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EFFECT OF REPLACING CORN WITH THREE FIBRE SOURCES ON GROWTH PERFORMANCE AND CARCASS QUALITY OF BROILER CHICKEN

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ABSTRACT: The experiment was carried out to evaluate the effect of replacing corn with three dietary fibre sources on the growth performance and carcass quality of broiler chicken. One hundred and forty four one-day old broiler chickens were used for the experiment. The birds were brooded for two weeks on commercial starter diet after which they were subjected to four experimental diets or treatments. The birds were randomly distributed into four treatments with three replicates, each replicate consisting of 12 birds. All birds in each treatment were fed with different–diet and weighed at the end of every week. The experimental design used was a completely randomized design. The experimental treatments were designated as treatment T1, T2, T3, T4 while T1 was tagged as a control diet without any source of dietary fibre, T2 as a diet with wheat bran as a source of dietary fibre, T3 as a diet with rice bran as a source of dietary fibre, T4 as a diet with brewers dried grain (BDG) as a source of dietary fibre. There was no significant ($p>0.05$) difference in the initial weight of the birds across the treatments, but there was a significant ($p<0.05$) difference in the final weight and body weight gain of the birds where T2 had the highest body weight gain and T3 has the lowest body weight gain. This trend was also observed in the carcass. Based on the result of this experiment wheat bran can be used as a source of dietary fibre for better growth performance of broiler chicken at a low inclusion level.

Keywords: Broiler, Carcass, Corn, Dietary fibre, Growth performance.

INTRODUCTION

Broilers are domesticated chicken usually raised for meat purpose, boilers have the genetic potential to gain a significant amount of weight for a very short period of time, in order to achieve this, nutrition of the birds has to be taken very important and be closely monitored. Feed is one of the most important factors which impacts broiler performance (Ferket and Gernat, 2006). Broilers consume a large amount of feed. Feed costs vary with the cost of ingredients, but normally feed costs for broilers represent 65-85% of the variable cost of production of the live broiler (Da Costa et al., 2017). This cost has risen significantly in the past few years due to increases in prices of many feed ingredients, particularly cereal grains, which are used mainly as a source of energy for the birds (Donohue and Cunningham, 2009). Total feed costs can be reduced by the inclusion of less grain in the diet (Bikker and Jansman, 2023; Sibanda et al., 2023). Such a practice would also improve the quality of poultry meat, as a result of the very rapid growth of birds and over-consumption of very high-quality feed (Azizi et al., 2011; Baéza et al., 2022). Researches have been done to check the nutrition requirement and how feed ingredients such as dietary fibre source can be effectively used for the broilers to be able to maximize their genetic potential.

Dietary fiber can be said to be a part of plant material consisting mainly of cellulose and non-cellulosic polysaccharides and a non-carbohydrate component lignin. These components are highly resistant to hydrolysis by the alimentary enzymes and cannot, therefore be digested or absorbed in the blood stream. Yet fiber plays an important role in poultry diets, if applied properly. Dietary fibers are diverse in chemical composition and can be grouped generally by their solubility, viscosity and ferment ability, fiber can be sub divided into two main components: soluble fiber and insoluble fiber. Dietary fiber is usually considered as energy diluents and as an anti-nutritional factor which negatively affects feed consumption and nutrient digestibility which may later have negative influence on the growth performance, in commercial poultry diet formulation. However, there are some reports on the favorite effects of moderate dosage of dietary fiber in the diet which can improve growth performance traits of broilers (Adibmoradi et al., 2016; Sekh and Karki, 2022). Broilers growth performance can be assess using some of the types of dietary fiber that has been frequently mentioned; Wheat bran, rice bran, and brewers dried grain (BDG). Inclusion of dietary fiber in the diet of broiler chicken is very low as part of nutrient requirement due to the fibrous component in the feed materials and also the presence of anti-nutritional factor in the feed materials can have negative effects on the growth performance of broiler chicken (Swennen et al., 2010). Therefore, the study was carried out to evaluate the effects of replacing corn with three fibre sources on the growth performance and carcass quality of Abor Acre broiler chickens.

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MATERIALS AND METHODS

Ethical Approval

The experiment was approved by the Federal University of Oye Ekiti (FUOYE) Faculty of Science Research Ethics Committee (RECOM), and reviewed and considered the submitted research protocol and hereby gives ethical approval (FUOYEFSC 201122-REC2022/014) to carry out the research.

Experimental location

The experiment was conducted at the Teaching and Research Farm of the Department of Animal Production and Health, Faculty of Agriculture, Federal University Oye-Ekiti, Ekiti State, Nigeria. The location is within longitude 5.5145^{0}E and latitude 7.7983^{0}N and at an elevation of 570m above sea level. The climate of the study area is typically tropical with relative humidity ranging from 57-92% and a mean average daily temperature of 68-90^{0}F.

Experimental birds and management

A total number of 144 day old Abhor acre birds was purchased from CHI farms, Ibadan, Oyo state Nigeria and were in a pen with concrete floors, walls and galvanized roof with open sided walls. Washing, cleaning and disinfection of the pen was done five days prior to the arrival of the birds, wood shavings were used as bedding materials for the birds, in other to absorb fecal, water and to prevent coccidiosis and the bedding was changed twice weekly and if water spillage is noticed, the bedding was changed immediately. The chicken was raised on deep litter system throughout the experimental period. Coal pot with charcoal and electric bulbs were used as source of heat for the chicks during the brooding period. Vaccine against Infectious Bursal disease (using Attenuated Infectious Bursal Disease Vaccine) was given one week (day 7) after housing and on the third week (day 21) of life respectively. Vaccine against Newcastle disease using (lasota vaccine) was given on the second week (day 14) and fourth week (Day28) of life respectively. All vaccines were administered orally. Antibiotics and vitamins were administered to the birds except the days of vaccination. The birds were fed ad-libitum with broiler starter diet for three weeks using the experimental diet for each treatment and broiler finisher for three weeks. Water was given ad-libitum throughout the experiment.

Experimental design and diets

There were total number of four treatments and three replicates per treatment with a total number of 12 birds per replicate in a completely randomized design. All chicks were fed commercial feed for the first two weeks of life, after which they were fed with experimental diets. Formulated experimental broiler starter diets were given two weeks after brooding from the 3rd week to the 4th week while the broiler finisher diets were given for the rest 4weeks (5th to 8thweek). The experiment lasted for eight weeks. The experimental diet was formulated for both starter (Table1) and finisher phase (Table 2). The major source of energy for the diet was maize and the major source of crude protein was soya bean meal. The control diet T1 was feed formulated without dietary fibre, T2 was feed formulated with wheat bran (6%) as the source of fibre, T3 was feed formulated with rice bran (6%) as the source of fibre, and T4 was feed formulated with brewers dried grain (BDG) (6%) as the source of fibre.

Table 1 - Ingredients and Nutrient composition of experimental diets fed to broiler starter chicken (3–4weeks)

Ingredients	T1 (Control %)	T2 (6% WB)	T3 (6% RB)	T4 (6% BDG)
Maize	53.65	48.65	48.65	48.65
Soya bean	40.00	39.00	39.00	39.00
Wheat bran	0.00	6.00	0.00	0.00
Rice bran	0.00	0.00	6.00	0.00
B D G	0.00	0.00	0.00	6.00
Fish meal	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00
Limestone	2.00	2.00	2.00	2.00
Methionine	0.10	0.10	0.10	0.10
Salt	0.10	0.10	0.10	0.10
Premix	0.10	0.10	0.10	0.10
Toxin binder	0.05	0.05	0.05	0.05
TOTAL	100.00	100.00	100.00	100.00
*ME				
Determined				
Moisture (%)	9.48	9.42	9.80	9.15
CP (%)	25.38	23.76	22.70	21.80
CF (%)	6.30	7.15	8.92	5.80
EE (%)	4.08	4.16	3.18	3.78
Ash (%)	10.79	9.57	9.24	11.91
NFE (%)	43.97	45.94	46.16	47.56

*ME=Metabolizable energy (Calculated); CP=Crude Protein; CF=Crude Fibre; EE=Ether Extract; NFE=Nitrogen Free Extract; Tl: Treatment 1 (diet without dietary fiber), T2: Treatment 2 (diet with wheat bran as source of fiber), T3: Treatment 3 (diet with rice bran as source of fiber), T4: Treatment 4 (diet with BDG as source of fiber), BDG: (brewer's dried grain).

Table 2 - Ingredients and Nutrient composition of experimental diets fed to broiler finisher chickens (5-8 weeks)

Ingredients	T1 (Control %)	T2 (6% WB)	T3 (6% RB)	T4 (6% BDG)
Maize	58.65	53.65	53.65	53.65
Soya bean	35.00	32.00	32.00	32.00
Wheat bran	0.00	8.00	0.00	0.00
Rice bran	0.00	0.00	8.00	0.00
B D G	0.00	0.00	0.00	8.00
Fish meal	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00
Limestone	2.00	2.00	2.00	2.00
Methionine	0.10	0.10	0.10	0.10
Salt	0.10	0.10	0.10	0.10
Premix	0.10	0.10	0.10	0.10
Toxin binder	0.05	0.05	0.05	0.05
TOTAL	100.00	100.00	100.00	100.00
*ME				
Determined				
Moisture (%)	10.89	10.50	10.58	10.33
C.P (%)	22.72	26.80	24.80	24.50
C.F (%)	5.38	6.10	7.51	6.33
E.E (%)	4.30	4.70	4.58	4.09
Ash (%)	6.90	6.88	7.58	9.95
NFE (%)	49.81	47.02	44.95	44.80

*ME= Metabolizable energy (Calculated); CP=; CF=; EE=; NFE=; TI: Treatment 1 (diet without dietary fiber), T2: Treatment 2 (diet with wheat bran as source of fiber), T3: Treatment 3 (diet with rice bran as source of fiber), T4: Treatment 4 (diet with BDG as source of fiber), BDG: (brewer's dried grain).

Data collection

Parameters determine were initial live weight, final live weight, average weight gain, total weight gain, feed intake and feed conversion ratio, carcass weight and organ weights.

Statistical analysis

The data collected were subjected to the analysis of variance procedure (ANOVA) according to (SAS v9.2, 2012) at p>0.05. Significant means was separated using Turkey's honestly significant difference.

Statistical model: Yij=U + Di + eij

Yij–General Observation; U–General Mean; Di—Effect of the dietary treatment; Eij—Random residual error

RESULTS

The result of the proximate analysis of the formulated starter and finisher diet as presented in Tables 1 and 2 indicates that, for the starter diet T1 (control diet) has the highest CP (25.38%) and T4 (diet with BDG) has the lowest CP (21.80%) while for the finisher diet T2 (diet with wheat bran) has the highest CP (26.80%) and T1 (control diet) has the lowest CP (22.72%). The CF (crude fibre) is higher for T3 (8.92%), (Diet with rice bran) for the starter diet and it is lower for T4 (5.80%) (Diet with BDG) while for the finisher diet T3 (diet with rice bran) has the highest CF (7.51%) and T1 has the lowest CF (5.38%).

Growth performance of broiler chicken fed three different dietary fibre sources

Table 3 shows the effect of three different dietary fibre sources on the growth performance of broiler chicken. There was no significant difference (P>0.05) among the birds across the treatments for initial weight at two weeks, but the birds in T3 (diet with rice bran) have the highest initial weight (219.13) and the birds in T1 (control diet) has the lowest initial weight (208.27). There was significant difference (P<0.05) among the birds across the treatments for final weight, with birds in T2 (diet with wheat bran) having the highest final weight (2268.23) and the birds in T3 (diet with rice bran) having the lowest final weight (2110.87). Birds in T1, T2 and T4 have similar weight. Average weight gain for birds in T2 (diet with wheat bran) was significantly (p<0.05) greater (47.769) while T3 (diet with rice bran) was significantly (p<0.05) lesser (43.98). The same trend was observed in Total weight gain with birds in T2 (diet with wheat bran) significantly (p<0.05) having greater weight gain (2055.21) while T3 (diet with rice bran) significantly (p<0.05) having lesser weight gain

(1891.14). There was no significant difference (P>0.05) among the birds across the treatments for Total Feed Intake, but birds in T4 (diet with BDG) consumed the highest feed (5999.6) and the birds in T1 (control diet) consumed the lowest feed (5500). There was no significant difference (P>0.05) among the birds across the treatments for FCR, but the bird in T4 (diet with BDG) has the highest FCR (3.0340) and the bird in T2 (diet with wheat bran) has the lowest FCR (2.7015).

Carcass weight of broiler chicken fed different fibre diet

Table 4 shows the effect of different dietary fibre on carcass weight of broiler chicken.

Result shows that there were significant differences in the live weight, slaughter weight, dress weight, wing weight, thigh weight, drum stick weight, breast weight and neck weight. From the table, T2 recorded the highest value in all the parameters measured in treatments across the groups except for the wing weight, with T1 (diet without dietary fibre) having the highest (101.25) wing weight and T3 (diet with rice bran as source of fibre) having the lowest (89.03). For internal organs, result shows that there were significant differences (P<0.05) in the weights of the intestine, crop, bile, pancreas and empty gizzard. It was observed that T2 (diet with wheat bran as source of fibre) had the highest values in all the parameters measured and T3 (diet with rice bran as source of fibre) recording the lowest.

Table 3 - Growth performance of broiler chicken fed different sources of dietary fibre

Parameters	T1	T2	T3	T4	SEM	LOS
Initial weight(g)	208.27	213.02	219.13	203.30	5.3219	NS
Final weight(g)	2225.40^{ab}	2268.23^{a}	2110.87^{b}	2181.20^{ab}	21.5620	*
Avg. weight gain(g)	46.91^{ab}	47.769^{a}	43.98^{b}	45.998^{ab}	0.4637	*
Total Weight gain (g)	2017.13^{ab}	2055.21^{a}	1891.14^{b}	1977.90^{ab}	19.9412	*
Total Feed Intake (g)	5500.00	5552.20	5597.10	5999.60	141.9530	NS
FCR	2.7286	2.7015	2.9612	3.0340	0.0713	NS

$^{ab-}$ Mean with different superscripts in the same row are significantly different (P<0.05). TI: Treatment 1 (diet without dietary fiber), T2: Treatment 2 (diet with wheat bran as source of fiber), T3: Treatment 3 (diet with rice bran as source of fiber), T4: Treatment 4 (diet with BDG as source of fiber), BDG: (brewer's dried grain). LOS: (Level of Significance) FCR: (Feed Conversion Ratio), Avg: (Average), NS: not significant at (P>0.05) level of Significant.

Table 4 - Weight of carcass (primal cuts) and internal organs of broiler chickens fed different fibre diets for 43 days (6 weeks).

Parameters (g)	T1	T2	T3	T4	SEM	LOS
Live weight	2225.40^{a}	2268.23^{a}	2110.87^{b}	2181.20^{ab}	85.21	*
SW	2156.40^{a}	2192.73^{a}	2033.87^{b}	2100.95^{ab}	93.01	*
DW	1715.64^{a}	1752.00^{a}	1581.87^{b}	1639.20^{b}	60.06	*
Dressed	77.09	77.24	74.94	75.15	2.97	NS
Wing weight	101.25^{a}	98.73^{b}	89.03^{b}	93.16^{b}	8.73	*
Thigh weight	283.98^{a}	287.42^{a}	268.05^{b}	273.71^{b}	4.01	*
DSW	195.23^{a}	198.45^{a}	184.31^{b}	185.18^{b}	6.07	*
Back weight	296.13	299.57	278.73	289.20	11.38	NS
Breast weight	496.15^{a}	501.10^{a}	460.66^{b}	461.74^{b}	20.21	*
Neck weight	64.10^{a}	65.05^{a}	54.63^{b}	60.33^{ab}	7.63	*
Shank weight	47.00	48.26	39.37	41.89	9.21	NS
Head weight	55.25	56.70	50.47	54.53	7.02	NS
Internal organs(g)						
Liver	30.56	34.89	28.72	30.01	6.23	NS
Spleen	1.80	1.81	1.78	1.80	0.20	NS
Lung	8.98	9.01	8.51	8.99	0.68	NS
Heart	7.91	7.97	7.09	7.95	0.90	NS
Intestine	64.58^{ab}	72.81^{a}	55.50^{b}	64.76^{ab}	9.00	*
Kidney	1.21	1.22	1.19	1.22	0.06	NS
Crop	12.21^{a}	12.30^{a}	11.37^{b}	12.19^{a}	0.64	*
Bile	2.03^{a}	2.04^{a}	1.82^{b}	2.01^{a}	0.19	*
Pancreas	4.51^{a}	4.57^{a}	4.33^{b}	4.53^{a}	0.13	*
Empty Gizzard	42.76^{ab}	50.10^{a}	36.31^{b}	46.00^{ab}	4.21	*

$^{ab-}$ Mean with different superscripts are significantly different at P (0<0.05). TI: Treatment 1 (diet without dietary fibre), T2: Treatment2 (diet with wheat bran as source of fibre), T3: Treatment3 (diet with rice bran as source of fibre), T4:Treatment4 (diet with BDG as source of fibre), BDG: (brewer's dried grain). LOS=Level of Significance; SW=Slaughter weight, DW =Dress weight, DSW=Drum stick weight.

DISCUSSION

Growth performance of broiler chicken fed different sources of dietary fibre

The result of the growth study in table 5 shows that there was no significant difference (P>0.05) among the growth parameters like initial weight, total feed consumed and FCR in the birds across the treatments. It was observed that the birds in T4 (diet with BDG) consumed more feed than all other treatments and they have the highest FCR, which means they do not convert the feed they consumed into an appreciable body weight when compared to the other treatments. However, the birds in T1 (diet without dietary fibre) had the least feed consumption and they have an appreciable FCR which is an indication that they were able to convert feed consumed into appreciable body weight, T2 has a moderate consumption rate and the lowest FCR which is an indication that they were able to convert a good amount of feed they consumed into body weight excellently and they have the highest weight gain (2055.21g).

The result of the growth study also shows that there is a significant difference (p>0.05) in the total weight gain and average weight gain between T1 (control diet) and T4 (diet with BDG), this can be due to the difference in the crude protein level of the diet for both starter and the finisher diet. T2 (diet with wheat bran) has the highest body weight gain 2055.21g and the highest average body weight gain 47.769g among all the treatments and it was observed that T2 (diet with wheat bran) was superior in converting feed into weight gain than birds in other treatments. Courtin et al. (2008) and Craeyveld et al., (2010) recorded that inclusion of moderate level of wheat bran improves growth performance in broiler chicken.

Broiler chickens fed rice bran has the lowest weight gain, this is in correlation with Gallinger et al., (2004) which says the inclusion of rice bran can bring about poor growth especially at a higher percentage. The lingo-cellulosic bond in rice is such that the monogastric animals i.e., broilers cannot break it down for release of glucose for muscle building. Also, the crude protein value is lower in rice bran compared to the other fibre diets. It is worth noting that rice bran has a low glycemic index compared to other fibre diets like wheat bran and brewer's dry grain. The result of the study also showed that broiler chickens fed control diet performed moderately but not better than those fed wheat bran diet which can be due to low level of feed intake, feed intake can be improve by addition of reasonable source of fibre as reported by Gonzalez et al. (2010). Broiler chickens fed BDG has the least performance but they have the highest feed consumption among other treatments, this can be due to the presence of high lignin and non-starchy polysaccharides which act as anti-nutritional factor as reported by Karlsen and Skov (2022). The live weight obtained for broilers in this study were lower than the value (2480±9.75g) reported for broilers by Omojola and Fagbuaro (2005).

Carcass weight and internal organs of broiler chicken fed different sources of dietary fibre

Lu et al (1996) reported that relative organ weight could be used as an indicator of organ function.

In the present study, the experimental diet with the highest (7.51%) Crude Fibre (T3 Diet with rice bran) significantly decreased weight of carcass parameters of broiler chicken fed different fibre diets for 43 days (6 weeks) on the following parameters measured; Live weight, dressed weight, wing weight, thigh weight, drum stick, back weight, breast weight and neck weight of broiler chickens compared with the control and other treatment groups. Similarly, Shahin and AbdElazeem (2005) found that fibre inclusion in broiler diets decrease carcass weight.

Also, in this study reduced (6.10%) dietary fibre increased the weight of the intestine in treatment 2 and in the weight of internal organs of broiler chicken fed different fibre diets (72.81g) (Table 6) which is contrary to the findings of Mateos et al (2012) who reported that dietary fibre decreased the intestinal length and weight of the organs of broiler chicken. Consequently, these changes might reduce carcass yield (Jorgensen et al., 1996; Tejeda and Kim, 2021). Present result is in agreement with a few others (Preston et al., 2000; Taylor and Jones, 2001; Mourao et al., 2008) in which dietary fibre increased the relative length and weight of the small intestine. The longer relative length of the small intestine in the fibre groups might be due to the increased effort of this organ to adapt to improve feed consumption and nutrient uptake (Mourao et al., 2008; Sittiya et al., 2020). However, the results of our study did not agree with those of a few other reviews. For instance, Amerah et al. (2009) and Sklan et al. (2003) found that increasing the insoluble fiber in the diet reduced the length of the small intestine. These conflicting findings may be due to the differences in the physiochemical characteristics, feed interactions and amount of the fibre sources as well as particle size (Mateos et al., 2012).

The decrease in the carcass or primal cuts and organs can be related to the bird's live weight that followed the same trend across treatments. These organs could be proportional to their respective live weights as may be fixed by their genetic makeup since the experimental birds are of the same breed (Abor Acre).

CONCLUSION

Based on the result of this experiment, birds fed with wheat bran had the highest live weight and carcass parameters or primal cuts as well as internal organs or offal's with no adverse effect. Wheat bran is also affordable and available since it is widely distributed throughout the tropics. However, a little percentage of inclusion of wheat bran (because of its high fibre content) will help improve the performance of broilers. Wheat bran is hereby recommended to intending poultry

farmers as a source of dietary fibre in the feed of broiler chicken at a little percentage (8%) for better growth performance of broiler chicken.

DECLARATIONS

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Data availability

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Authors' contribution

Mercy Oluwaseyi Okowonleyin collected the samples and carried out the field work and wrote the first draft. Anthony Henry Ekeocha supervised the overall research, Ademiju Adeolu AGANGA provided the resources for the research work, Oloriire Kolade Aderemi assisted in the statistical analysis and Patrick Chinedu Emerue revised the draft of the manuscript. All authors approved the final version of the manuscript for publication in the present journal.

Competing interests

The authors declare no competing interests in this research and publication.

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