

Morphometric Traits in Arbor-Acres Broiler Chicken (*Gallus gallus*) Fed Graded Levels of Cocoa Bean Shell Meal

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Target audience: Farmers, broiler line breeders; Animal scientists.

Abstract

Fifty sixth day morphometric and body weight measurements were taken on one hundred and forty eight Arbor Acres broiler chickens reared under the Deep Litter system in the guinea savana Zone of Nigeria. This study aimed to determine the effects of substituting treated and untreated Cocoa Bean Shell (CBS) at 50 and 100% inclusion levels for Wheat bran (WB) on final live weight and morphometric body measurements. Data were taken from birds that were randomly allotted into five different isocaloric and isonitrogenous diet treatments (T) replicated threetimes with graded levels of CBS substituted for WB (0% replacement of WB by CBS was the control, T₂(50% untreated CBS), T₃(50% treated by boiling CBS), T₄(100 %untreated)and T₅(100% replacement of wheat bran with treated CBS). Data obtained were analysed with one way ANOVA using SAS (2004) software at 5% probability level and means compared with the Duncan's New Multiple Range Test option of the software. Results showed that, T₃ with 50 % replacement with treated (by boiling) CBS performed best in terms of body weight (3143 ± 0.08 g) at $p < 0.05$ although with no significant difference with the value in the control (0 % replacement) (3089 ± 0.06 g) and T₂ 50 % untreated (3070 ± 0.08 kg) respectively. Body length ranged between 41.60 ± 0.34 (100 % replacement with untreated CBS) and 42.24 ± 0.34 cm (50 % treated CBS) although no significant difference ($p > 0.05$) was detected across all the treatments for this trait. The values for chest circumference ranged between 37.53 ± 0.37 cm (lowest) in 100 % replacement with untreated CBS and 39.13 ± 0.27 cm (significantly highest ($p < 0.05$)). The values for shank length ranged between 8.25 ± 0.16 and 8.65 ± 0.15 cm with no significant difference ($p > 0.05$) between the treatment groups. Other traits with no significant differences ($p > 0.05$) across all the treatments and their ranges in parenthesis are wing length (21.38 ± 0.25 and 21.97 ± 0.21 cm); head length (7.72 ± 0.13 and 8.04 ± 0.15 cm); neck length (14.13 ± 0.40 and 14.67 ± 0.19 cm) and beak length (2.47 ± 0.04 to 2.56 ± 0.04). Other traits that showed significant differences ($p < 0.05$) across treatment groups include, thigh length with T₂ showing highest value (20.98 ± 0.18 cm) and the lowest value was recorded in T₅ ($19.83 \pm$

0.30 cm). Comb length also ranged between lowest in T_5 (3.91 ± 0.28 cm) and highest in T_3 (5.00 ± 0.34 cm). The longest Toe length was recorded in T_2 (8.20 ± 0.11) while the shortest was recorded in T_5 . The results from this study indicated that treated CBS meal at inclusion level of 50% in replacement for WB is a good substitute for WB with no negative effects on the body morphology in Arbor Acres broiler chicken.

Key words: morphometric traits, Cocoa Bean Shell, Arbor-Acres, broiler chicken

Description of the problem

The most critical challenge facing the poultry production in Nigerian is the cost and unavailability of the conventional feedstuffs in which Wheat bran (WB) is among. This has resulted in the continuous abandonment of the poultry business as a result of consistent inability to break even throughout the production cycles in both Broiler and laying enterprises. This has affected the entire players in the industry due to increase in cost of production and subsequent effect on the profit margin in the poultry business in Nigeria. Oluyemi and Roberts (1) indicated that feed account for 66% or more of the total cost of broilers production and a shift to alternative sources of ingredients especially non-conventional sources may help especially when the ingredients are of less competition and are sufficiently available.

Wheat bran (WB) is a by-product in the production of flour from whole wheat in the flour mills. It is abundant but the continuous demand for Wheat bran (WB) to feed other species of livestock which include pigs and other small ruminants had placed increased demand on WB. This has increased the cost and thus an increase in cost of poultry feed. In quest for alternative feed ingredient sources for the poultry industry, several agro allied by products had been experimented as feed

resources in the poultry industry. These include wild Sunflower meal (2); Rice Bran (3); Cocoyam corm meal (4) and (Mango seed kernel (5).

Commercial broiler chickens are bred to have very fast growth rate, high feed conversion efficiency and to attain table size at the shortest possible time. There are many breeds of broilers chickens that are kept by poultry farmers in Nigeria. Partial listing of the available broiler breeds include; Arbor-Acres, Marshal, Hubbard and Anak 2000. Arbor-Acres broiler breed was used in the study because of the nearness of the hatchery and the breeder farm to the location of this study. The two locations are in the guinea savana zone of Nigeria.

Many studies had been conducted on the possible use of cocoa by-products as feed ingredient for poultry, these include (6) using cocoa pod husk; (7); (8); in replacement of maize in layers (9) and (10); Cocoa bean shell. CBS as a waste product from chocolate and cocoa milling industries and that it is the husk immediately surrounding the cocoa bean. It is available in large quantities and its inclusion in animal feed will reduce the cost of its disposal in cocoa processing factories. Gohl (11) reported that CBS is high in nutritive value but it contains Theobromine. Ching and Wong (12) indicated that theobromine is a member of naturally occurring methylated Xanthine group as

caffeinewhich is an anti-nutritional factor in this feed resource. Olubamiwa and Hamzat (13), however reported that the anti-nutritional compound could be reduced by heat, sun drying and boiling. None of the reports in the use of cocoa by-products had shown the effects on morphometric traits in broiler chickens. Thus, this study seeks to assess the effect of substituting CBS for WBat graded levels on body weight and morphometric traits in Arbor-Acres broiler breed.

Materials and methods

Location

The experiment was conducted in the broiler pen at the Poultry Unit of the Landmark University Teaching and Research Farm, Omu Aran. Omu - Aranis located 88 kilometers South of Ilorin, capital of Kwara State and 16km North-East of OtunEkiti, in Ekiti State. It is located on Latitude 8.9^oN and Longitude 50.61^oE. The climate is tropical maritime with long wet season, the weather is moderate, subject to modest variations of hot and cool as the season changes. Rain is typically heavy and the season lasts for about eight months in a year. It lies within the zone that enjoys the highest rainfall in Kwara State. The soil is rich with a large expanse of greenery typical of guinea savannah. The soil favours the production of food crops and cash crops including cocoa, kola and oil palm (14).

Experimental birds and management

One hundred and fifty day old Arbor-Acre broiler chicks were purchased from Yammy Farms in Offa, Kwara State. The birds were managed on a deep litter system with wood shavens as the

bedding materials. Feed and water were given to the birds *ad-libitum*. The pens were partitioned into cubicles with wire mesh and wood frames of dimensions 3 m × 1.5 m which housed each replicate of ten birds each. Prior to the arrival of the birds, the pens were washed with detergent and disinfectant (Lysol[®]). After this, the whole building was disinfected and cross ventilation was allowed to dry the floor and the pen was shut and re-disinfected to avoid any carry over contamination from the previous productions. The feeders and drinkers were also washed and dried. Then properly dried wood shaven was spread evenly on the floor of the cubicles. Foot dip was prepared on a daily basis at the entrance of the pen. Heat for brooding was supplied using coal as the source of heat for a period of two weeks. Other source of heat was the suspended 100watts electric bulbs in each cubicle. The initial temperature for brooding on arrival was 35^oc and temperature was gradually reduced to environmental temperature at the end of the two-week brooding period.

The birds were vaccinated following a vaccination schedule provided by the veterinarian. The experiment lasted for eight weeks (August 28, 2014 to the 16th of October 2014). On arrival (day one) birds were served water with Glucose D[®], Vitalyte (anti-stress) dissolved in it. Conflux antibiotics was also mixed with water from day 2 to day 8, while on the 12th day the first a gumboro vaccine was administered orally. On day-20, Lasota vaccine was also administered via water and prophylactic anticoccidiosis treatment with Amprolium commenced on the 24th day

and lasted for two days. The second Gumboro and Lasota vaccines were administered on the 30th and 37th day respectively. Antibiotics (Neoceryl plus) was administered from the 44th day till 48th day and enbazine forte was mixed with the water simultaneously from 44 to 46d. Finally, Embazin forte was administered from 49th to 51st day. Routine operations which included cleaning and washing of drinkers and the feeders were done daily.

Experimental Diet

The study is part of a large scale study on effects of replacing WB with CBS by the second author in Landmark University Teaching and Research Farm. The birds were fed with a common diet (commercial diet) for the first one week after which the birds were weighed and randomly distributed into replicates. The dietary formula is such that meets the standard nutritional requirements of broiler chickens as given by (15), that is, 23% crude protein and 2800kcal energy for starter ration; 20% crude protein and 3000kcal energy for finisher ration. The cocoa bean shell for the experiment was obtained from Ile Oluji cocoa products Ltd. Ile Oluji, Ondo State. Other feed ingredients used were purchased and compounded at "Ola Jesu" Feed Mill in Omu-aran, Kwara State. Diet 1 was the control diet with 0% WB replacement with CBS meal; Diet 2 was 50% replacement of wheat bran with untreated CBS; Diet 3 was 50% replacement of wheat bran with treated (15 minutes boiling) CBS; Diet 4 had 100% replacement of WB with untreated CBS and Diet 5 was 100% replacement

of wheat bran with treated CBS. The treatment that was imposed on the CBS was boiling for fifteen minutes. Details of the procedure are as explained by (9)

Experimental design

The birds were raised from day old to the end of the first week with a commercial diet. Birds were weighed and randomly distributed into their respective labelled pens. Feeding with the experimental diets commenced and lasted for the remaining seven weeks of the experiment. Birds were randomly allocated to treatment and replicated three times with 10 birds per replicate making 30 birds per treatment in a Completely Randomized Design (CRD).

Data collection

ACamry[®] top loading weighing scale of 20-Kg capacity and a tailor's measuring rule with a side graduated in Cm were used to measure the live body weight and 10 morphometric traits respectively. These measurements were taken on 148 mature broiler birds at 56th day of life. The measurements were taken according to the procedures of (16), (17) and (18). These include live weight (LWT) taken on a top loading scale. Body length (BL) was measured as the distance between the tip of the Rostrum maxillare (beak) and that of the Caudal (tail without feathers). Chest circumference (CC) was taken behind the wings at the anterior borders of the breast-bones crest and the central thoracic vertebra. The shank length (SL) was measured as the distance from the shank joint to the extremity of the Digitus pedis and one wing span (WS) measured by stretching out the left upper wings and measured from the point of attachment to the body and the tip.

Others are thigh length (THL) The distance between the hock joint and the pelvic joint; comb length (CL); horizontal distance from the beginning to the end of the comb; head length (HL):The distance between the occipital bone (bone situated at the back and lower part of the skull), to the insertion of the beak into the skull (where the plumage starts). neck length (NL): distance between the occipital condyle and the cephalic borders of the coracoids, toe length (TL) The longest toe was measured distance between the spur and the claw while beak length (BL) was the measured distance from rectal apterium to the maxillary nail.

Statistical analysis

Data were analysed using the one-way analysis of variance. Duncan's New Multiple Range Test option of Statistical Analysis Systems software (19) was used to separate the significant means.

Results and Discussions

Tables 1 and 2 show the percentage composition of the feeds used at both the starter and finisher phases respectively. All the diets contained same % of all the ingredients except WB that was substituted for at graded levels of 50 and 100 % untreated and treated CBS meals. Diet 1 contained 8 % WB with 0 % inclusion both untreated and treated (boiled) CBS meal. Table 3 shows the live weights across all the treatments at

56th day, it indicates that Abor -Acre broilers are fast growing and early maturing with the live weight ranging between 2807 ± 0.06 g (100 % untreated replacement of WB) which was the lowest and 3143 ± 0.08 g (50 % treated by 15-boiling) that showed the highest value. This live weight was not significantly different ($p > 0.05$) in the control treatment (3080 ± 0.06 g), T₂ at 50 % inclusion of untreated CBS (3007 ± 0.08 g) and T₃ (50 % replacement of WB with treated 15-minutes boiling of CBS) was 3014 ± 0.08 g. However, there was a significant reduction in body weight ($p < 0.05$) in the two treatments of 100 % untreated and treated CBS replacements for Wheat bran. Reduction in body weight at higher level of inclusion of the test ingredient (Treatments 4 and 5) could have been due to low feed intake caused by residual theobromine content. This indicates that Abor-Acres broiler birds will not be able to tolerate the replacement of CBS treated and untreated for WB higher than at 50 % level. This can be deduced from the lower values of 2810 ± 0.06 g and 2870 ± 0.06 g in treatments 4 and 5 in Table 3. This result is in the same trend with the report of (9) although in Laying hens where no significant difference was observed between 15- minutes boiling diet at 20 % replacement level of maize with the control diet ($p > 0.05$).

Table 1: Ingredient composition of the experimental starter diets (%)

Ingredient	Diet 1	Diet 2	Diet 3	Diet4	Diet5
Yellow maize	53.00	53.00	53.00	53.00	53.00
Soya bean meal	17.00	17.00	17.00	17.00	17.00
Groundnut cake	18.00	18.00	18.00	18.00	18.00
Wheat bran	8.00	4.00	4.00	0.00	0.00
Untreated CBS	0.00	4.00	0.00	8.00	0.00
Treated CBS	0.00	0.00	4.00	0.00	8.00
Fishmeal	1.50	1.50	1.50	1.50	1.50
Oyster shell	0.80	0.80	0.80	0.80	0.80
Bone meal	0.25	0.25	0.25	0.25	0.25
Lysine	0.30	0.30	0.30	0.30	0.30
Methionine	0.45	0.45	0.45	0.45	0.45
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Total	99.80	99.80	99.80	99.80	99.80
Crude protein (%)	23.20	23.20	23.20	23.20	23.20
ME (Kcal)	2921.32	2921.32	2921.32	2921.32	2921.32

Premix provided per kg diet: Vitamin A 15,000 I.U., Vitamin D₃ 3000 I.U., Vitamin E 15 I.U., B₁₂ 0.013 mg, Vitamin K 4 mg, Riboflavin 10 mg, Folic acid 2 mg, Nicotinic acid 44 mg, Pantothenic acid 13 mg, Biotin 0.064 mg, Vitamin B₁ 2.2 mg, Vitamin B₆ 5.5 mg, Choline Chloride 350 mg, Copper 6.25 mg, Iodine 1.5 mg, Zinc 62.5 mg, Manganese 62.5 mg, Selenium 0.1 mg, BHT (Antioxidant) 100 mg, Zinc Bacitracin 10 mg.

Table 2: Ingredient composition of the experimental finisher diet (%)

Ingredient	Diet1	Diet 2	Diet 3	Diet 4	Diet 5
Yellow maize	63.80	63.80	63.80	63.80	63.80
Soya bean meal	12.00	12.00	12.00	12.00	12.00
Groundnut cake	12.00	12.00	12.00	12.00	12.00
Wheat bran	8.00	4.00	4.00	0.00	0.00
Untreated CBS	0.00	4.00	0.00	8.00	0.00
Treated	0.00	0.00	4.00	0.00	8.00
Fishmeal	2.00	2.00	2.00	2.00	2.00
Oyster shell	0.70	0.70	0.70	0.70	0.70
Bone meal	0.25	0.25	0.25	0.25	0.25
Lysine	0.30	0.30	0.30	0.30	0.30
Methionine	0.45	0.45	0.45	0.45	0.45
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Crude protein (%)	19.63	19.63	19.63	19.63	19.63
ME (Kcal)	2921.32	2921.32	2921.32	2921.32	2921.32

Finisher Premix provided per kg diet: Vitamin A 10,000 I.U., Vitamin B 2000 I.U., Vitamin E 13,000 I.U., Vitamin K 1500 mg., Vitamin B₁₂ 10 mg, Riboflavin 5000 mg, Pyridoxine 1300 mg, Thiamine 1300 mg Folic acid 500 mg, Nicotinic acid 28,000 mg, Pantothenic acid 8000 mg, Biotin 40 mg, Copper 7000 mg, Iodine 60mg, Manganese 48000 mg, Iron 58000 mg, Selenium 120 mg, Zinc 58000 mg, Cobalt 300 mg, Choline 2750 mg.

Table 3 showed that there were no significant differences ($p > 0.05$) among body lengths from all the treatments, it ranged between 41.60 ± 0.34 cm (untreated CBS) and 42.24 ± 0.34 cm (50 % untreated replacement). This indicates that there is no detrimental effect for substituting WB with treated or untreated CBS in this broiler breed. This implies that at critical moments during scarcity of WB the poultry industry make use of CBS meal in replacement of WB. There were significant differences in the chest circumference ($p < 0.05$) with treatment T₂ (untreated CBS) having the highest chest circumference (39.13 ± 0.27) followed by Treatment 3 (38.91 ± 0.32) followed by the control diet T₁, 38.83 ± 0.38 . However, treatments 4 and 5 with 100 % treated and untreated replacement had the least values of 37.53 ± 0.37 and 38.08 ± 0.32 cm respectively. This indicates that 100 % inclusion for both treated and untreated CBS meal will affect chest circumference in this broiler breed. This result of significant differences in chest circumference is consistent with the trend in the effect of CBS on weight which indicates that there is a relationship between body weight and chest circumference. It must be noted that chest breast meat is highly valuable trait in broiler production. The shank length and one wing span ranged between 8.25 ± 0.16 to 8.65 ± 0.15 and 21.38 ± 0.25 to 21.97 ± 0.21 although there was no significant difference ($p > 0.05$)

between the treatments in these two traits. The significantly longest ($p < 0.05$) thigh length is in treatments 2 and 1 with values of 20.98 ± 0.18 and 20.83 ± 0.29 respectively. This is noteworthy since the meat from the thigh muscle in broiler production is another important economic trait for profitability. The least thigh lengths occurred in treatments 5 and 4 with 100 % inclusion of untreated and treated CBS. This indicates that 100 % inclusion level has negative effect on the thigh length in this broiler breed. It is also consistent with the trend in the effect of CBS meal on body weight. Comb length is also negatively affected by 100 % inclusion of treated and untreated CBS meal in treatments 5 and 4 (in Table 3). The least comb lengths 3.91 ± 0.28 (occurred in treatment 5 and the highest mean was in treatment with 0 % inclusion of CBS meal. Treatment 1). There were no significant differences ($p > 0.05$) among the means in head, neck and beak lengths. The means ranged between 7.72 ± 0.13 to 8.04 ± 0.15 , 14.13 ± 0.40 to 14.67 ± 0.19 and 2.47 ± 0.03 to 2.56 ± 0.04 for head, neck and beak lengths respectively. There is significant difference in the toe length with the highest mean in Treatment 2 (8.20 ± 0.11) where wheat bran was substituted with 50 % CBS meal and least recorded again in treatment 5 with 100 % level of substitution of Wheat bran. The toe length is of no significant economic value in broiler production since it is treated as offal during processing and packaging.

Table 3: Means and standard errors of body weight and morphometric measurement of the different treatments

Parameters	T1 (0%Control) Mean± SE	T2(50% Untreated) Mean± SE	T3(50% Treated) Mean± SE	T4(100% Untreated) Mean± SE	T5(100% Treated) Mean± SE
Body weight (Kg)	3089 ±0.06 ^a	3070±0.08 ^a	3143±0.08 ^a	2807±0.06 ^b	2873±0.06 ^b
Body length (Cm)	41.85±0.42	42.24±0.34	42.11±0.40	41.60±0.34	41.93±0.32
Chest circumference (Cm)	38.83±0.38 ^{ab}	39.13±0.27 ^a	38.91±0.32 ^{ab}	37.53±0.37 ^c	38.08±0.32 ^{bc}
Shank length (Cm)	8.31±0.11	8.65±0.15	8.59±0.15	8.57±0.14	8.25±0.16
Wing span (one wing) (Cm)	21.43±0.51	21.89±0.23	21.92±0.22	21.97±0.21	21.38±0.25
Thigh length (Cm)	20.83±0.29 ^a	20.98±0.18 ^a	20.46±0.23 ^{ab}	20.39±0.28 ^{ab}	19.83±0.30 ^b
Comb length (Cm)	4.93±0.32 ^a	4.80±0.28 ^a	5.00±0.34 ^a	4.23±0.27 ^{ab}	3.91±0.28 ^b
Head length (Cm)	7.72±0.13	8.02±0.15	8.04±0.15	7.93±0.11	7.81±0.31
Neck length (Cm)	14.13±0.40	14.67±0.19	14.53±0.16	14.63±0.20	14.19±0.28
Toe length (Cm)	8.03±0.12 ^a	8.20±0.11 ^a	8.01±0.15 ^a	7.94±0.11 ^{ab}	7.60±0.13 ^b
Beak length (Cm)	2.56±0.04	2.47±0.03	2.49±0.03	2.51±0.04	2.51±0.29

Means in each row with different superscript a, ab, bc and c are significantly different ($P < 0.05$). T1= Treatment 1 (control diet), T2=Treatment 2, T3 =Treatment 3, T4 = Treatment 4 and T5= Treatment 5. SE= Standard Error

Conclusion and Application

It was observed that, birds

1. From 50 % inclusion diet (15-minutes boiled CBS) performed better than the other treatments and the control diet in the most valued economic trait in broiler production. That is, the breast muscles that is found around the chest circumference in this study.
2. It can also be concluded that, CBS can be used in replacement for WB up to 50 % treated or untreated levels of inclusion without any negative effect on live body weight.
- 3 This study recommends that, further investigations should be carried out to ascertain the actual age at which this broiler breed will attain a live weight of between 1700 to 2000 g so that it could be harvested for commercial processing thereby increasing the profit of the broiler chicken producers.
- 4 Furthermore, studies should be carried out on the effect CBS on body weight, morphometric traits and carcass

characteristics in other broiler chicken breeds.

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