British Journal of Applied Science & Technology
3(2): 268-276, 2013

SCIENCEDOMAIN *international*
www.sciencedomain.org

Effect of Activated Coconut Shell Charcoal Meal on Growth Performance and Nutrient Digestibility of Broiler Chickens

E. Z. Jiya[1*], B. A. Ayanwale[1], A. T. Ijaiya[1] A. Ugochukwu[1] and D. Tsado[1]

[1]Department of Animal Production, Federal University of Technology Minna, Niger state, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Authors EZJ and BAA designed the study, author EZJ wrote the protocol, analyzed the data and edited the paper after peer review. Authors ATI, AU and DT managed the literature searches, supervised the data collection. All authors read and approved the final manuscript may use the following wordings for this section. Author AU wrote the first draft. All authors read and approved the final manuscript.

Research Article

Received 20th August 2012
Accepted 4th February 2013
Published 23rd February 2013

ABSTRACT

Aim: A 56 days feeding trial was conducted with 225 Marshal Broiler chicks to evaluate the effect of activated coconut charcoal on their growth performance and nutrient digestibility.
Study Design: The design of the experiment was completely randomized design (CRD).
Place and Duration of Study: Poultry unit of the Teaching and Research Farm of the Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology Minna, Niger State, between September- October 2011.
Methodology: The birds were randomly allocated into five dietary treatments designated as T1, T2, T3, T4 and T5 containing 0, 0.5, 1, 1.5 and 2 % of activated coconut shell charcoal meal respectively. Each treatment had three replicates with 15 birds in each replicate. The birds were fed *ad libitun*. Data were collected on body weight, feed intake, body weight gain; feed conversion ratio, protein efficiency ratio and nutrient digestibility were calculated. The starter phase covered week 0-4 and the finisher phase from week 5-8.
Results: The result showed that feed intake and feed conversion ratio values were

**Corresponding author: E-mail: ez_jiya@yahoo.com;*

(P<0.05) different at the starter phase. The result of the finisher phase revealed (P<0.05) differences in the values of mean final body weight, body weight gain, feed conversion ratio and protein efficiency ratio. Also high percentage mortality was observed in birds fed 2% activated coconut charcoal meal. The result of the nutrient digestibility showed no (P>0.05) difference in dry matter, crude protein, ether extract and nitrogen free extract. However, (P<0.05) differences were observed in the digestibility of crude fibre and ash values.

Conclusion: It was concluded that activated coconut shell charcoal supplementation at 2% inclusion at the starter phase increased feed intake and final body weight. However, at the finisher phase activated coconut shell charcoal can be included up to 0.05% inclusion level for better performance.

Keywords: Broilers; activated coconut shell charcoal; supplementation performance.

1. INTRODUCTION

More emphasis than ever is placed on global food security, both in terms of availability in the right nutrient proportions and affordability to the masses at a reasonable cost [1]. Poultry meats offer considerable potential in bridging the gap between supply and demand for animal protein especially in developing countries like Nigeria. In this continent and other less developed nations, the low level of supply of animal protein is due to poor performance of livestock industry, [1] which has been attributed to factors such as inadequate nutrition, high price and poor quality of feed industries [2]. However attempts have been made to reduce the risk of mycotoxin in poultry feed which are secondary metabolites of fungi, especially by species of Aspergillus, Penicillium, and Alternaria. Mycotoxins in feed can cause huge problem for humans and animals. Consumption of a mycotoxin-contaminated diet may induce acute and long term chronic effects resulting in carcinogenic, estrogenic or immune suppressive effects. Direct consequences of consumption of mycotoxin contaminated animal feeds, include reduced feed intake, feed refusal, poor feed conversion, diminished body weight gain, increase in diseases incidence (due to immune suppression) and reduced reproductive capacity [3] which will lead to economic losses. The most common mycotoxins are aflatoxins. The addition of mycotoxins binders to contaminated diets has been considered the most promising dietary approach to reduce effects of mycotoxins [4]. The theory is that the binder decontaminates mycotoxins in the feed by binding them strongly enough to prevent toxic interaction with the consuming animals and prevent mycotoxin adsorption across the digestive tract. It is impossible to completely remove such mycotoxins from the animal and human food chain given that feed and its precursor (raw materials) can be stored and transported through a range of time interval, atmosphere humidity and temperature, here lies the opportunity for mycotoxins to do their detrimental damage during the cultivation and harvest stages of grains.

Practical methods to detoxify mycotoxin from contaminated grain in a larger scale and in a cost effective manner are not currently available [5]. Varieties of physical, chemical and biological techniques have been employed; however they have met with only limited success. A recent approach has been the addition of non-nutritive adsorptive material to the diet in order to reduce the absorption of mycotoxins from the gastro intestinal tract. Activated charcoal is a form of carbon with increased surface area for absorption. The term charcoal generally refers to carbonaceous residue of wood [6]. The very tiny, odorless, tasteless black powder is absorbent for many toxins, gases, drugs, and fat soluble substance without any specific action [6]. The adsorptive effect could be increased by

treating with various substances at temperature ranging from 500-900º C, a treatment known as activation [6]. The final product is called activated charcoal [7]. Charcoal acts as an insoluble carrier that non-specifically absorbed molecule, thereby preventing their absorption. Several researchers have tested the efficacy of activated charcoal in binding mycotoxins. [7], found that the addition of different levels of activated sheabutter tree charcoal to laying pullets significantly ($p<0.05$) improved egg weight and quality. The results were attributed to increased mineral intake and utilization enhanced by charcoal supplementation and also improved absorption capacity of charcoal for dietary fat. [8] investigated the feeding value of wood vinegar in weanling pigs and showed that wood vinegar added to the diets of pigs could improve the performance, apparent nutrient digestibility and selectively inhibit the harmful coliforms. There were many advantages of adding charcoal to animal diets as it controls lactic acid concentration in the gastrointestinal tract of ruminant, maintaining of pH level and micro flora in the rumen of steers ([9, 10] and controls pathogenic bacteria [11]. In Nigeria and indeed many other countries, various feeds and additives are incorporated into poultry diets to ensure maximum productivity. Therefore the aim of this research was to evaluate the effect of activated coconut shell charcoal meal on growth performance and nutrient digestibility of broiler chickens.

2. MATERIALS AND METHODS

A total of two hundred and twenty five (225) day old Marshal Chicks were used for the experiment. The birds were randomly allocated into five treatment (Table 1) groups of 45 birds and each group assigned to one of the dietary treatment of T_1 (0%), T_2 (0.5%), T_3 (1%), T_4 (1.5%) and T_5 (2%) activated coconut shell charcoal in a completely randomized design. Each treatment group was further subdivided into three replicates of 15 birds each. Feed and water were provided *ad-libitum,* uniform light were provided 24 hours and proper vaccinations and medications was taken while body weight was recorded weekly. Feed conversion ratio and body weight gain were used as measures for birds growth performance. The experiment lasted for 8weeks, the starter phase covered the first four weeks and the last four weeks covered the finisher phase. The birds were managed under a deep litter system. The birds were managed purely on concrete floor with wood shavings on it, demarcated with wire mesh. The pen was thoroughly cleaned and disinfected before the commencement of the experiment. Heat was provided for the chicks during the brooding period with the use of charcoal pot and electric bulbs which were lit every evening and left all night. Vaccination and medication program were strictly adhered to. Other routine management procedures included, weighing of birds on arrival before the commencement of the experiment and subsequently at weekly intervals. Feed and clean water were supplied *ad-libitum*. Records of mortality, weight changes and feed intake were kept. The daily operation performed includes removal of left over feeds, cleaning of the drinkers and replacing the feeder and drinker with new feed and water. The following data were collected:

Table 1. Composition of the basal diets

Ingredients	Starter phase (%)	Finisher phase (%)
Maize	51.63	59.67
Soybean meal	18.82	14.27
Ground nut cake	17.21	13.10
Fish	4.00	3.00
Wheat bran	2.62	5.00
Bone meal	2.00	2.00
Oyster shell	1.00	1.00
Premix	0.30	0.30
Methionine	0.20	0.20
Lysine	0.20	0.20
Salt	0.30	0.30
Palm oil	2.00	1.00
Total	100	100
Calculated values		
Crude protein	24.0 1%,	20.60%
Metabolizable energy	3150 (kcal/kg ME)	3250 (Kcal/Kg ME)

2.1 Premix

Each 2.5kg contain: vit. A 10,000,000 IU; vit D 2,000,000 IU; vit. E 20,000 IU; vit. K 2,250 mg; thiamine 170mg; riboflavin 5,000mg; pyridoxine 2,750mg; niacin 27,500mg; vit B12 15mg; pantothenic acid 7,500mg; folic acid 7,500mg; biotin 50mg; manganese 80g; zinc 50g; copper 5g; iodine 1.5g; selenium 200mg and cobalt 200mg; Activated coconut shell charcoal supplementation (starter and finisher phase) at0, 0.5, 1, 1.5, and 2 kg per 100kg of diet.

2.2 Data Collection

Data collected for ascertaining the performance of the birds include: initial body weight which was collected by taking the weight of the day old birds at arrival in the farm using a weighing scale; final body weight was collected at the last day of the experiment using the same weighing scale; body weight gain was calculated by subtracting the initial body weight from the final body weight; feed intake was also calculated by subtracting the amount of feed refused from the amount of feed offered the birds and feed conversion was calculated by dividing the feed intake by the body weight gain.

2.3 Digestibility Trial

The digestibility trial was conducted by selecting two birds from each replicate of the treatments which were weighed and transferred into the metabolism cages. The birds continued to receive their diets for five days of the trial, the faecal droppings from each replicate was separately collected daily and were weighed and oven dried at 104^{o}c until a constant weight was obtained. After drying, the droppings from each treatment were grouped together and sub-samples were taken for proximate analysis [12].

2.4 Statistical Analysis

Data obtained from the experiment were subjected to the analysis of variance (ANOVA) in a completely randomized design using the procedure of [13].

3. RESULT AND DISCUSSION

The growth performance of broilers fed diets supplemented activated coconut shell charcoal (Table 2, Fig. 1) had no significant effect on the parameters measured at the starter phase. However the mean feed intake and feed conversion ratio were statistically different among the treatment means. Although the birds fed 2% activated coconut shell charcoal had higher feed intake the feed conversion ratio was better in the control (T_1).The better utilization might be as a result no supplementation of the activated coconut shell charcoal.

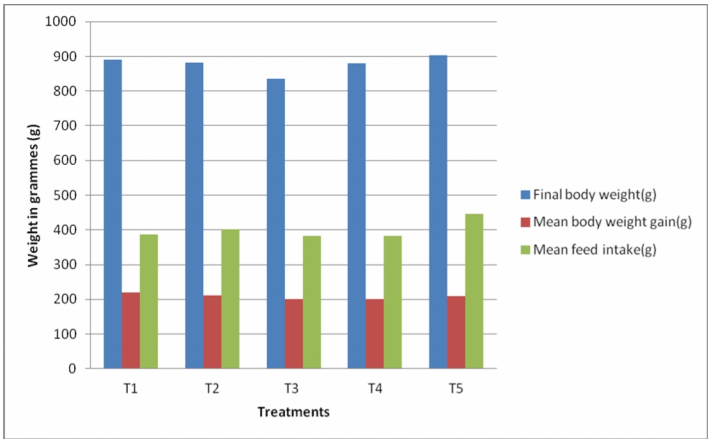

Fig. 1. Growth performance of broilers fed diets supplemented with Activated coconut shell charcoal. (Starter phase)

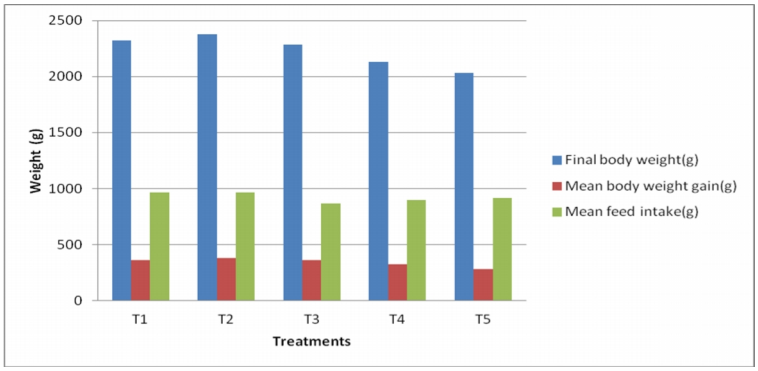

Fig. 2. Growth Performance of broilers fed diets supplemented with Activated coconut shell charcoal. (Finisher phase)

Table 2. Growth Performance of broilers fed diets supplemented with activated coconut shell charcoal. (Starter phase)

Parameters	T_1	T_2	T_3	T_4	T_5
Initial body wt(g)	33.33±0.00	33.30±0.00	33.30±0.00	33.23±0.00	33.33±0.00
Final body wt(g)	889.88±32.82	880.78±27.73	834.35±28.97	880.37±12.91	903.97±85.12
Mean wt gain(g)	218.61±23.89	211.95±28.17	200.29±29.91	199.60±10.83	209.43±84.46
Mean feed int(g)	387.66^{b}±22.61	401.28^{b}3.77	381.62^{b}±13.64	382.68^{b}±13.94	445.82^{a}±11.22
FCR	1.76^{a}±0.06	1.82^{ab}±0.05	1.82^{ab}±0.02	1.84^{ab}±0.04	1.92^{b}±0.13
PER	7.34±0.91	8.02±0.48	7.99±0.06	8.17±0.19	8.34±0.37

Means on the same row with different superscript are significantly different (P<0.05)
T_1-0% activated charcoal supplementation. T_2-0.5% activated charcoal supplementation.
T_3-1% activated charcoal supplementation. T_4-1.5% activated charcoal supplementation.
T_5-2% activated charcoal supplementation.
Int = intake, wt = weight, FCR = Feed conversion ratio, PER = Protein efficiency ratio.

Table 3. Growth performance of broilers fed diets supplemented with activated coconut shell charcoal. (Finisher phase)

Parameters	T_1	T_2	T_3	T_4	T_5
Initial body wt(g)	889.88±32.82	880.78±27.73	834.35±28.97	880.37±12.91	903.97±85.12
Final body wt(g)	2324.70^{a}±120.15	2378.50^{a}±50.67	2284.90^{a}±93.67	2131.40^{a}±65.42	2034.60^{b}±44.56
Mean wt gain(g)	358.59^{ab}±97.26	382.74^{a}±130.57	362.59^{ab}±87.99	325.29^{ab}±77.63	282.60^{b}±40.57
Mean feed int(g)	964.04±32.67	967.39±11.13	868.91±113.66	899.65±14.48	915.52±32.62
FCR.	2.92^{b}±0.19	2.32^{c}±0.28	2.74^{ab}±0.14	2.96^{b}±0.16	3.75^{a}±0.19
PER.	7.53^{ab}±0.29	8.11^{a}±0.80	7.45^{ab}±0.25	7.01^{ab}±0.47	6.57^{b}±0.13

Means on the same row with different superscript are significantly different (P<0.05)

The result of growth performance of broilers fed diets supplemented with Activated coconut shell charcoal (Table 3, Fig. 2) revealed statistical differences in the final body weight and mean body weight gain. Birds fed 0.5 % activated coconut shell charcoal supplementation had higher weights in terms of final body weight and mean body weight gain. The observation in this study is in line with the report of [6]. The authors observed a decrease in body weight of broiler birds fed at 2 % at 49 days of age.

The experimental birds showed no significant ($P>0.05$) difference in body weight gain at the starter phase, however at the finisher phase (Table 3) the significant ($P<0.05$) difference observed agrees with the report of [14], Whose report suggested that activated charcoal supplementation at 2% affected average weight gain not through feed intake, but possibly dilution of nutrient concentration or possible nutrient binding [14]. The author reported that force feeding data with matured broiler roosters suggested less energy and protein availability when 2% activated charcoal was used in diet with less moldy corn.

The mean feed intake of 2% supplement group was higher ($P<0.05$) than the control and the other supplemented groups during the starter phase. However at the finisher phase feed intake was not ($P>0.05$) different. This result is consistent with those reported by [6] who also reported that oak charcoal showed similar result up to 28 days of age. This increase in feed intake might be the reason behind the increase in body weight at the starter phase.

There were ($P<0.05$) differences observed at the starter and finisher phases for feed conversion ratio. The starter phase revealed higher ($P<0.05$) efficiency of feed with the birds fed control diets (0% charcoal supplementation) in respect of the 2% supplemented group; it could be that increased supplementation reduced utilization of feed by the broilers. The observed results might be as a result of the source of activated charcoal used as reported by [14]. The authors suggested that activated charcoal made from willow tree affected average body weight gain. The authors corroborated that feeding activated charcoal at 2% supplementation might reduce energy and protein availability. The report of this study also agrees with the reports of [7], who used activated charcoal to feed laying hens. The authors reported that the effectiveness of activated charcoal is dose dependent. At the finisher phase the birds had higher ($P<0.05$) efficiency with birds fed 0.5% activated charcoal supplementation. This also might be as a result of feed utilization.

There was no ($P>0.05$) difference observed in protein efficiency ratio at the starter phase, however at the finisher phase ($P<0.05$) differences were observed. The proteins were effectively utilized by birds fed 0.5% activated coconut shell charcoal meal diet followed by 0% inclusion of the activated coconut shell charcoal meal diet. This might be as result of possible nutrient binding or dilution of nutrient concentration. This result is consistent with the report of [14] who stated that force feeding data with mature broiler rooster suggest less energy and protein availability when 2% activated charcoal was used in diet with less moldy corn. Leg problems were observed in birds fed 1.5% and 2% activated coconut shell charcoal meal diet. These developments were also reported by [14] who's report suggested that activated charcoal at 2% dosage could be harmful for the birds even in normal diets.

The ($P<0.05$) difference observed in Table 4 showed that faecal nutient digestibility of ash contents amongst birds fed activated coconut shell charcoal supplementation might be as a result of the mineral content of the charcoal used in the diets which might aids digestion in monogastric animals. [6] also reported that activated charcoal supplementation in broiler increases carcass ash content.

Table 4. Faecal nutrient digestibility of broilers fed diets supplemented with activated coconut shell charcoal

Parameters (%)	T_1	T_2	T_3	T_4	T_5
Dry matter	81.46±2.83	83.07±2.83	81.87±2.83	79.78±2.83	78.84±2.83
Crude protein	92.21±2.83	93.50±2.83	91.25±2.83	89.96±2.83	88.62±2.83
Ether extract	90.37±2.83	90.02±2.83	91.35±2.83	92.42±2.83	91.11±2.83
Ash	77.32^{ab}±2.83	71.88^{b}±4.24	78.92^{ab}±2.83	80.23^{ab}±2.83	81.23^{a}±2.83
NFE	70.40±2.83	76.03±2.83	75.19±2.83	72.05±2.83	71.90±2.83

Means on the same row with different superscript are significantly different (P<0.05)

4. CONCLUSION

It is therefore concluded that activated coconut shell charcoal supplementation had no significant effect on final body weight mean body weight gain. However, birds fed 0.5 % activated coconut shell charcoal supplementation had better performance amongst the parameters measured.

ACKNOWLEDGEMENT

The authors wish to express their profound gratitude to the Head of Department Animal Production. Federal University of Technology, Minna Niger state, Nigeria for permission to publish the study. The authors are also grateful to Ruojun Wang, College of Food Science and Nutritional Engineering, China Agricultural University, China, Dr. S. M. Lutful Kabir, Department of microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh, Bangladesh and one other Anonymous reviewer for adding quality to this work.

COMPETING INTERESTS

Authors have declared no competing interests.

REFERENCES

1. Onibi GE, Oluwatoyin EA, Adebowale NF, Ayodeji VA. Responses of Broiler Chickens in terms of performances and meat quality to garlic (*Allium sativum)* supplementation. Afr J Agric Res. 2009;4(5):pp.511-517.
2. TEWE OO. Microbial Degradation of cassava residues and their utilization for livestock feeding. Afr J. Root and Tuber.1997;2(1&2):129-131.
3. Binder EM. Managing the risk of mycotoxins in modern feed production. Anim Feed Sci Tech. 2007;133(1):149-166.
4. Afzal M, Zahid A. Effect of addition of a mycotoxin detoxiter in poultry feed containing different levels aflatoxin on the performance of broiler. Asian – Australia J Anim Sci. 2004;17(7):990-994.
5. Edrington TS, Kubena LF, Harley RB, Rotinghaus GE. Influence of super activated charcoal on the toxic effect of aflatoxin or T-2 toxins in growing broilers. Poult Sci.1996;76:1205-1211.
6. Kutlu HR, Unsa I, Gorgulu M. Effects of providing dietary wood (oak) charcoal to broiler chicks and laying hens. Animal Feed Science Technology Elsevier. 2000;90:213-226.

7. Ayanwale BA, Lanko AG, Kudu YS. Performance and egg quality Characteristics of pullets fed activated shea butter charcoal based diet. Internat J of Poult Sci. 2006;5(10):927–931.
8. Choi JY, Shinde PL, Kwon IK, Song YH, Chae BJ. Effect of wood vinegar on the performance, nutrient digestibility and intestinal microflora in weanling pigs. Asian-Autral J Anim Sci. 2009;22(92):267-274.
9. Hosh K, Yamamoto NT, Sako T, Koyama HM. Effects of activated charcoal on intra-ruminal lactic acid. Bull Nippon vet. 1991;40:22-28.
10. Jean RK, Alexis T, Berrain MM, Joseph T. Growth Performance and carcass characteristics of broiler chickens fed diet supplemented with graded level of charcoal from maizecob or seed of canarium schwein furtii engl. Tropcal Animal Health Production. 2010;43:51-56.
11. Nikoleavia I, Grigore AV, Zuanenski IL, Koval V. An experiment study of enterosorbents in salmonellosis. Zh. Microbial. Epedemol. Immunobiol. 1994;2:1-7.
12. AOAC. Association of official analytical chemist official method of Analysis19th edn; 1990.
13. SAS, Statistical Analysis Institute. The SAS system for windows. Release 801, SAS Institute, Cary, USA; 2000:943.
14. Wang RJ, Fui SX, Miao CH, Feng DY. Effects of different mycotoxins Adsorbents on performance, meat characteristics and blood profiles of Avian broilers fed mold contaminated corn (Asian – Australia Journal of Animal Science. 2006;19:No1:72–79).

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=191&id=5&aid=972