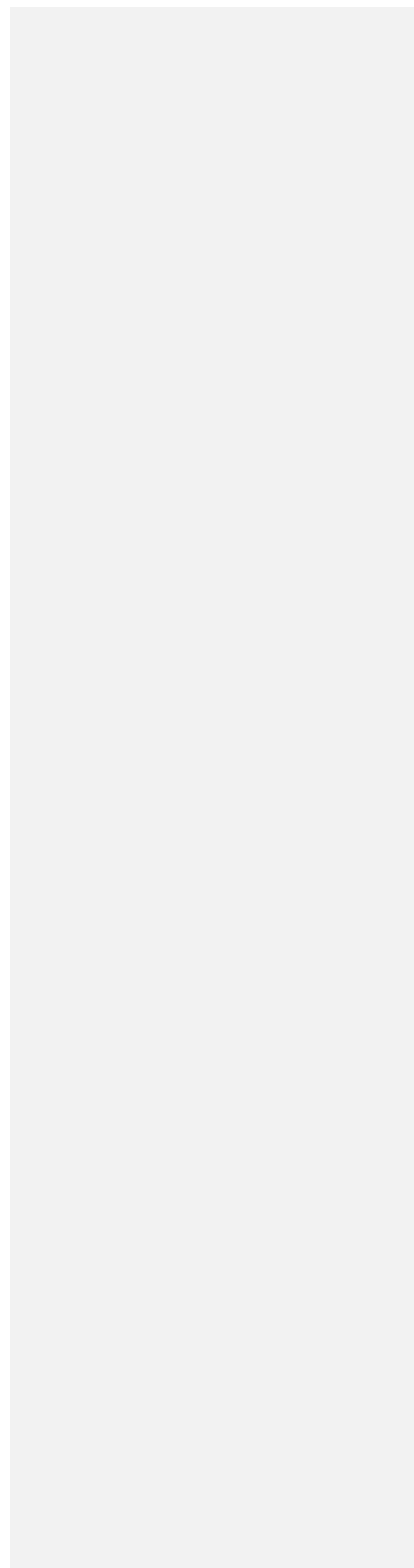
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163 due to the need for more grinding activities resulting in increased musculature consequent
164 on increased fibre content of the diet. The liver equally increase in size in the birds fed rice
165 husk without enzyme supplementation, liver plays a major role in metabolism, it produces
166 bile an alkaline compound which aids in digestion via emulsification of lipids. The liver's
167 highly specialized tissues regulate a wide variety of high volume biochemical reactions,
168 including the synthesis and breakdown of small and complex molecules [19]. The various
169 functions of the liver are carried out by the liver cells; these cells can differentiate and
170 probably increase with the need for more work. With enzyme supplementation a greater
171 proportion of non-starch polysaccharide (NSP) was digested thereby attenuating the
172 increased function of the responding organs. NSP enzymes acting on the feed carbohydrate
173 fraction are widely used for the capacity to increase feed digestibility and to decrease the
174 anti-nutritional effects of certain carbohydrates. Enzyme supplementation irrespective of the
175 type reduces the workload of the organs investigated. Addition of enzyme to broiler's feed
176 reduced viscosity of the intestinal digesta and showed a marked improvement on the various
177 morphological effects of feeding fibrous materials to chicken broilers. A viscous digesta
178 slows down digestion processes and encapsulates nutrients, making them inaccessible to
179 digestive enzymes, supplementation of feed with enzyme help to address NSP viscosity.
180 Mclean *et al.* [20] observed that addition of enzymes to monogastric feed reduced viscosity
181 of the intestinal digesta and showed a marked improvement on the various morphological
182 effects of feeding fibrous materials to non-ruminants. Enzyme supplementation has a
183 beneficial effect on the performance of animals [21].
184
185



187 THE NUMBER OF TABLES MUST BE REDUCED. THERE ARE TOO MANY TABLES IN THIS MANUSCRIPT.
 188 I STRONGLY SUGGESTED TO AUTHORS TO MODIFY THE PRESENTATION OF RESULTS IN THREE TABLES AS DETAILED
 189 BELOW.
 190
 191 THIS FORMAT OF TABLE SHOWS THE RESULTS OF THE EIGHT DIETARY TREATMENTS, AND AT THE SAME TIME IT ALLOWS TO
 192 READERS TO CLEARLY MAKE DIFFERENT COMPARATIONS AMONG THEM.
 193 I

	control				Rice hush					
	1	2	3	4	1	42	43	24	Rice hush X enzyme3	SEM4
Feed intake	<u>Mean value</u> ^{a,A}	<u>Mean value</u> ^{a, A}	<u>Mean value</u> ^{a, A}	<u>Mean value</u> ^{a, A}	<u>Mean value</u> ^{a, A}	<u>Mean value</u> ^{a, A}	<u>Mean value</u> ^{a, A}	<u>Mean value</u> ^{a, A}		
Weight gain										
Feed /gain										

197
 198
 199 a Small superscript letters denote significant differences among different enzymes for the same level of rice hush
 200 B Capital superscript letters denote significant differences among different level of rice hush for the same enzyme.
 201
 202

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

[illegible]

60.01 ^b	0	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
	0
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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

	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

	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

	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

	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	
	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	
		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	
		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	
		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
	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
	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
	0
25.50 ^c	22.31 ^b
25.51 ^c	25.51 ^c
19.42 ^a	25
23.80 ^b	23.81 ^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
	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
	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
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
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
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
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
19.42 ^a	
23.81 ^b	23.80 ^b
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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	
23.81 ^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	
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	
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	
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	
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	
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	
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
	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
	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
	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
	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
	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	

	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	

	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	

	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	

	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	
	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	
	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		
	2.51 ^a	2.50 ^a
2.50 ^a		25
2.70 ^b		2.53 ^a
2.52 ^a	2.53 ^a	
	2.50 ^a	2.50 ^a
25		2.70 ^b
2.53 ^a		2.52 ^a
2.53 ^a		
	2.50 ^a	
25		2.70 ^b
2.53 ^a		2.52 ^a
2.53 ^a		
	25	
2.70 ^b		2.53 ^a
2.52 ^a	2.53 ^a	
	25	2.70 ^b
2.53 ^a		2.52 ^a
2.53 ^a		
	2.70 ^b	2.53 ^a
2.52 ^a	2.53 ^a	
	2.53 ^a	2.52 ^a
2.53 ^a		
	2.52 ^a	2.53 ^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

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

No enzyme	Enzyme I	Enzyme II	Enzyme III
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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

Different superscripts indicate significant differences (P= .05)

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 ^b	1.70 ^a	1.70 ^a	1.70 ^a

Different superscripts indicate significant differences (P= .05)

4. Conclusion

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

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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