

RESEARCH ARTICLE

EFFECT OF BIOCHAR AND CLAY ON GROWTH PERFORMANCE AND ORGAN WEIGHT OF BROILER

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ABSTRACT

This study was conducted to investigate the effect of dietary inclusion of biochar and clay as feed additives on the growth performance and organ weight of broilers in a 56-day feeding trial. A total of ninety-six-day-old broilers (Ross 308) were fed diets containing biochar and clay. Treatments 1, 2, 3 and 4 were composed of T1 (control), T2 (5% biochar), T3 (5% clay) and T4 (2.5% biochar + 2.5% clay) in a completely randomized design having three replicates, each consisting of eight birds. The growth parameters were measured during the feeding trial and organ weight parameters were measured at the end of the experiment. The data collected were analyzed using one-way analysis of variance to determine the significant differences among the dietary treatments. The results showed that treatments were significantly ($p < 0.05$) different in final body weight, total body weight gain, average daily body weight gain, total feed intake, average daily feed intake, feed cost per kg weight gain and kidney weight. Treatment 4 had the highest final weight value of 1.4067kg, highest total body weight gain of 1.3597kg, highest average daily body weight gain of 0.0242kg, highest total feed intake of 5.1097kg, highest average daily feed intake of 0.0910kg and highest feed cost of N3227.21. However, there were no significant ($p > 0.05$) differences in initial body weight, feed conversion ratio, feed cost per kg body weight gain, heart, liver, pancreas, gizzard, spleen and lung weights. The results imply that inclusion of biochar and clay at 2.5% each in broiler diet can potentially increase growth performance.

KEYWORDS

breeding, diet, bird, feed additive.

1. INTRODUCTION

Broiler production is now regarded as a critical component of the global poultry industry since it provides significant sources of quality animal protein that can provide for the demand by the ever-increasing human population. The world human population was projected to rise to 10 billion by 2050 and these teeming human population will need adequate and nutritious food supply through sustainable production systems (FAO, 2009). The industry also provides employment opportunities for many people. The National Bureau of Statistics estimated that the poultry industry employs over 30 million people and broiler production, being a significant aspect of the poultry industry contributes significantly to job creation in the country (NBS, 2018).

The use of antibiotics growth promoters have been explored for the past decades with the hope of improving the efficiency of feed nutrient utilization in poultry production (Hamasalm, 2016). There are evidences of several health challenges emanating from using antibiotic growth promoters in broiler nutrition. Hence, the need to explore for locally available and natural feed additives without negative health implications on humans (Saleha et al., 2009; Hajati and Hazaei, 2010).

Among these additives, biochar and clay have emerged as promising candidates due to their potential benefits in enhancing nutrient utilization, mitigating the impact of toxins, and promoting gastrointestinal health. Biochar, a carbon-rich material derived from the pyrolysis, gasification and hydrothermal carbonization of organic biomass, has shown positive effects on animal growth and health in various livestock species. In broiler farming, biochar is used as a feed additive to improve growth

performance, carcass quality, and gut health of broilers. A study by found that inclusion of 1% biochar in broiler diets significantly enhanced feed conversion rate and body weight gain compared to control diets (Alzueta et al., 2017). Biochar acts as a probiotic enhancer, promoting the growth of beneficial gut bacteria and reducing the presence of harmful bacteria, such as *E. coli*. A group researcher reported that 1% biochar inclusion in broiler diets resulted in a significant increase in the population of *Lactobacillus* bacteria and a decrease in *E. coli* population in the gut (Bhatt et al., 2019).

Clay is also a natural mineral that has been used for centuries as feed additive for animals and humans. It contains high level of minerals like calcium, magnesium, and silica, and has been shown to have a positive effect on gut microbiota and growth performance of broilers. One of the mechanisms of action of clay is its ability to absorb toxins and pathogens in the gut, preventing their absorption and promoting their excretion. This helps to minimize the challenges of digestive disorders, like diarrhea and enteritis in broilers. Moreover, clay has also been shown to enhance nutrient utilization and improve growth performance of broilers. A group researcher reported that 2.5% clay inclusion in broiler diets led to a significant improvement in feed conversion rate and body weight gain compared to control diets (Akinmutimi et al., 2014). The authors attributed this improvement to the capacity of clay to improve nutrient digestibility and utilization in broilers.

Poultry are mostly exposed to various mycotoxins such as aflatoxins found mostly in feed (Denli and Okan, 2004; Mabbett, 2004; Magnoli et al., 2011). These Mycotoxins affects animal feed consumption and growth. The presence of mycotoxins in the milk, egg and meat that we consume may have serious effects on human health (Ani et al., 2014). Presently,

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mycotoxin binders like clay minerals, aluminosilicates, esterified glucosaminan and modified mannoglycosaccharides have attracted significant scientific and industrial attention as potential materials for the reduction of mycotoxins from feeds (Ani et al., 2014). The use of clay as feed additives in the production of animal feeds is well established. Clay supplements such as bentonites and kaolinite are also used to lubricate and bind other ingredients during the production of pelleted feeds for different animals (Owen et al., 2012).

The investigation of biochar and clay as feed additives in broiler production holds great significance. It offers an opportunity to explore sustainable and eco-friendly practices that can potentially improve broiler growth performance, reduce the environmental impact of poultry farming, and enhance the overall profitability of the industry. By understanding the impact of these additives on broiler growth and organ health, we can develop informed strategies to optimize their usage and contribute to the advancement of broiler nutrition and production systems. Despite the potential benefits of biochar and clay in poultry nutrition, research focusing on their combined effects on broiler growth performance and organ weight remains relatively limited. Therefore, this study aims to bridge this knowledge gap by evaluating the effects of incorporating biochar and clay into broiler feed.

2. MATERIALS AND METHODS

2.1 Location of the Study

The experiment was carried out at the Research farm of the Department

of Animal Science, Nnamdi Azikiwe University, Awka. According to a study, Ifite-Ogwari have an annual rainfall of 5798.78 mm and monthly total rainfall average of 1739.62 mm (Ifeka and Akinbobola, 2015). Their minimum temperature is 25.4°C and maximum temperatures of 30.6°C, with swampy tropical forest vegetation.

2.2 Sourcing and Processing of Biochar and Clay

The biochar was purchased from Charcoal mini market in Onitsha while the clay was got from the stream bank in Awka. The biochar and clay were sun dried to reduce their moisture content. The dried biochar and clay were ground into tiny particles and sieved for perfect mixture and smooth consumption for the experimental birds. These materials were incorporated into the broiler feed in the right specification for the various treatments.

2.3 Experimental Diets

Four experimental diets were compounded for the broiler’s starter phase and another four diets for the finisher phase. The feed ingredients were purchased from a reputable feed mill at Nnobi Market, Anambra State. Using the Feed ingredients composition, the rations were formulated with biochar and clay included at levels of 0% (control), 5% (biochar), 5% (clay) and 2.5% biochar + 2.5% clay designated as T1, T2, T3 and T4, respectively. The starter experimental diets (22% CP) was fed to the birds for twenty eight days (28 days) while the finisher diet (20% CP) was fed for another twenty eight days. Table 1 shows the dietary content of the starter feed while Table 2 shows the dietary content of finisher feed for the experimental birds.

Table 1: Ingredient composition of the experimental diet at starter phase

Ingredients	Treatments			
	T1	T2	T3	T4
Maize (%)	55.00	50.00	50.00	50.00
Soybeans meal(%)	24.00	24.00	24.00	24.00
Fish meal(%)	4.00	4.00	4.00	4.00
Biochar (%)	-	5.00	-	2.50
Clay (%)	-	-	5.00	2.50
Wheat Bran (%)	3.00	3.00	3.00	3.00
Bone meal (%)	3.00	3.00	3.00	3.00
Groundnut cake (%)	10.00	10.00	10.00	10.00
Lysine(%)	0.25	0.25	0.25	0.25
Methionine(%)	0.25	0.25	0.25	0.25
Salt(%)	0.25	0.25	0.25	0.25
V/M premix(%)	0.25	0.25	0.25	0.25
TOTAL	100	100	100	100
ME (Kcal/kg)	2854.36	2682.76	2682.76	2682.76
CP (%)	23.57	23.07	23.07	23.07

Table 2: Ingredient composition of the experimental diet at finisher phase

Ingredients	Treatments			
	T1	T2	T3	T4
Maize (%)	60.00	57.00	57.00	57.00
Soybeans meal(%)	18.00	18.00	18.00	18.00
Fish meal(%)	3.00	3.00	3.00	3.00
Biochar (%)	-	5.00	-	2.50
Clay (%)	-	-	5.00	2.50
Wheat Bran (%)	5.00	3.00	3.00	3.00
Bone meal (%)	3.00	3.00	3.00	3.00
Groundnut cake (%)	10.00	10.00	10.00	10.00
Lysine(%)	0.25	0.25	0.25	0.25
Methionine(%)	0.25	0.25	0.25	0.25
Salt(%)	0.25	0.25	0.25	0.25
V/M premix(%)	0.25	0.25	0.25	0.25
TOTAL	100	100	100	100
ME (Kcal/kg)	2877.06	2748.98	2748.98	2748.98
CP (%)	21.09	20.99	20.99	20.99

2.4 Experimental Birds and Management

A total of ninety-six (96) unsexed day - old broiler chicks (Ross 308) were purchased from a reputable hatchery in Ibadan, Oyo State - Nigeria. The birds were randomly allotted to four dietary treatments with twenty-four (24) birds per treatment where each treatment was further replicated three (3) times with eight (8) birds per replicate in a Completely Randomized Design (CRD). The experimental birds were raised on a deep litter system. Feed and water were supplied *ad libitum*. The pens were kept clean and routine medication properly given to prevent disease outbreak.

2.5 Parameters Measured

The measured parameters were initial body weight, final body weight, organ weights, feed intake, while average daily feed intake, average daily body weight gain, feed conversion ratio, feed cost, feed cost per kg body weight gain were calculated.

2.6 Experimental Design and Statistical analysis

Completely randomized design was used in this experiment. Data collected were subjected to analysis of variance (ANOVA) using statistical package for social science (SPSS) and statistically significant means were separated using Duncan's New Multiple Range Test as described (Steel and Torrie, 1980).

2.7 Data Collection

2.7.1 Feed Intake

The feed intake was weighed daily to determine the average feed intake of the birds in each replicate pen. Feed intake was calculated by subtracting

feed remaining from initial feed given divided by the number of birds in the replicate.

2.7.2 Weight Gain

The birds were weighed weekly to determine the average body weight gain of the birds. The body weight gain was calculated by subtracting final body weight from the initial body weight.

2.7.3 Feed Conversion Ratio

The feed conversion ratios were calculated by dividing the quantity of feed consumed by the body weight gain.

2.7.4 Organ Weight

The birds were randomly picked from each replicate. They were slaughtered and weighed after being starved for 12 hours. The internal organs (heart, kidney, gizzard, lungs) were weighed and their percentages were determined in relation to live weight.

3. RESULTS AND DISCUSSION

3.1 Growth Performance of Broilers fed Diets Containing Biochar and Clay

The growth performance of broilers fed diets containing biochar and clay is shown in Table 3. There were significant ($p < 0.05$) differences among treatments in final body weight, total body weight gain, average daily body weight gain, total feed intake, average daily feed intake and feed cost. However, treatments did not differ significantly ($p > 0.05$) in initial weight, feed conversion ratio and feed cost per kg body weight gain.

Table 3: Growth Performance of Broilers Fed Diets Containing Biochar and Clay

Ingredients	Treatments				Pvalue
	T1	T2	T3	T4	
Initial Weight (kg)	0.0427	0.0423	0.0420	0.0430	0.100
Final Weight (kg)	1.1767 ^{ab}	0.9133 ^b	1.2167 ^{ab}	1.4067 ^a	0.032
Total Weight gain(kg)	1.1337 ^{ab}	0.8863 ^b	1.1780 ^{ab}	1.3597 ^a	0.028
ADWG (kg)	0.0202 ^{ab}	0.0158 ^b	0.0210 ^{ab}	0.0242 ^a	0.030
TFI (kg)	4.1470 ^b	3.4823 ^c	4.2553 ^b	5.1097 ^a	0.001
ADFI (kg)	0.0737 ^b	0.0620 ^c	0.0757 ^b	0.0910 ^a	0.001
FCR	3.6367	4.2300	3.6000	3.7867	0.800
Feed cost (N)	2059.8553 ^c	2765.2833 ^b	2687.6200 ^b	3227.2133 ^a	0.001
FCPKGWTG (N)	7498.0900	11728.3617	9688.7733	12371.5933	0.234

a, b, c, Means on the same row with different superscripts are significantly different ($p < 0.05$). ADWG: Average Daily Weight Gain; TFI: Total Feed Intake; ADFI: Average Daily Feed Intake; Feed Conversion Ratio; FCPKGWG: Feed Cost Per Kg body Weight Gain.

Broilers fed Treatment 4 diet had the highest final weight of 1.4067 kg/bird compared to broilers fed treatment 2 diets with the least total weight of 0.9133kg/bird. The results obtained showed that the total body weight gain of broiler chickens in Treatment 4 had the highest total body weight gain of 1.3397 kg/bird while broilers fed diet containing only biochar in treatment 2 had the least total body weight gain of 0.8863kg/bird which implies that the inclusion of biochar at 2.5% and clay at 2.5% increased the performance of broiler chickens more than the other treatments. This result agrees with the studies by who stated that combination of toxin binders (biochar and clay) improved the growth performance of broilers (Lee et al., 2023). This is also in line with the findings by who reported that broilers fed with 5% biochar and 5% clay in their diets had significantly higher final body weights and total body weight gains compared to the control group (Adebiji et al., 2016). The result of this experiment is however contrary to the results obtained by who reported no significance difference ($p > 0.05$) in total body weight gain of broilers fed diets containing varying levels of biochar (Anwar et al., 2022).

The average daily body weight gain of birds fed control diets was the least but the broilers fed T4 diet containing (biochar + clay) had the highest average daily body weight gain. This means that Treatment 4 gained more weight daily than other treatments. Broilers in treatments 4 consumed more feed than broilers in the other treatments. Broilers in T4 had the highest feed intake of 5.1097 kg/bird while those in treatment 2 had the least total feed intake of 3.4823 kg/bird. This could be as a result of the effect of palatability, flavor, colour or even odour of the feed additives.

The feed conversion ratio of the treatment diets obtained in this

experiment do not agree with the findings of who reported that birds fed diets containing biochar showed an increased daily weight gain, body weight gain and a reduced feed conversion ratio (Goiri et al., 2021). The standard feed conversion ratio (FCR) of broilers varies depending on several factors such as breed, age, and management practices. In general, broilers have a FCR of around 1.5-2.0, which means they require 1.5-2.0 kg of feed to gain 1 kg of body weight. However, some researchers have reported lower FCR values, ranging from 1.3-1.8. Feed conversion ratio may be influenced by the humidity and temperature as well as quality and composition of feed (Nahashon et al., 2006; Kuo et al., 2015).

3.1.1 Feed Cost

Feed cost varied significantly among treatments. Treatment 1 had the least cost of N 2059.85 while treatment 4 had the highest cost of N 3227.21. This is in contrast with the study by which showed that broilers fed diets containing 5% biochar and 5% clay had lower feed costs compared to the control group (Olugbemi et al., 2014). It is also in disagreement with the report by who stated that biochar in diet reduced feed cost. This could be as a result of the high feed intake in treatment 4 (Kalus et al., 2020).

This result is in contrast with the report by who reported no significant ($p > 0.05$) differences in all the growth performance parameters of broilers fed diets containing different fauna modified clay sources at 5% inclusion level (Ugwuowo and Obikwelu, 2022). The significantly better performance of broilers in treatment 4 may likely be attributed to the fact that biochar and clay had synergistic effects.

3.2 Organ Weight of Broilers Fed Diets Containing Biochar and Clay

The organ weights of broilers fed diets containing biochar and clay are shown in Table 4. There was significant ($p < 0.05$) difference among treatments in percentage kidney weight. However, treatments mean did not differ significantly ($p > 0.05$) in the percentage weights of heart, liver, pancreas, gizzard, spleen and lungs.

Table 4: Organ weight of broiler fed diets containing biochar and clay

Parameters (%)	Treatments				
	T1	T2	T3	T4	Pvalue
Heart	0.7500	0.5767	0.7200	0.7100	0.339
Liver	2.7533	2.0900	2.1167	2.2467	0.276
Kidney	0.8667 ^a	0.5333 ^b	0.4700 ^b	0.5567 ^b	0.027
Pancreas	0.5300	0.4033	0.4233	0.3700	0.081
Gizzard	4.9700	4.4233	3.4700	3.7300	0.231
Spleen	0.1900	0.1900	0.1433	0.1467	0.586
Lungs	0.7000	0.5167	0.5767	0.6800	0.601

a, b, c, means on the same row with different superscripts are significantly different ($p < 0.05$).

The result of this experiment is in contrast with the report by who reported that the inclusion of clay in diets increased the liver weight of broilers (Adebiyi et al., 2016). The non-significance difference ($p > 0.05$) in liver weight of broilers used in this experiment was also contrary to the report by who got a result that decreased as the quantity of clay and biochar increased in the diet of breeder broiler (Lee et al., 2023). The uniform weight of liver got in this experiment was evidence that clay and biochar did not affect the functioning of the liver and hence the normal shape, size and weight were maintained.

There was significant difference ($p < 0.05$) between treatments in percentage kidney weight of broilers. Treatment 1 had the highest percentage weight of 0.8667% while treatment 3 had the least percentage weight of 0.4700%. These results were above the normal range of kidney weight which is between 0.21 - 0.35%. The decrease in the kidney weights of broiler fed diets containing biochar and clay from those in the control diets may be due to the reduced activities of the kidney in carrying out some physiological activities.

The non-significance difference in mean weights of spleen as obtained in this experiment agrees with the findings of who also got results that were not significant in breeder broiler when fed diets containing biochar and clay (Lee et al., 2023). This also shows that clay and biochar inclusion in the treatment diets did not affect the spleen weight of these broilers.

There were no significant differences ($p > 0.05$) among treatments in percentage weight of lungs, pancreas, heart and gizzard. These results also agree with the results obtained by who recorded non-significant differences ($p > 0.05$) in the percentage weight of lungs, pancreas, heart, and gizzard of breeder broiler fed diets containing biochar and clay (Lee et al., 2023). The non-significance differences as obtained in this experiment show that the inclusion of biochar and clay in the diet of broiler did not have any deleterious effect on the heart, lungs, pancreas and gizzard of broiler.

4. CONCLUSION

Broilers fed treatment 4 diet containing biochar at 2.5% and clay at 2.5% performed better than broilers in the other treatments but the kidney weight was negatively affected and the values were above the normal range of between 0.21 - 0.35g. Therefore, it can be concluded that combination of biochar and clay in broiler diets at 2.5% inclusion levels can potentially enhance their growth performance.

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