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Performance of Broilers Fed Graded Levels of Bio-Detheobrominized Cocoa Bean Shell (CBS) Based Diets

G. O. Adeyemo[1*], A. O. Ajayi[1] and O. O. Olubamiwa[2]

[1]Department of Animal Science, Faculty of Agriculture, University of Ibadan, Nigeria.
[2]Department of Animal Science, College Agricultural Sciences, Landmark University, Omu- Aran, Kwara State, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author OO designed the concept of the study and wrote the protocol. Author GOA reviewed the experimental design and supervised the feeding trials, wrote the first draft of the manuscript and all drafts of the manuscript. AOA carried out the feeding trials, managed the analyses of the study and was involved in contributing to the final drafts of manuscript.

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ABSTRACT

A study was carried out to observe the effect of bio-detheobromised cocoa bean shell based diets on the performance of broilers. One hundred and ninety six (196) day-old broiler chicks were randomly assigned to seven diets, with each diet replicated four times and seven birds allocated to each replicate. Cocoa Bean Shell was included at varying levels of 0, 5, 10, 15, 20, 25 and 30% in the diets. Results showed that Cocoa Bean Shell inclusion had significant influence on the final weight, weight gain, feed intake and feed conversion ratio ($p<0.05$), while there were no significant differences observed ($p>0.05$) for gut weight and primal cuts. It was observed that Cocoa Bean Shell inclusion at up to 10% had no adverse effect on the performance and primal cut output of broilers.

Keywords: Bio-detheobrominized cocoa bean shell; Broilers; Performance; Primal cut.

*Corresponding author: E-mail: gbemiadeyemo7@gmail.com, gbemiadeyemo@yahoo.com,

1. INTRODUCTION

In Nigeria, the seasonality of conventional food and feed sources (both legume and cereal grains) for human, livestock and industrial use has caused man and livestock to compete with each other for some food supplies [1]. This has resulted in high costs of such ingredients to a level that their ideal usage in livestock feeding becomes almost uneconomical. Cocoa bean shell (CBS), the thin husk immediately surrounding the cocoa bean, is a waste product from chocolate and cocoa milling industries. It is a potential tropical feed resource and its utilization in animal feeding will greatly reduce the disposal problem facing the cocoa processing factories [2]. CBS also has an intermediate buffer value between the protein and cereal sources of feed [3]. This suggests that animals consuming cocoa bean shell might not have difficulty in lowering the gastric pH thus, improving protein digestibility and utilization. Other waste products from cocoa such as cocoa pod husk, cocoa dust, and cocoa bean cake have been successfully utilized in livestock feeding [4,5]. Cocoa Bean shell and other by-products from cocoa contain theobromine, an alkaloid poisonous to animals which limits their use for livestock feeding [6]. Theobromine detoxification in the animal body is handled by the liver. Heat treatment, sun-drying, and boiling has been shown to reduce the theobromine present in cocoa bean by-products [7]. Studies have been carried out to find the optimum processing technique for detheobrominising cocoa bean shell for feeding laying hens. One of the most recent and proven methods of enhancing fibre digestibility is by fermentation with *Pleurotus spp.* [8]. *Pleurotus spp.* (giant mushroom) also known as wood white rot contains enzymes mainly laccase (LAC), and Manganese peroxidase (MnP), that degrade lignin present in vegetable [9].

2. MATERIALS AND METHODS

2.1 Fermentation of Cocoa Bean Shells with *Pleurotus Tuberigium*

The dried cocoa bean shells used for the fermentation were milled to a uniform particle size of 2mm using a hammer mill, after which composting took place. During composting, the substrate (cocoa bean shells) was spread on black polythene sheet. Water was sprinkled on milled CBS and turned several times until right moisture content was attained (probably, about 60-65%), which was determined by taking handful of the wetted substrate, squeezing it and ensuring no water droplets drip out between the finger, this is an improvised method of moisture determination. The substrate was then heaped to a height of 1.5m and covered with the polythene to protect it and was left for four days with intermittent turning over every two days to ensure equal distribution of water and heat throughout. [8]. This also ensured uniform degradation and replenishing of oxygen. The composted substrate was then supplemented with 4% calcium carbonate to control the pH of the materials during fermentation. The composted substrate was wrapped in aluminum foils in 200g portions and arranged in a pressure pot suspended in water and tightly covered under pressure. Sterilization was achieved by applying heat at105°C for 15 minutes. After the sterilized substance was cooled, the bottle containing the spawn was shaken to loosen the grains and then 2 grams of the grains was introduced into 200 grams of the substrate in each foil.

2.2 Inoculation and Incubation of CBS with *Aspergillus Niger*

The aluminum foils with the inoculated substrates were kept under room temperature to allow the growth of the mycelia on the substrates. The mycelia were grown for eight weeks on the substrate after which the substrate were dried and milled to homogeneity. One hundred grams of sterile CBS powder (Substrate) were inoculated with 1 gramme of *Aspergillus niger* spores. Substrate inoculated with the *A. niger* spores were kept in a room temperature condition for seven days after which diets containing graded levels of fermented CBS were formulated and compounded.

2.3 Experimental Design and Management of Birds Fed CBS Based Diets

One hundred and ninety six, 1 day old Ross broilers were randomly allotted to seven [7] dietary treatments in a completely randomized design with four replicates and seven birds per replicate. The diets contained graded levels of CBS at 0, 5, 10, 15, 20, 25 and 30% respectively. Fermentation reduced the theobromine content by approximately 56.85%. The approximate theobromine content in each of the diets therefore were 0, 2.5, 5, 7.5, 10, 12.5, 15 (g/kg) respectively. Diet one had no CBS and served as the control. The birds were reared on deep litter.

The usual conventional brooding practices and poultry management were observed during the experimental period. Routine vaccination schedule were strictly adhered to as recommended by the breeder farms.

3. DATA COLLECTION FROM BIRDS FED CBS DIETS

Birds were weighed at the beginning of the experiment and subsequently once a week. Average body weight gain and feed intake were determined on weekly basis for replicates of each diet. The efficiency of feed utilization was calculated as feed intake per unit body weight gain. One bird per replicate each of the seven treatment diets were randomly selected at eight weeks old, slaughtered, dressed and weighed to determine warm dressed weight. The carcasses were cut into several parts.

3.1 Proximate Composition of CBS and Diets

Table 1 shows the proximate composition of the fermented CBS (crude protein, crude fiber, either extract, ash) which were determined using AOAC method [10]. The content of theobromine in diets was determined using gravimetry method by Holmes [10]. The experimental starter and finisher diets are shown in tables 2 and 3 respectively

3.2 Statistical Analysis

All data obtained were analyzed using analysis of variance of the completely randomized design [11] and least significant difference was used to separate the treatment means at 5% level of probability.

4. RESULTS

The results shown in Table 4 indicated that there was significant difference observed for final weight, weight gain, feed intake and feed conversion ratio ($p<0.05$). A decreasing trend in final weight of the experimental birds as the level of cocoa bean shell inclusion in the diets increased from 5% to 30% was observed. Also values indicated a decrease in the weight gain of birds fed cocoa bean shell diets as the inclusion level of cocoa bean shell increased. At 5 and 10% inclusion weight gain was higher than on the control diet. However at 25% inclusion, there was significantly lower weight gain compared with the control. Feed intake of birds fed CBS diets were also significantly influenced by the inclusion levels, with significantly lower values at 15 and 25% inclusion. FCR of birds fed CBS based diets was also influenced by the inclusion levels, with significantly higher vales from 20% inclusion and higher. The result shown in Table 5 revealed that there were no significant differences ($p>0.05$) in the percentage weights of the gut and primal cuts of birds fed varying levels of CBS. However gut weight was highest at 30% CBS inclusion, while the lowest was at 5% inclusion. Inversely, breast weights were however, highest at 5% inclusion level and the lowest was at 20% level of CBS inclusion.

Table 1. Chemical composition of cocoa bean shell

Component	Values
Dry matter (%)	84.52
Crude Protein (%)	14.98
Ether Extract (%)	2.39
Crude Fiber (%)	7.67
Ash (%)	11.66
Metabolizable Energy (kcal/kg)	2,800
Theobromine (mg/g)	50

5. DISCUSSION

The performance characteristics of broiler birds fed graded levels of bio-detheobrominized CBS-based diet indicated that there was a decreasing trend in the final weight of the experimental birds as the level of CBS inclusion in the diets increased from 5% to 30%. The lower values observed in the final weight of the birds at 15 and 30% CBS could be attributed to the low weight gain observed in the respective treatments. Therefore, low weight gain could result to low final weight. Birds fed CBS diets beyond the 10% inclusion level recorded low weight gain compared to those fed the control and 5%. The decrease in the weight gain of birds fed CBS based diet is suggested to be caused by poor utilization of nutrient by the birds especially as the crude fiber increases in the CBS based diets beyond 10% inclusion. There is also a likelihood of theobromine and/or other anti-nutrients binding or locking up essential nutrients thereby impairing their bio-availability to the birds thus, impeding the overall growth of the birds. However, it was observed that the inclusion level of CBS in the broiler diets had no effect on their feed intake. The optimum feed utilization was observed in birds fed 5% CBS, which had a lower FCR compared to value for the control diet. Also it was observed that as the level of dietary

CBS increased beyond 10%, there was a significant reduction in the feed conversion ratio of broilers fed CBS-based diets. This is in agreement with the findings of [5,12] that beneficial effects could be achieved in broiler starter and finisher diets if CBS is included at 10% level of inclusion beyond which weight gain was decreased and poorer feed to gain ratio resulted. The less varying values obtained for all parameters studied for carcass characteristics across the diets showed that there were less increases in volume and length of the bird's GIT due to a less variability in the feed intake of the birds fed the CBS-based diets.

Table 2. Composition of cocoa bean shell based diets fed to experimental birds at starter phase (kg/100kg)

Ingredients	0%CBS	5%CBS	10%CBS	15%CBS	20%CBS	25%CBS	30%CBS
CBS	0.00	5.00	10.00	15.00	20.00	25.00	30.00
Maize	53.00	50.00	46.00	43.00	40.00	37.00	34.00
Soya Bean Meal	38.00	36.00	35.00	33.00	31.00	29.00	26.00
Fish Meal	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Bone Meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00
DCP	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Limestone	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
B-Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Methionine	0.20	0.20	0.20	0.20	0.20	0.20	0.20
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Proximate analysis							
M.E(kcal/kg)	3,185.38	3,156.42	3,126.14	3,097.18	3,068.22	3,039.26	3,010.33
Crude Protein (%)	24.46	24.04	23.96	23.54	23.11	22.69	22.26
Ether Extract (%)	3.47	3.28	3.09	2.89	2.71	2.52	2.33
Crude Fiber (%)	3.55	3.76	3.80	4.03	4.84	4.95	5.21
Calcium (%)	1.20	1.55	1.79	2.04	2.29	2.53	2.46
Phosphorus (%)	0.61	0.54	0.68	0.82	0.96	1.09	1.23

M.E= Metabolisable Energy (kcal/kg)

Table 3. Composition of cocoa bean shell based diets fed to experimental birds at finisher phase (kg/100kg)

Ingredients	0%CBS	5%CBS	10%CBS	15%CBS	20%CBS	25%CBS	30%CBS
Cocoa Bean Shell	0.00	5.00	10.00	15.00	20.00	25.00	30.00
Maize	63.00	60.00	57.00	54.00	51.00	48.00	45.00
Soya Bean Meal	31.00	29.00	27.00	25.00	23.00	21.00	19.00
Fish Meal	0.70	0.70	0.70	0.70	0.70	0.700	0.70
Molasses	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bone Meal	1.50	1.50	1.50	1.50	1.50	1.50	1.50
DCP	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Limestone	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
B-Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Methionine	0.15	0.15	0.15	0.15	0.15	0.15	0.15
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Proximate analysis							
M.E(kcal/kg)	3,224.93	3,195.97	3,167.01	3,138.05	3,109.09	3,080.13	3,051.71
Crude Protein(%)	20.31	19.89	19.46	19.04	18.61	18.91	18.76
Ether Extract(%)	3.62	3.42	3.24	3.05	2.86	2.67	2.48
Crude Fibre(%)	3.29	3.40	3.80	4.55	4.90	5.26	5.50
Calcium(%)	0.81	1.06	1.31	1.55	1.79	2.02	2.29
Phosphorus(%)	0.45	0.52	0.65	0.79	0.92	1.06	1.98

Table 4. Performance of broilers fed graded levels of cocoa bean shell based diets (kg)

Parameters	0%CBS	5%CBS	10%CBS	15%CBS	20%CBS	25%CBS	30%CBS	SEM
Initial weight	0.0495	0.0478	0.0475	0.0540	0.0523	0.0498	0.0498	0.0001
Final weight	1.815[a]	1.943[a]	1.85[a]	1.608[ab]	1.615[ab]	1.31[b]	1.508[ab]	0.0673
Weight gain	1.766[ab]	1.897[a]	1.802[a]	1.554[ab]	1.563[ab]	1.26[c]	1.458[abc]	0.0683
Feed intake	3.843[a]	3.85[a]	3.873[a]	3,525[b]	3.943[a]	3.643[b]	3.828[a]	0.0778
FCR	2.208[b]	2.055[b]	2.215[b]	2.28[b]	2.633[a]	2.935[a]	2.63[a]	0.1313

Means with different super scripts are significantly different (P≤0.05)

Table 5. Weights of gut and primal cuts of broiler birds fed cocoa bean shell based diets (percentage of dressed weights)

Parameters	0%CBS	5%CBS	10%CBS	15%CBS	20%CBS	25%CBS	30%CBS	SEM
Gut	14.51	13.22	13.43	15.46	15.69	15.56	16.50	3.16
Wing	7.97	7.90	8.04	7.99	7.623	7.60	8.04	0.41
Breast	22.15	22.62	21.31	20.39	20.00	20.19	20.20	2.53
Thigh	11.02	10.96	11.17	11.26	10.86	10.37	10.94	0.24
Drumstick	10.29	10.73	10.32	10.64	10.48	9.67	10.59	0.47
Back	15.64	15.94	15.90	14.29	15.09	15.75	14.85	0.91

Means with no super scripts are not significantly different (P>0.05)

6. CONCLUSION AND RECOMMENDATION

Results of this study revealed that the bird's overall growth and feed utilization was adversely affected when dietary cocoa bean shell inclusion exceeded 10%. The bio-availability of nutrients is a desired essential characteristic of feedstuffs in animal nutrition. Thus, additional research is needed to find further techniques of processing cocoa bean shell so that its theobromine content could be further reduced since it affects the bioavailability of nutrients to animals.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Adeyemo GO. Effects of exposure duration to cotton seed cake based diets on broiler performance. International Journal of poultry science. 2010;9(2):162-166.
2. Aina AA. Potential of Cocoa by-product as livestock Feeds. Proceeding of National Workshop on Alternative Formulation of Livestock Feed held at ARMTI, Ilorin. 1998:21- 25.
3. Carolien M. Acid Binding Capacity in feedstuffs. Feed Int. 2001;21-25
4. Odunsi AA, Longe OG. The nutritive value of hot water or cocoa pod ash solution treated cocoa bean cake for broiler chicks. Brit. Poult. Sci. 1998;39:519-525.
5. Olubamiwa O, Soetan O A, Olamijulo OA, Hamzat RA, Longe OG. Utilization of variously treated cocoa bean shells in layer mash. Proc., 27th Annual Conf., Nig. Soc. of Animal Production (NSAP) March 17-21, 2002, Fed. University of Technology, Akure, Nigeria. 2002;267-269.
6. F. A. O. Animal Feed Resources Information System. Tropical feeds. 2002;76-82.
7. Menon MA. Cocoa by-products and their uses. Planter, Kuala Lumpur. 1982:58:286 -295.
8. Alemawor F. Dzogbefia VP, Oldham JH, Oddoye OK. Effect of fermentation on the composition of cocoa pod husk: Influence on time and Mn2+ supplementation on the fermentation process. African Journal of Biotechnology. 2009;8(9):1950-1958.
9. Abreu LD, Marino RH, Mesquita, JB, Ribeiro GT. Degradação da Madeira de *Eucalyptus sp.* porbasidiomicetos de podridãobranca. Arq. Inst. Biol. 2007;74:321-328.
10. Association of Official Analytical Chemists. Methods of Analysis, 15th edition, Arlington, VA. 2002;4:54.

11. SAS, Statistical Analysis System Institutes. User's guide SAS Instiute Inc. Cary N.C; 2010.

12. Hamzat RA, Babatunde. Utiljzation of cocoa bean shell as a feed ingredient for broiler chickens. Proceedings of the 15th International Cocoa Research Conference, Costa Rica. 2006;84-86.

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