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Research Article
Growth Performance and Haematological Indices of Broiler Chickens Fed on Rice Husk Supplemented with Oyster Mushroom (*Pleurotus ostreatus*) and Brozyme Enzyme

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Abstract
Objective: The present study aimed to investigate the effects of native rice husk on the growth performance and haematology of Broiler Chickens. **Materials and Methods:** A total of 210 day old broiler chicks of Arbor Acre breeds were fed starter and finisher diets containing (I) *Pleurotus ostreatus* fungus fermented rice husk (PFFRH) and (ii) exogenous brozyme enzyme supplemented rice husk (ESRH). Different levels of the test feeds (10, 20 and 30%) were included in the broiler diets to replace maize at the two phases. The birds were distributed in a completely randomized design to make a 2×3 factorial arrangement that gave 7 treatments and 3 replicates with 10 birds in each replicate. **Results:** The results showed that birds fed on the control diet and 10% PFFRH inclusion in the diet, had the highest ($p<0.05$) average daily weight gain (ADWG), the best feed conversion ratio (FCR) and protein efficiency ratio (PER) for the starter and finisher phases and for the entire 56 days. However, all the parameters were at the lowest level ($p<0.05$) in the birds fed diet supplemented with 30% ESRH. The treatment interaction effects were the highest ($p<0.05$) in birds fed the control diet at the starter phase while the treatment groups (PFFRH and ESRH) had similar values for growth parameters at the finisher phase and for the entire experimental period. The haematology and serum chemistry indices included packed cell volume (PCV), red blood cell (RBC), white blood cell (WBC), haemoglobin concentration (Hbc), total protein, albumin, globulin, creatinine, cholesterol, aspartate amino transaminase, alanine transaminase and alkaline phosphatase were within the acceptable range for all the treatment groups. **Conclusion:** Diets supplemented with 10% PFFRH and 10% ESRH could be optimally used in poultry feed without negative effects on the growth and health status of the broiler birds.

Key words: Poultry feed, rice husk, serum chemistry of broilers, maize, fungus, enzyme

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Poultry meat serves as an important source of high quality animal protein in the world. Increase in population and urbanization has led to an upsurge in the demand for poultry products in terms of meat and eggs in Nigeria.

Provision of good quality feeds and the competition with man for the conventional feedstuff by livestock has been a major challenge to poultry farmers in Nigeria[1] and has become an important focus for animal nutrition research. Therefore, to address the situation, crop residues such as rice husk and other agro industrial wastes are being evaluated to assess their nutritive potential with a view to use them as component of farm animal's diets.

Several factors have been identified which limit the use of rice husk as non-conventional feedstuff in broiler chicken feed in particular. Some of these limitations include fibre content, poor nutritive value and bulkiness[2-4]. As a result, its inclusion in poultry diets often give negative responses with corresponding reduction in nutrient utilization and precipitation of metabolic dysfunctions that leads to growth depression when ingested by non-ruminants[5-7]. Nevertheless, some studies indicated that increasing the fibre content in the diet of poultry and turkey enhanced growth performance because of some of the gut health benefits[4,8,9].

Various processing techniques have been documented and applied to reduce the fibre content[10]. The methods to reduce the limiting factors in rice husk utilization include soaking in hot water, irradiation, acid and alkaline hydrolysis, ensiling, fermentation and use of enzymes and antibiotics[2,11]. Some of these techniques are defective because of their inability to adequately biodegrade lignin[10]. The application of biotechnology or bioconversion to convert agro by products and farm wastes into beneficial animal feeds has been explored to degrade the cellulose cell wall. This process take the advantage of micro organisms such as bacteria and fungi's ability to synthesize enzymes that biodegrade the cell wall of fibrous feedstuff. Fungi such as mushrooms have been documented to be very useful in the recycling of organic wastes with efficient capacity to return nutrients to the ecosystem[12,13]. Fungi and bacteria have been identified as microbes that possess the ability to biodegrade lignin however, fungi was noted to have a faster rate of degradation of lignin than bacteria[10]. *Pleutrotus ostreatus* or oyster mushroom has been reported to bioconvert lignocellulosic materials due to the secretion of extracellular enzymes[14-16].

Reports have shown that the use of microbial exogenous enzymes (with xylanase activity) in poultry and livestock feeds remarkably improved nutrient utilization and were noted to destroy antinutrient factors, manipulate gut flora population as well as supplementing endogenous enzymes activities[17,18].

Studies have shown that the haematology and serum biochemical indices are veritable coefficients to ascertain the health and nutritional status of animals, their physiological dispositions as well as assessment of nutritional standards of feeds, acceptability and toxicity to animals[19,20]. Therefore, a close monitoring of the haematology and serum biochemical parameters becomes imperative in the quest for alternative non-conventional feed resources and their nutritional effects on the animal.

This study therefore compared the response of broiler chicken to diets containing *Pleurotus ostreatus* fungus fermented rice husk (PFFRH) and enzyme supplementation of feeds containing same test feedstuff (ESRH).

MATERIALS AND METHODS

Site of experiment: The study was carried out at the Poultry Research Unit of the Teaching and Research Farm, Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti, Nigeria. The town is located on longitude 7°40 North andlatitude 5° 15 East of the Greenwich Meridian in the rainforest zone with average rainfall of 1500 mm, ambient temperature between 22 and 38°C and relative humidity of 70% in the southwestern Nigeria (www.ekitistate.gov.ng).

Preparation of *Pleurotus ostreatus* test feed and the experimental diets: Pure culture of *P. ostreatus* was obtained from the Department of Applied Biological Science, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. The fungus sample was maintained on Potato Dextrose Agar (PDA) slant, multiplied and stored in a refrigerator at a temperature of 4°C in the Department of Microbiology Laboratory, Ekiti State University, Ado-Ekiti, Nigeria.

The native rice husk was collected from the rice milling centres in Igbemo-Ekiti, Ekiti State, Nigeria and air- dried to a moisture content of about 12%. It was then packed in polythene bags and sterilized in the autoclave at 121°C for 30 min.

The samples were allowed to cool and divided into two equal parts. One part was moistened with distilled water at the rate of 300 mL per kg rice husk and later inoculated with 5 plates of the cultured *P. ostreatus* fungus following the technique described by Aderolu *et al.*[21] Each of the inoculated sample was well mixed, labelled and incubated within an environment of 28°C and 100% relative humidity. The samples were kept in a dark cupboard. The fungus was hereafter added

to the rice husk in a black vat and fermented for 7 days as described by Dairo *et al.*[22]. The *P. ostreatus* fungus fermented rice husk (PFFRH) was harvested after fermentation, air- dried under a shed at diurnal temperature of 31°C to a point when moulds could not grow on it and stored in a jute bag for use. It was later included in the formulated experimental diets at 10, 20 and 30% in replacement for maize (Table 1).

The exogenous enzyme Brozyme (www.zeusindia.net) was obtained from Metro-vet Feeds Ltd., Ado-Ekiti and was added as supplement without further processing to the formulated feed at 10, 20 and 30% dietary inclusion at the rate of 400 g per tonne.

Experimental design and management of animals: The birds were distributed in a completely randomized design with a 2×3 factorial arrangement forming seven treatment groups including a control both at the starter and the finisher phases. The treatment groups had 30 birds and each was replicated thrice, therefore each replicate consisted of 10 birds. The feeding trial lasted for 56 days. The birds were weighed in batches on arrival after allotment to the different treatment groups and replicates on the first day of the experiment and subsequently on weekly basis using a sensitive top loading salter scale.

Feed and water was provided twice a day at 7:00 h and 14:00 h during the different phases and the average daily feed intake (ADFI) in grams was recorded. The starter diet was given for the initial period of 28 days while the finisher diets were fed as a follow up for the same number of days. On the 35th day of the study, two birds per replicate were randomly selected and relocated to the digestibility cage for digestibility studies. They were allowed to acclimatize to their new cage environment for 7 days and fed the experimental diets accordingly hereafter. The feed intake was noted for each replicate and faecal droppings were collected using polythene sheet spread underneath each cell of the cage according to the replicate groups. The droppings were collected daily, feed and feather contaminations were immediately removed and the wet weight was obtained using a sensitive salter top loading balance before air drying for about 24 h. Each daily collection was then dried to a constant weight in the oven at low temperature of 55°C for 72 h.

Chemical analyses: The proximate composition of the native rice husk, *Pleurotus ostreatus* fermented rice husk (PFFRH), experimental feeds and faecal samples were determined using the methods described by AOAC[23]. The crude fibre (CF), neutral detergent fibre (NDF) and acid detergent fibre (ADF)

Table 1: Composition of experimental diets containing PFFRH and ESRH for the broiler starter and finisher phases

	Starter phase							Finisher phase						
	Inclusion of PFFRH with *Pleurotus ostreatus* (%)							Inclusion of ESRH (%)						
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Ingredients	0	10	20	30	10	20	30	0	10	20	30	10	20	30
Maize	55.60	46.60	39.60	31.60	46.60	39.60	31.60	60.60	50.60	45.60	35.60	50.60	45.60	35.60
FFRH		10.00	20.00	30.00	-	-	-	-	10.00	20.00	30.00	-	-	-
EDRH	-	-	-	-	10.00	20.00	30.00	-	-	-	-	10.00	20.00	30.00
Palm oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00	-	-	-	-	-	-	-
SBM *(FFSBM)	18.00	18.00	16.00	16.00	18.00	16.00	16.00	18.00	18.00	15.00	15.00	18.00	15.00	15.00
**GNC	19.00	18.00	17.00	15.00	18.00	17.00	15.00	15.00	15.00	13.00	13.00	15.00	13.00	13.00
Fish meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Wheat offal	-	-	-	-	-	-	-	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Oyster shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Bone meal	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Brozyme	-	-	-	-	610.00	720.00	830.00	-	-	-	-	615.00	725.00	835.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Determined analyses (%)														
Crude protein (%)	22.68	22.67	21.97	21.90	22.59	21.79	21.70	20.83	20.13	19.78	19.82	19.88	20.34	19.64
Crude fibre (%)	3.56	3.60	3.57	3.61	3.60	3.70	3.61	3.56	3.58	3.61	3.63	3.60	3.59	7.41
Fat (%)	6.72	7.24	6.80	6.78	7.24	6.80	6.78	6.67	6.84	6.74	7.41	6.84	6.74	7.41
ME (MJ)	12.74	12.59	12.53	12.54	12.14	11.62	11.05	13.39	13.20	13.11	12.92	12.75	12.20	11.55

*FFSM: Full fat soybean meal was used at the finisher phase only, **GNC: Groundnut cake·Premix supply the following kg^{-1} feed: 10^4IU vitamin A, 2621 IU vitamin D3, 40 IU vitamin E, 1.6mg Menadione, 2 mg Thiamine, 5.72 Riblovavin60mg Niacin, 3.2 mg pyridoxine, 0.0144 mg B12, 12.32 mg Pantothenic acid, 0.8 mg folic acid, 0.2 mg biotin, 2.5 mg ethoxyquin; 64mg Fe, 96 mg Zn, 96 mg Mn. FFRH: Fungus Fermented rice

were also determined as described by Van Soest *et al.*[24]. The amino acids profile of the PFFRH and the native rice husk (NRH) was determined as reported by Dairo *et al.*[22]. The metabolizable energy was calculated using the Carré *et al.*[25] prediction equations.

Statistical analysis: The data obtained were subjected to analysis of variance (ANOVA) at 5% probability level and means separated by Duncan Multiple Range Test using the Minitab computer package software[26].

RESULTS

The result of the proximate analyses of fungus *Pleurotus ostreatus* fermented rice husk (PFFRH) indicated that it contained 86.71% dry matter (DM), 12.37% crude protein (CP), 12.58% crude fibre (CF), 4.87% ether extract (EE), 40.37% nitrogen free extract (NFE), 18.71% ash, 12.23% acid detergent fibre (ADF) and 12.00% neutral detergent fibre (NDF) and 9.5 MJ metabolizable energy[22].

Starter phase: Table 2 shows the effect of the dietary treatment on the growth performance of the broiler chickens. The average daily weight gain (ADWG) was significantly ($p<0.05$) highest for the birds fed the control diet (21.96±0.77 g) but similar to those birds fed on 10% PFFRH and 10% ESRH (20.55±3.33 g and 20.03±4.06 g respectively) and lowest ($p<0.05$) for birds fed 30% ESRH (18.01±0.09 g). The feed conversion ratio (FCR) and protein efficiency ratio (PER) at the end of the 28 days starter period followed the pattern observed for ADWG while the average daily feed intake (ADFI) was not ($p>0.05$) affected. The interaction effects of the treatment (Table 3) showed that birds fed the control diet had significantly ($p<0.05$) highest value (21.96±1.72 g) and similar to those on diets containing PFFRH (19.03±1.34 g) but the least value was obtained from birds fed on ESRH (18.72±0.55 g). However, the FCR was the best in the control group (1.97±0.15) followed by those fed on PFFRH (2.29±0.08) while the chickens fed diets containing ESRH showed the least value (2.36±0.07) ($p<0.05$). The PER had the same pattern. The ADFI was not influenced by the treatment interaction.

Table 2: Growth performance of broiler fed PFFRH and ESRH as component of their feed at starter phase

	Inclusion of PFFRH (%)				Incusion of ESRH (%)		
	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Parameters	0	10	20	30	10	20	30
Initial L/weight	35.00±0.00	34.670±0.58	35.33±1.53	36.67±1.16	36.00±1.73	36.67±1.53	36.67±1.52
Final L/weight	633.30±10.55^{a}	610.000±8.00^{a}	533.30±7.50^{b}	545.70±2.87^{b}	596.44±7.79^{a}	543.70±6.12^{b}	541.00±0.99^{b}
ADWG	21.96±0.77^{a}	20.550±3.33^{a}	18.50±9.09^{b}	18.18±2.14^{bc}	20.03±4.06^{ab}	18.11±6.12^{bc}	18.01±0.09^{c}
ADFI	43.26±2.13	44.000±3.19	44.50±5.99	42.30±5.32	43.45±2.56	43.82±5.12	44.80±1.22
FCR	97.00±0.15^{a}	2.14±0.10^{ab}	2.41±0.03^{bc}	2.33±0.06^{bc}	2.17±0.00^{ab}	2.43±0.01^{bc}	2.49±0.01^{c}
PER	0.51±0.33^{a}	0.470±1.04^{a}	0.42±1.8^{b}	0.43±0.40^{bc}	0.46±1.59^{ab}	0.41±1.20^{bc}	0.40±0.07^{c}

^{a,b,c}Means with the different superscript and in the same row differ significantly ($p<0.05$)

Table 3: Interaction effects of treatment on growth performance of broiler starter chickens

Parameters	Control	PFFRH	ESRH
Initial L/weight (g)	36.44±4.36	35.55±1.08	35.00±1.28
Final L/weight (g)	633.30±27.30^{a}	599.67±17.77^{b}	560.47±13.67^{b}
Average daily gained (g)	21.96±1.72^{a}	19.03±1.34^{b}	18.72±0.55^{c}
Average daily feed intake (g)	43.26±2.89	43.60±1.74	44.69±1.62
Feed conversion ratio (FCR)	1.97±0.15^{a}	2.29±0.08^{b}	2.36±0.07^{c}
PER	0.51±0.01^{a}	0.43±0.70^{b}	0.42±0.33^{c}

^{a,b,c}Means with the different superscript and in the same row differ significantly

Table 4: Growth performance of broiler fed PFFRH and ESRH as component of their feed at the finisher phase

	Inclusion of PFFRH (%)				Incusion of ESRH (%)		
	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Parameters	0	10	20	30	10	20	30
Initial L/weight	633.30±10.55^{a}	610.00±8.00^{a}	533.30±7.50^{b}	545.70±2.87^{b}	596.44±7.79^{a}	543.70±6.12^{b}	541.00±0.99^{b}
Final L/weight	1932.67±32.5^{a}	1921.67±27.70^{a}	1675.67±28.70^{cb}	1393.33±75.10^{d}	1699.00±91.40^{b}	1523.33±92.90^{cd}	1367.67±67.80^{d}
ADWG	46.41±4.09^{a}	46.85±0.89^{a}	35.83±7.33^{c}	29.91±3.50^{d}	41.15±2.51^{b}	34.90±0.55^{d}	29.53±0.96^{d}
ADFI	143.25±9.01	144.19±15.02	145.90±12.09	143.30±3.11	143.99±3.12	143.92±0.98	145.71±7.02
FCR	3.09±00^{a}	3.08±0.09^{a}	4.07±0.01^{c}	4.79±0.07^{d}	3.50±0.05^{b}	4.12±0.1^{d}	4.92±0.03^{d}
PER	0.32±0.05^{a}	0.33±0.06^{a}	0.25±0.61^{c}	0.21±1.12^{d}	0.29±0.80^{b}	0.24±0.56^{d}	0.20±0.14^{d}

^{a,b,c}Means with the different superscript and in the same row differ significantly ($p<0.05$)

Table 5: Interaction effects of treatmentson growth performance of broiler finishers

Parameters	Control	PFFRH	ESRH
Initial L/weight (g)	633.30±27.30[a]	569.67±17.77[b]	543.80±18.67[b]
Final L/weight (g)	1932.67±32.50[a]	1659.17±70.50[b]	1530.00±22.03[c]
Average daily gained (g)	46.41±2.85[a]	37.53±2.73[b]	35.23±1.84[b]
Average daily feed intake (g)	143.25±4.87	144.46±2.87	144.54±2.61
Feed conversion ratio (FCR)	3.09±0.12[a]	3.85±0.27[b]	4.12±0.53[b]
PER	0.03±0.06[a]	0.26±0.09[b]	0.24±.07[b]

[a,b,c]Means with the different superscript and in the same row differ significantly

Table 6: Growth performance of broiler chicken fed FFRH and EDRH as component of their feed for 0-56 days

	Inclusion of PFFRH (%)				Incusion of ESRH (%)		
	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Parameters	0	10	20	30	10	20	30
Initial L/weight	35.00±0.00	34.67±0.58	35.33±1.53	36.67±1.16	36.00±1.73	36.67±1.53	36.67±1.52
Final L/weight	1932.67±32.5[a]	1921.67±27.70[a]	1675.67±28.70[cb]	1393.33±75.10[d]	1699.00±91.40[b]	1523.33±92.90[cd]	1367.67±67.80[d]
ADWG	33.88±0.58[a]	33.70±1.03[a]	29.29±0.53[b]	24.22±1.32[c]	29.70±1.65[b]	26.55±1.63[cb]	23.54±2.92[c]
ADFI	70.22±3.02	71.88±2.98	74.10±1.44	69.90±2.34	71.13±3.11	71.43±4.12	74.21±2.44
FCR	2.07±0.28[a]	2.13±0.10[ab]	2.53±0.09[abc]	2.89±0.36[bcd]	2.40±0.32[abc]	2.69±0.09[cd]	3.12±0.69[d]
Protein intake	14.61±1.59	14.53±1.24	14.66±0.11	13.86±1.44	14.15±1.13	14.54±1.24	14.58±0.17
Nitrogen Retained	1.33±0.25	1.39±0.31	1.09±0.04	0.97±0.44	1.32±0.41	1.28±0.14	1.31±0.01
Nitrogen Digestibility	56.99±0.98[ab]	59.37±5.09[a]	46.51±8.04[ab]	42.69±2.54[b]	55.99±0.07[ab]	54.94±6.09[ab]	56.29±3.79[ab]
PER	1.97±0.23[a]	1.94±0.23[a]	1.61±0.08[bc]	1.33±0.05[cd]	1.70±0.13[ab]	1.42±0.18[c]	1.23±0.19[bc]
Survivability	0.00[b]	0.00[b]	0.00[b]	6.00[a]	0.00[b]	0.00[b]	0.00[b]

[a,b,c]Means with the different superscript and in the same row differ significantly ($p<0.05$)

Generally, the growth pattern appeared similar at this phase for broiler chickens fed PFFRH and ESRH.

Finisher phase: The growth perormance data is shown in Table 4 for the finisher phase. The ADFI was not affected by the dieatary treatments. Though the ADWG were similar for birds fed the control diet (46.41±4.09 g) and those fed on 10% PFFRH diet (46.85±0.89 g) but the values were significantly ($p<0.05$) higher than all the other treatment groups. Birds fed 30% PFFRH, 20% ESRH and 30% ESRH showed the similar ADWG (29.91±3.50 g), (34.90±0.55 g) and (29.53±0.96 g) respectively and were the lowest ($p<0.05$). The FCR and PER followed the same pattern.

Table 5 shows the treatment interaction effects on the finisher's phase. The ADWG were similar for birds fed on the control diet and those fed PFFRH (46.41±2.85 g and 37.53±2.73 g respectively) and higher ($p<0.05$) (53.23±1.84 g) than those fed on ESRH. The FCR and PER followed the same trend.

Growth performance for the entire experimental period (0-56 days): The growth performance of the broiler chickens fed PFFRH and ESRH for the entire experimentalperiod is shown in Table 6. The average daily weight gain (ADWG), feed conversion ratio (FCR) protein efficiency ratio (PER) and apparent nitrogen digestibility coefficients (ANDC) were significantly ($p<0.05$) influenced by the inclusion of the differently treated rice husk (PFFRH and ESRH) whereas the average daily feed intake (ADFI) and nitrogen retention (NR) were not for the 56 days feeding trial. The ADWG were similar in values for the birds fed the control diet and diet containing 10% PFFRH (33.88±0.58 g and 33.70±1.03 g respectively) but the two values were significantly ($p<0.05$) higher than those of the other treatment groups. The lowest value was obtained in birds fed diet containing 30% ESRH. The FCR and percent ANDC values almost followed the same trend whereas the PER did not. This is because the significantly ($p<0.05$) lowest value was recorded in broiler chicken fed diet containing 20% ESRH while the highest PER was recorded for birds fed control diet and diet containing 10%PFFRH (1.94±0.23 and 1.97±0.23 respectively). Generally birds fed PFFRH diets had superior weight gained than those on the ESRH.

Table 7 shows the interaction effects of treatment on the growth performance of the broiler chickens fed diets containing native rice husk fermented with *P. Ostreatus* fungus as well as those supplemented with brozyme enzyme for 0-56 days. The ADWG, FCR and PER values were significantly ($p<0.05$) affected by the interaction effects. The interaction effect was significantly ($p<0.05$) superior for ADWG(33.88±058 g), FCR (2.07±0.20)and PER (1.97±0.23) for birds fed the control diet. The lowest ($p<0.05$) values for ADWG (26.60±2.07 g), FCR (2.75±0.22) and PER (1.45±0.14) was recorded for birds fed diets supplemented with brozyme fibrolytic enzyme. All the other growth performance indices (ADFI, NR and ANDC) were not affected by the interaction of dietary treatments ($p>0.05$).

Table 7: Interaction effects of treatments on growth performance of broilers (0-56 days)

Parameters	Control	PFFRH	ESRH
Initial L/weight (g)	36.44±4.36	35.55±1.08	35.00±1.28
Final L/weight (g)	1932.67±32.50^{a}	1663.56±70.50^{b}	1530.00±22.03^{c}
Average daily gained (g)	33.88±0.58^{a}	29.07±1.26^{b}	26.60±2.07^{c}
Average daily feed Intake (g)	70.22±7.73	71.96±4.60	72.26±4.22
Feed conversion ratio (FCR)	2.07±0.20^{a}	2.44±0.20^{b}	2.75±0.22^{b}
Nitrogen retained (g)	1.33±0.25	1.15±0.27	1.31±0.13
Nitrogen digestibility (%)	56.99±9.98	49.52±9.31	55.74±4.26
Protein efficiency ratio (PER)	1.97±0.23^{a}	1.63±0.08^{b}	1.45±0.14^{b}

^{a,b,c}Means with the different superscript and in the same row differ significantly ($p<0.05$)

Table 8: Haematological indices of broiler chickens fed rice husk treated with *Pleurotus ostreatus* and fibrolytic enzyme (0-56 days)

	Inclusion of PFFRH (%)				Inclusion of ESRH (%)		
	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Parameters	0	10	20	30	10	20	30
Packed cell volume	26.67±0.00^{d}	33.33±0.01^{a}	27.00±0.02^{c}	26.67±0.00^{d}	27.33±0.03^{b}	24.00±0.01^{e}	27.00±0.01^{bc}
Red blood cell (10^6mm^3)	2.60±0.00^{a}	2.58±0.02^{a}	2.07±0.00^{bc}	2.18±0.02^{bc}	2.28±0.02^{b}	1.92±0.00^{c}	2.00±0.04^{b}
White blood cell (10^6 L^{-1})	2.10±0.01^{a}	2.11±0.02^{a}	2.00±0.02^{ab}	1.98±0.00^{ab}	2.00±0.02^{ab}	1.89±0.00^{ab}	1.86±0.01^{b}
Haemoglobin (%)	8.40±0.20^{a}	8.40±0.40^{a}	7.86±0.01^{b}	7.31±0.04^{c}	7.31±0.03^{c}	6.83±0.15^{d}	8.12±0.02^{ab}
MCHC (g dL^{-1})	31.56±0.02^{a}	26.00±0.02^{g}	29.11±0.02^{c}	26.62±0.02^{f}	26.75±0.05^{e}	28.21±0.02^{d}	30.07±0.03^{b}
MCV (fL)	102.57±0.02^{e}	129.19±0.02^{b}	125.07±4.65^{c}	122.34±0.08^{d}	119.87±2.96^{cd}	125.00±0.02^{c}	135.00±0.00^{a}
MCH (pg cell^{-1})	32.31±0.01^{f}	33.56±0.02^{d}	37.97±0.00^{b}	32.57±0.02^{e}	32.06±0.04^{g}	35.26±0.02^{c}	40.60±0.02^{a}

^{a,b,c}Means with the different superscript and in the same row differ significantly ($p<0.05$)

Table 9: Interaction effects of treatments on the haematology of broilers fed diets (0 -56days)

Parameters	Control	PFFRH	ESRH
Packed cell volume	26.67±0.00^{b}	29.00±0.01^{a}	26.11±0.02^{c}
Red blood cell	2.60±0.00^{a}	2.28±0.01^{b}	2.07±0.14^{c}
White blood cell	2.10±0.10^{a}	2.03±0.07^{ab}	1.92±0.01^{b}
Haemoglobin	8.40±0.20^{a}	7.86±0.15^{b}	7.09±0.16^{c}
MCHC (g dL^{-1})	31.56±0.02^{a}	27.24±0.02^{c}	28.34±0.03^{b}
MCV (fL)	102.57±0.20^{b}	124.71±1.58^{a}	127.19±0.99^{a}
MCH (pg cell^{-1})	32.30±0.10^{c}	34.70±0.13^{b}	35.97±0.09^{a}

^{a,b,c}Means with the different superscript and in the same row differ significantly ($p<0.05$)

The haematological parameters monitored were all significantly ($p<0.05$) affected by the dietary treatments (Table 8). The values of the parameters for broiler chickens fed the control diet without the native rice husk were within the range expected in birds fed the normal diets. The values of the red blood cell (RBC) count (2.60±0.0010^6 mm^3), white blood cell (WBC) count (2.10±0.0110^6 L^{-1}) and haemoglobin concentration (Hbc) (8.40±0.20%) were similar in birds fed the control diet and diet containing 10% PFFRH while others were significantly ($p<0.05$) highest among the treatment groups. Broiler chickens fed diet containing 20% ESRH showed the lowest ($p<0.05$) values for red blood cell (RBC) count (1.92±0.0010^6 mm^3), white blood cell (WBC) count (1.89±0.0010^6 L^{-1}) and haemoglobin concentration (Hbc) (6.83±0.15%). However, the packed cell volume (PCV) was 33.33±0.00% for birds fed diets containing 10% PFFRH and significantly ($p<0.05$) higher than others while birds fed on diet containing 20% ESRH had the lowest value (24.00±0.00%) for PCV. The mean corpuscular volume (MCV) (32.31±0.01 pg) and mean corpuscular haemoglobin concentration (MCHC) (102.57±0.02Fl) was the lowest ($p<0.05$) in birds fed on the control diet while the highest values of MCV (40.60±0.02 pg) and MCHC (135±0.00 fL) were recorded for broilers fed diet containing 30% ESRH. All the values monitored did not follow any pattern but appeared to be higher in birds fed PFFRH than those on ESRH.

Table 9 shows the interaction effects of dietary treatment for all the parameters. The PCV (29±0.01%), MCV (127.19±0.99 fL) and MCH (35.97±0.09 pg) were the highest ($p<0.05$) for birds fed PFFRH. The birds fed the control diet had the highest value for RBC (2.60±0.00 10^6 mm^3), WBC (2.1±010^6 L), haemoglobin concentration (8.40±0.20%) while the lowest values were obtained in birds fed ESRH except for MHCH that was recorded in birds fed PFFRH (27.24±0.02 g dL^{-1}).

Table 10 shows the serum chemistry indices namely total protein (TP), albumin, globulin, aspartate amino transaminase (AST), alanine amino transaminase (ALT), alkali phosphatase

Table 10: Serum chemistry of broiler chickens fed diets containing fungus fermented and enzyme supplemented rice husk (0-56 days)

	Inclusion of PFFRH (%)				Inclusion of ESRH (%)		
	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Parameters	0	10	20	30	10	20	30
Total Protein (mg dL^{-1})	3.12±0.06^{b}	2.95±0.15^{c}	2.44±0.14^{d}	2.36±0.00^{d}	2.43±0.05^{d}	3.57±0.07^{a}	3.27±0.08^{b}
Albumin (mg dL^{-1})	1.15±0.87	1.14±0.94	1.12±0.03	0.79±0.61	1.15±0.02	1.14±0.03	1.12±0.02
Globulin (mg dL^{-1})	1.97±0.87^{abc}	1.79±0.04^{abc}	1.32±0.03^{c}	1.57±0.61^{bc}	1.28±0.02^{c}	2.43±0.03^{a}	2.15±0.02^{ab}
AST (IU L^{-1})	200.00±21.79^{d}	213.00±13.32^{cd}	240.00±13.08^{ab}	223.23±2.35^{bc}	243.23±5.09^{b}	246.27±1.18^{a}	250.10±7.02^{a}
ALT (IU L^{-1})	5.60±0.17	6.33±0.02	6.31±0.94	6.40±0.80	6.33±0.20	5.83±1.48	5.71±0.46
ALP (IU L^{-1})	46.15±2.62	48.79±4.74	47.20±3.76	44.10±7.47	46.64±2.60	46.31±1.18	44.18±1.37
Creatinine (mg dL^{-1})	0.17±0.01	0.12±0.00	0.16±0.09	0.11±0.01	0.12±0.02	0.17±0.02	0.11±0.01
Cholesterol (mg dL^{-1})	131.75±1.03^{a}	98.30±4.04^{b}	93.75±0.01^{b}	96.90±5.37^{b}	94.57±0.01^{b}	98.983±10.03^{b}	94.21±0.99^{b}

^{a,b,c}Means with the different superscript and in the same row differ significantly ($p<0.05$). AST: Aspartate amino transaminase, ALT: Alanine amino transaminase; ALP: Alkaline phosphatase

Table 11: Interaction effects of treatments on the serum chemistry of broilers (0-56 days)

Parameters	Control	FFRH	EDRH
Total protein (mg dL^{-1})	3.12±0.06^{a}	2.58±0.10^{b}	3.09±0.07^{a}
Albumin (mg dL^{-1})	1.15±0.87	1.02±0.22	1.14±0.02
Globulin (mg dL^{-1})	1.97±0.87	1.56±0.22	1.95±0.02
AST (IU L^{-1})	200.00±21.79^{c}	225.52±9.58^{b}	246.57±4.43^{a}
ALT (IU L^{-1})	5.60±0.17	6.35±0.59	5.96±1.05
ALP (IU L^{-1})	46.15±2.62	46.70±5.32	45.71±1.72
Creatinine (mg dL^{-1})	0.17±0.07	0.13±0.05	0.13±0.05
Cholesterol (mg dL^{-1})	131.75±1.03^{a}	96.32±3.26^{b}	95.87±3.06^{b}

^{a,b,c}Means with the different superscript and in the same row differ significantly ($p<0.05$)

(ALP) and creatinine. Cholesterol value was significantly ($p<0.05$) higher in broiler birds fed the control diet (131.75±1.03 mg dL^{-1}) while the Cholesterol values were similar and the lowest ($p<0.05$) for birds fed on the other treatment diets. Aspartate amino transaminase (AST) value was significantly ($p<0.05$) highest (246.27±1.18 IU L^{-1}) and similar for birds fed diet containing 20% ESRH, 30% ESRH and 20% PFFRH whereas the lowest ($p<0.05$) value (200±21.79 IU L^{-1}) was recorded for the control group. The pattern followed by the globulin was distinct but birds fed on the control diets and those fed diet containing 10% PFFRH, 20% ESRH, 30% ESRH all had similar values that ranged from 2.43±0.03 mg dL^{-1} -1.79±0.04 mg dL^{-1} while birds fed diet with 10% ESRH recorded the lowest values (1.28±0.02 mg dL^{-1}) ($p<0.05$) (Table 10).

Table 11 shows the treatment effects on the birds' serum chemistry. The total protein values (TP) were similar (3.12±0.06 mg dL^{-1}) and higher in the control group and 30% ESRH (3.09±0.07 mg dL^{-1}). The AST values was lowest ($p<0.05$) for birds fed on the control diet but highest for birds fed diet containing 30% ESRH (Table 11). Creatinine, alanine transaminase, alkali phosphatase, albumin and globulin were not influenced ($p<0.05$) by the treatment effects.

DISCUSSION

Growth performance: The average feed intake of the broiler chickens were not affected across the treatments groups. This may be due to the increased fibre content of the diets as the level of the dietary rice husk inclusion increased either as PFFRH or ESRH. A general increase in feed intake would have been expected as birds eat to meet their energy needs but this might have been mitigated by the nature or type of fibre in the rice husk in the diets that is largely composed of lignocellulose made up of cellulose and hemicellulose. The cellulose is in β (1→4) glucose chain linked bond with different layers joined by hydrogen bonds and makes it resistant to degradation by the enzymes produced in the digestive system of the birds. In addition, lignin contain hemicellulose that are made up of pentose sugars such as arabinose galactose, mannose and xylose coupled with the existence of some alcohol derivatives like p-coumaryl alcohol, coniferyl alcohol and sinapyl alcohol all of which polymerised to form the mesh-structured microfibril that constitute the cell wall in plants tissues[27,28]. This arrangement brings about different viscous properties of the fibre when dissolved in the intestine of the broiler chickens and could lead to 'gut filling' experienced by the birds bringing about a reduction in the digesta rate of flow in the intestinal lumen with consequential expectation of reduced feed intake[4,29,30]. However, the similarities in the intake of the birds across the treatments may be due to 'decreased effect' on feed intake consequential to "gut filling" experienced by the birds as explained above. Therefore, expected increase in feed intake as the fibre constituent of the rice husk increased in the experimental diets was cancelled out.

The growth performance indicated the broiler chickens fed *Pleurotus ostreatus* fermented native rice husk both at the starter and finisher phases and the entire period of the feeding trial had higher weight gain than those fed on the brozyme supplemented diets containing the same test feed. *Pleurotus ostreatus* is a fungus that has efficient capacity to degrade lignin which are components of most fibrous agricultural wastes. It was described to be an edible mushroom that has lignin degrading power similar to ligninolytic white rot fungi endowed with the most efficient capacity for biotransformation of wastes[31] because it contains xylanases (EC 3.2.1.8), cellulase (EC 3.2.1.4) and laccases (EC 1.10. 3.2)[32,33]. The presence of the ligninolytic enzymes empowered *Pleurotus ostreatus* to unlock and degrade the cellulose and other cell wall components nutrients in the rice husk making available to the broiler chickens for growth. In addition *Pleurotus ostreatus* contain proteins of good quality amino acid profile[22,34] that are often made available to the broiler chickens for bioconversion during fermentation[16] and utilization for growth and other metabolic activities of the birds.

The decrease in the ADWG observed as the dietary inclusion of the treated native rice husk increased both in the birds fed PFFRH diets and those on ESRH could be due to the increased dietary fibre levels as the inclusion of the test feeds increased. The crude fibre fractions constitution or types impair digestion and utilization of the feeds. However, the crude fibre requirement for broiler chickens was documented to range from 3-4%[35,36] and has been documented as antinutritional factor that negatively correlates with the digestibility of protein and fats with reduced growth performance[4]. Therefore, this explains the observed trend in this trial where the feed conversion ratio (FCR) and the protein efficiency ratio (PER) followed the pattern observed for the body weight gained.

Haematology and serum biochemistry: Though the parameters monitored for the haematological indices such as PCV, RBC , WBC and haemoglobin concentration, MCHCH, MCH and MCV showed significant differences, the values were all within the range for broiler chicken[37]. The values obtained for all the parameters did not follow any particular trend and it suggests that the observations could not be strongly linked to the feedstuff. The broiler chickens did not exhibit any known physical health issues throughout the feeding trial and this could be corroborated with the white blood cell count recorded that ranged from 1.86 ± 0.00-2.10 ± 0.01 10^6 L^{-1}. However, the relative low values of the indices recorded in birds fed 20% ESRH for PCV might be as a result of better availability of the nutrients from the fermented rice husk for utilization than the enzyme supplemented because *Pleurotus ostreatus* fungus had already degraded the native rice husk during fermentation process than the degradation process that would be lately done in the gut of the broilers by the time the supplemented feed is consumed. Therefore, the rate of absorption and utilization would be faster for birds fed the PFFRH diets than the ESRH[30].

The values for serum enzymes AST and ALT that were indicators of hepatocellular damage though increased as the level of the treated rice husk increased. The values recorded were higher for birds fed ESRH than those fed PFFRH and the control diet. This may not be attributable to the occurrence of liver damage. This is because the broiler birds all through were healthy and active without any disease outbreak or anemia, in addition, studies have shown that ALT is not a good indicator to assess liver dystrophy but other incidentals in the physiology of the animals like kidney dystrophy or other mild internal organ degeneration[38,39]. AST may not be a good indicator as well because its presence in the blood had been reportedly attributed to muscle dystrophy among other internal physiological disruption in avian species[40,41].

Alkaline phosphatase values were not affected significantly, which indicated consistency with the results observed from other serum enzymes that there was no liver damage neither was there bone calcification or osteoblast which is an indication of adequacy of calcium in the diet[38]. Creatinine levels though was influenced by the treatment diet but did not indicate any wastage of the dietary protein[39]. This implies that there was no muscle wastages in the experimental animals fed treated rice husk.

CONCLUSION

It can be concluded that *Pleurotus ostreatus* fungus fermented rice husk can be used for 7 days as a feed ingredient for better growth performance and to enhance nutrient utilization and could replace maize source in broiler chicken diets. It is recommended PFFRH could be included at 10% of the broiler diets for optimal growth performance.

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