

## Evaluation of performance, carcass characteristics, serum biochemistry and hematological parameters of broilers fed graded levels of raw cocoa bean shell based diet

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### Abstract

Competition exists between man and his livestock for conventional feed ingredients like maize. This has necessitated the search for alternative ingredients. Large quantities of cocoa bean shell are produced and wasted annually by farmers and associated processing industries in Nigeria. A total of one hundred and fifty day-old Anak broiler chicks were randomly allotted to five dietary treatments with 30 birds per treatment, replicated thrice, in a completely randomised design. The treatments were: A (0% CBS-control diet); B (5% RCBS); C (10% RCBS); D (15% RCBS) and E (20% RCBS). Birds were fed ad libitum throughout the experimental period of eight weeks. The feed intake and weight gained were monitored. Carcass analysis, serum and hematological parameters such as total protein, albumin, globulin, cholesterol, glucose, creatinine, red blood cell, white blood cells, hemoglobin and packed cell volume were determined. Significant differences were observed in the feed intake, the birds fed with the control diet A had the highest feed intake 4556.50gm compared with birds fed diet D and E with mean values of 4177.50gm and 4097.00gm respectively. The highest weight gain was obtained from birds on control diet (1952.00gm) and the lowest from birds with 20% RCBS (1550.00gm, diet E). As the level of inclusion of RCBS increased the feed conversion ratio value increased. The dressed out percentage ranged from 73.67% - 67.00%. Apparent variations in the values obtained for total protein, creatinine, red blood cells, hemoglobin and packed cell volume of the birds fed graded levels of RCBS were not significant. However, white blood cells and globulin values increased with increase in the level of CBS in the diet. RCBS could effectively replace up to 10% maize in the diets of broilers without a deleterious effect on broiler chicken.

**Keywords:** Competition, graded level, cocoa bean shell, carcass, hematology.

### Introduction

Poultry production in the tropics is facing the challenges of poor nutrition (Babayemi *et al.*, 2004). Livestock and poultry generally compete with humans for maize grain. Therefore other sources of energy in poultry feeds must be found in order to reduce the cost of production. Cocoa bean shell (CBS) is a waste product from chocolate and cocoa processing industries, the disposal of which is causing problem. This “wastes” can therefore be converted

into “wealth” in the form of feed for poultry. This CBS has high nutritive potential but it is of limited use in animal feeds because of its theobromine content (Gohl, 1981). Previous studies (Akinsoyinu *et al.*, 2008 and Olumide *et al.*, 2008) have shown that the addition of Rovabio enzyme and fermentation reduces its theobromine content. Cocoa (*Theobroma cacao*) tree is widely cultivated in Nigeria. In addition to the highly flavored cocoa butter that cocoa tree produces, by products such as cocoa

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pod husk and cocoa bean shell can also be obtained from it (Owosinbo *et al.*, 2007). Cocoa bean shell is a potential feed resource and its utilisation by animals will greatly reduce disposal problem facing cocoa processing industries. However, the occurrence of theobromine and caffeine in plant parts of cocoa has limited the direct use of most of these products in livestock rations (Sananakaye and Wijesekara, 1971). Cocoa bean shell contains 1.3-2.0% theobromine, which limit its use as animal feed ingredient (Owusu-Domfeh, 1970; Gohl, 1981; Abiola and Tewe, 1991). Cocoa by products must be processed to reduce the theobromine content before they can be satisfactorily offered to livestock. The different methods of processing include boiling, drying, alkali and urea treatment. Odunsi and Longe (1999) reported the effectiveness of alkaline and boiling treatment of cocoa bean cake in reducing theobromine level and improving performance of broilers. The exploitation of the potentials of cocoa bean shell appears rational and more economical than their disposal problems. Olubamiwa *et al.* (2006) worked on the effect of boiling time on the utilisation of cocoa bean shell in laying hen feed and the result showed that 15min boiling duration is best for optimal and profitable utilisation of cocoa bean shell in layers mash. However, there is paucity of information on the use of graded levels of raw cocoa bean shell in the diets of broiler birds. Therefore, the objective of this study is focused on evaluation of performance, carcass characteristics, hematology and serum biochemistry of broilers fed graded levels of cocoa bean shell based diets.

### **Materials and methods**

#### ***Experimental site***

The research was carried out at the Poultry section of Kolmart Farm, Erunmu, Egbeda,

Ibadan, Oyo State, Nigeria.

#### ***Experimental birds and management***

A total of one hundred and fifty, One-day old Anak broiler strain were used for this research. Birds were randomly allotted to five dietary treatments with ten birds per replicate in a completely randomised design. The CBS used in this study were sourced from cocoa industry in Ikeja, Lagos. The treatments were: A (0 % CBS- control), B (5 % RCBS), C (10 % RCBS), D (15 % RCBS) and E (20 % RCBS). Tables 1 and 2 shows the composition of starter and finisher diets respectively. A total of five experimental starter and five experimental finisher diets were formulated, in which maize was replaced with graded levels of raw cocoa bean shell. The birds were kept on starter diet for 4weeks and 4 weeks for finisher diet. The birds were fed *ad libitum*. Other daily management operations were carried out as outlined according to Oluyemi and Robert (1979).

The initial weight was measured on first day of the experiment and subsequently on weekly basis, weight gain (WG) was computed as final weight (FW) – Initial weight (IW). Feed Intake (FI) was obtained as the measurement of the quantity of feed consumed on a weekly basis.  $FI = \text{Amount of feed consumed} - \text{Amount of feed remaining}$ . Feed Conversion Ratio (FCR) =  $\text{Feed intake (g)} / \text{Weight gain (g)}$ . Mortality was measured in percentage as  $\text{number of dead birds} / \text{total number of birds} \times 100$ ,

Five birds were randomly selected from each of the replicates for carcass analysis. The selected birds were starved overnight and their live weights recorded. The birds were slaughtered by severing the jugular vein and were fully bled before scalding in hot water. The birds were de-feathered after scalding and their plucked weights were taken. The birds were eviscerated and the eviscerated weight recorded. The dressed

weights, thigh weights, drumsticks and organ (liver, heart and gizzard) weight were expressed as percentage of live weight.

***Haematological and serological characteristics of the experimental birds***

At the end of the 8week, blood samples were collected from the birds for hematological studies by the technique of John and Lewis (1991). The birds were bled by the wing vein using hypodermic needle with syringe. One into a container with ethylene diamine tetra acetic acid (EDTA) as an anti-coagulant while the other for serum collection had no anti-coagulant. The parameters measured were red blood cell, packed cell volume, hemoglobin and white blood cell. Serum biochemical indices investigated include total protein, globulin, albumin, and albumin: globulin ratio, glucose cholesterol and creatinine.

***Statistical analysis***

All data collected on performance and blood indices of broiler chicks were subjected to analysis of variance using SAS, statistical package, SAS (1999) and significant means were separated using Duncan multiple range test of the same software.

**Results**

The gross composition of the starter and finisher diets is as shown in Tables 1 and 2. Result of performance of the birds is shown in Table 3. There were significant ( $p < 0.05$ ) differences in feed intake between birds on the control and RCBS supplemented diets. Birds fed the control diet (A) had the highest feed intake of 4556.50g compared to those fed diets D and E with means of 4177.50g and 4097.00g respectively. However, the final weight revealed that bird fed diet A (control diet) had the highest weight (1952.00g), while birds on the diet E has the lowest (1550.00). The weight gain and feed conversion ratio of bird fed the RCBS based diets were significantly ( $p > 0.05$ ) different from their contemporary on the control diets (A). The FCR revealed that birds on diets E had the highest significant value of 2.81. As the level of inclusion of RCBS in the diet increases the feed conversion also increases. The mortality rate was highest with the bird fed with diet containing 20 % RCBS, this shows that the highest tolerable level of raw cocoa bean shell is 10%.

**Table 1: Gross composition of experimental broiler starter diets**

<b>Ingredients (kg)</b>	<b>A (0%)</b>	<b>B (5%)</b>	<b>C (10%)</b>	<b>D (15%)</b>	<b>E (20%)</b>
Maize	57.00	54.15	51.30	48.45	45.60
Cocoa Bean Shell (CBS)	-	2.85	5.70	8.55	11.40
Soybean meal	33.51	33.51	33.51	33.51	33.51
Fishmeal 72%	1.00	1.00	1.00	1.00	1.00
Full fat Soya	4.10	4.10	4.10	4.10	4.10
Oyster shell	0.50	0.50	0.50	0.50	0.50
Bone meal	3.30	3.30	3.30	3.30	3.30
Methionine	0.04	0.04	0.04	0.04	0.04
Salt	0.30	0.30	0.30	0.30	0.30
Premix	0.025	0.025	0.025	0.025	0.025
Total	100.00	100.00	100.00	100.00	100.00
<b>CALCULATED NUTRIENTS</b>					
Crude Protein (%)	23.21	23.41	23.62	23.83	24.04
Metabolisable Energy (Kcal/kg)	2951.62	2925.57	2899.52	2873.47	2847.40
Crude Fibre (%)	4.01	4.34	4.66	4.99	5.35

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**Table 2: Gross composition of experimental broiler finisher diets**

<b>Ingredients (kg)</b>	<b>A (0%)</b>	<b>B (5%)</b>	<b>C (10%)</b>	<b>D (15%)</b>	<b>E (20%)</b>
Maize	57.00	54.15	51.30	48.45	45.60
Cocoa Bean Shell (CBS)	-	2.85	5.70	8.55	11.40
Soybean meal	25.80	25.80	25.80	25.80	25.80
Palm kernel oil	2.47	2.47	2.47	2.47	2.47
Full fat Soya	10.00	10.00	10.00	10.00	10.00
Oyster shell	0.50	0.50	0.50	0.50	0.50
Bone meal	3.30	3.30	3.30	3.30	3.30
Methionine	0.08	0.08	0.08	0.08	0.08
Salt	0.30	0.30	0.30	0.30	0.30
Premix	0.025	0.025	0.025	0.025	0.025
Total	100.00	100.00	100.00	100.00	100.00
<b>CALCULATED NUTRIENTS</b>					
Crude Protein (%)	21.48	21.69	21.90	22.11	22.32
Metabolisable Energy (Kcal/kg)	3122.33	3096.28	3070.23	3044.18	3080.13
Crude Fibre (%)	3.81	4.14	4.47	4.80	5.12

Table 4 shows the carcass characteristics of broilers fed raw cocoa bean shell based diets. The live weight gain of birds on 5, 10, 15 and 20% RCBS were 1812.33, 1739.67, 1630.67 and 1550.67g respectively. Significant difference ( $p < 0.05$ ) were obtained in the values of plucked weight, eviscerated weight, visceral organ, dressed % while the values obtained for thigh, drumstick, gizzard and heart were not significantly different.

Results of the hematological and serum biochemistry are as shown in Table 5. The value obtained for total protein ranged from 5.40 - 5.65g/dl, while that of albumen ranged from 2.20 -2.80. The highest value for globulin were obtained from birds fed diet E (20%) and the least value obtained

from birds fed diet B (5%).Cholesterol values ranged from 157.00 -165.37, with the highest value obtained from birds on the control diets and the least from birds fed diet containing 20% RCBS. The glucose values ranged from 155.30– 159.20. Creatinine value obtained in this experiment ranged from 1.25 – 1.35. No significant different ( $p>0.05$ ) on the hematology of the birds. The RBC value ranges from  $2.35 \text{ mmx}10^6$  to  $2.57 \text{ mmx}10^6$  while the range of values for Hb was from 8.90% to 9.26%. The blood profile shows that although differences were observed in the performance of the birds fed different levels of supplemented CBS. The values for the blood profile were all within the recommended values of Mitruka and Rawnsley, 1977.

**Table 3: Performance characteristics of broilers fed raw cocoa bean shell based diet**

<b>Parameters</b>	<b>A (0%)</b>	<b>B (5%)</b>	<b>C (10%)</b>	<b>D (15%)</b>	<b>E (20%)</b>	<b>SEM</b>
Average feed Intake {g}	4556.50 <sup>a</sup>	4529.00 <sup>b</sup>	4200.50 <sup>c</sup>	4177.50 <sup>d</sup>	4097.00 <sup>e</sup>	2.33
Initial weight {g}	37.00	37.00	37.00	36.00	36.00	-
Final weight {g}	1952.00 <sup>a</sup>	1812.00 <sup>b</sup>	1739.00 <sup>c</sup>	1630.00 <sup>d</sup>	1550.00 <sup>e</sup>	7.34
Average weight gain {g}	1915.00 <sup>b</sup>	2076.56 <sup>a</sup>	1901.00 <sup>b</sup>	1806.00 <sup>c</sup>	1665.00 <sup>d</sup>	1.84
FCR	2.37 <sup>b</sup>	2.55 <sup>d</sup>	2.58 <sup>c</sup>	2.40 <sup>b</sup>	2.81 <sup>a</sup>	0.21
Mortality %	0.00	3.33	3.33	6.66	10.00	0.01

Note: Values with different letters on the same row are significantly ( $p>0.05$ ) different.

**Table 4: Carcass characteristics of broilers fed graded levels of raw cocoa bean shell based diets**

PARAMETERS	0% Control	5% RCBS	10% RCBS	15% RCBS	20% RCBS	SEM
Live weight(g)	1952.00 <sup>a</sup>	1812.33 <sup>b</sup>	1739.67 <sup>c</sup>	1630.67 <sup>d</sup>	1550.67 <sup>c</sup>	9.38
Plucked weight(g)	1752.00 <sup>a</sup>	1708.67 <sup>a</sup>	1489.67 <sup>b</sup>	1380.00 <sup>a</sup>	1360.67 <sup>c</sup>	9.15
Eviscerated weight (g)	1518.67 <sup>a</sup>	1493.33 <sup>a</sup>	1348.67 <sup>b</sup>	1280.33 <sup>b</sup>	1130.00 <sup>c</sup>	8.09
Visceral organ Dressed weight(g) %	233.33 <sup>a</sup>	200.00 <sup>b</sup>	150.00 <sup>d</sup>	146.67 <sup>c</sup>	176.67 <sup>c</sup>	8.56
Dressed %	1438.03 <sup>a</sup>	1286.88 <sup>b</sup>	1215.50 <sup>b</sup>	1116.67 <sup>c</sup>	1116.67 <sup>c</sup>	12.9
Breast %	73.67 <sup>a</sup>	71.02 <sup>a</sup>	69.90 <sup>a</sup>	67.00 <sup>b</sup>	69.07 <sup>a</sup>	1.23
Thigh %	23.00 <sup>a</sup>	23.00 <sup>a</sup>	22.00 <sup>a</sup>	21.00 <sup>b</sup>	19.80 <sup>b</sup>	2.34
Drumstick %	15.76	15.55	15.69	15.36	14.15	2.12
Heart %	14.99	14.50	14.50	14.00	14.00	1.52
<b>Organ weight</b>						
Gizzard %	3.24	3.08	3.36	3.41	3.59	0.88
Liver %	2.76 <sup>d</sup>	3.33 <sup>c</sup>	3.88 <sup>c</sup>	4.34 <sup>b</sup>	5.31 <sup>a</sup>	0.40
Heart %	0.68	0.66	0.66	0.62	0.61	0.12

a, b, c,d,e,; Means along the same rows with different superscripts are significant (P < 0.05)  
RCBS = Raw Cocoa Bean shell  
SEM=Standard Error of Means.

**Table 5: Serum biochemical Indices and hematological parameters of broilers fed raw cocoa bean shell based diet**

PARAMETERS	CONTROL	5%	10%	15%	20%	SEM
Total protein (g/dl)	5.59	5.55	5.45	5.40	5.65	0.05
Albumin (g/dl)	2.36 <sup>bc</sup>	2.80 <sup>a</sup>	2.60 <sup>ab</sup>	2.42 <sup>bc</sup>	2.20 <sup>c</sup>	0.05
Globulin (g/dl)	3.23 <sup>ab</sup>	2.75 <sup>b</sup>	2.84 <sup>bc</sup>	2.98 <sup>bc</sup>	3.45 <sup>a</sup>	0.08
Alb: Globulin	0.73 <sup>bc</sup>	1.02 <sup>a</sup>	0.91 <sup>ab</sup>	0.81 <sup>bc</sup>	0.64 <sup>c</sup>	0.04
Cholesterol (mg/dl)	165.37 <sup>a</sup>	165.25 <sup>a</sup>	165.10 <sup>a</sup>	161.75 <sup>b</sup>	157.00 <sup>c</sup>	4.83
Glucose (mg/dl)	158.72 <sup>as</sup>	158.08 <sup>a</sup>	159.20 <sup>a</sup>	159.20 <sup>a</sup>	155.30 <sup>b</sup>	1.93
Creatinine (mg/dl)	1.28	1.34	1.35	1.30	1.25	0.03
RBC (mm <sup>3</sup> X 10 <sup>6</sup> )	2.57	2.45	2.40	2.42	2.35	0.17
WBC (mm <sup>3</sup> X 10 <sup>3</sup> )	23.95 <sup>a</sup>	18.50 <sup>c</sup>	21.00 <sup>b</sup>	23.15 <sup>a</sup>	24.00 <sup>a</sup>	0.10
Hb (%)	9.10	9.16	9.26	9.00	8.90	0.39
PCV (%)	23.75	24.15	23.40	22.42	21.75	1.06

a ,b, c; Means along the same row with different superscripts are significant (P < 0.05)  
RCBS = Raw Cocoa Bean Shell  
RBC =Red Blood Cell Count  
WBC =White Blood Cell Count  
Hb =Hemoglobin  
PCV =Packed Cell Volume  
SEM = Standard Error of Means.

## Discussion

The feed intake of broiler on the control diet and on the graded levels of raw cocoa bean shell was apparent and this may point to the inability of the broilers to utilize or handle anti-nutritional factors in the CBS-based diets. This could be due to decreasing acceptability, due to the increased in the CBS. The mean voluntary feed intake value however conformed to the

recommendations for broilers (Oluyemi and Robert, 1979). Birds on the control diet had the highest average feed intake value while the least was recorded for birds on diet containing 20% RCBS. Tion *et al.* (2005) however reported that the feed intake of broilers increased as the dietary protein level decreased. There were outstanding reductions in the average gain as the levels of substitution of RCBS for maize in the

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diets increased, this could be explained by the content of residual anti nutritional factors in the raw CBS used as substitutes for maize in the ration formulation. Raw lima bean fed to rat depressed weight gain as a consequence of impaired digestion and absorption of dietary carbohydrate as well as marked alterations in the normal activities of certain hepatic and extra-hepatic enzymes. (Aletor and Fetuga, 1984) The effect was also attributed to the anti-nutritional factors in lima-bean. Depressed growth rate and apparent retention of dry matter, crude protein and crude fiber with 15% shea butter cake inclusion in broilers diet, compared with 5 and 10% inclusion levels was also reported. Olorode *et al.*, (1996) Aderemi *et al.*, (1999) reported that cassava root sieviate is rich in non-soluble polysaccharides (NSP), a characteristic that could reduce its utilization. The higher average weight gain of the birds on control diet than those on all RCBS based diets could be explained by the relatively low crude fiber level and either extract value of the control diet compared with the CBS based diets. In addition to the effect of the CF which increased with increase in substitution level of CBS for maize, it could also be the effect of anti-nutritional factors, that could have affected weight gain. Decnypere *et al.* (1992) however observed slight increase in dietary protein levels under hot and humid tropical conditions were beneficial for growth rate and feed efficiency in broilers. When a low dietary energy feed, are fed, bird may not meet energy requirement. This could result in poor performance in terms of gains and carcass yield. At high dietary energy birds accumulate more fat. (Gardiner, 1971) Increasing the contents of fibre in diets has a negative linear effect on body weight (Zaczek *et al.*, 2003). The CBS may be deficient in some amino acid and mineral,

since the substitution of CBS for maize was on weight basis. This deficiency could have had its negative effect on weight gain of the birds on CBS-based diet. The profit obtained from broilers depends on the carcass quantity and feed conversion or feed efficiency ratio. A lower value of feed conversion ratio (FCR) is an indication of better performance and feed conversion into flesh. There were significant variations in FCR of the birds fed RCBS diets as the feed conversion was acceptable up to 15% inclusion levels. The FCR of the broilers on control diet (2.37) and those on various levels of RCBS based diets were lower than the range 3.27-4.03 (Oyewola *et al.*, 2002) 3-67-5.97 (Adetunji and Ologhobo, 1999).

The values, however, compared favorably with 2.84-5.97 (Adetunji *et al.*, 1997) and 3.34-3.65 (Akpodiete *et al.*, 1997). Apparent differences in the values recorded by these authors and to the present study could be caused by differences in the ingredients used in ration formulation, breed of birds, site of experimentation whether tropic or temperate.

The highest mortality value was obtained from birds fed 20% RCBS based diets, this could be traced to the level of theobromine in the diet.

It was observed that as the level of substitution of maize with CBS increased the percentage mortality increased. The increase in the percentage mortality was in line with the findings of Olubamiwa *et al.* (2000) Owusu-Domfeh (1972) that inclusion of CBS in the diet of birds beyond 10% caused mortality, while differences exist in the live weight of birds fed graded levels of RCBS based diets. Hunton, (1972) identified nutrition, age, sex, environment, stage of development, efficiency of feed as determinants of carcass quality. He observed that high energy diets promote more rapid

growth and better utilization of feed than low energy diets. Significant differences exist, in the live weight of birds feed graded levels of RCBS based diets.

Birds on the control diet had a live weight of 1952.00 g while those on the various levels of RCBS were 1812.33g, 1739.67g 1630.67g and 1550.67g. As the level of substitution of CBS for maize increased the lives weight decreased. The plucked weight in this study did not follow any particular trend, however, the notable lower eviscerated weight and dressed weights of broilers on 10 and 15% RCBS and were due to the treatment effect Reports (Bartov and Bornstein, 1976), depicted multifactor influencing carcass yield which dietary quality and composition as prominent in influencing carcass yield as observed in this study (Whitehead, 1990, Johnson and McNabb, 1983).

The dressing-out percentage values ranged from 67.00 to 73.67%. The highest dressed percentage was obtained from birds on the control diet (73.67%). The value was lower than the range 77.33-83.00 (Akpodiete *et al.*, 1997) but fall within the range 60.30-74.65 recommended for broiler chickens (Bamgbose and Niba, 1998). Apparent differences in the values of thigh and drumstick percentage were not significant. Variations in the size of the gut have been associated with the amount of fibre consumed by birds in the process of meeting their energy requirement. The increase in the size of gizzard observed with increases in levels of substitution of CBS for maize in the diet could be explained by the increase in dietary fibre as the higher the crude fiber the lower the digestibility of a diet (Eggum *et al.*, 1982). Increase in fibre intake could increase gut and gizzard size with fibre intake as reported elsewhere (Summers and Leeson, 1986, Savory and Gentle, 1973, Akinola and Abiola, 1999) for cockerels

fed on 30% melon husk diet having dietary crude fibre as in this study. The percentage weights of liver and gizzard of the birds on CBS-based diets were however, higher than range of 2.57-2.65% and 2.40- 2.46% respectively for broilers fed maggot meal (Akpodiete *et al.*, 1997). Variations observed in the liver percentage 0.47-0.68 were excellent, as the level of substitution of CBS for maize increased the liver percentages increased. Summer and Leeson, (1986) and Yamashita *et al.*, (1975) however observed that high dietary fibre level could be linked with lower abdominal fat and decreased liver weight.

Biochemical and haematological estimations are used as valuable aids for diagnosis in veterinary medicine (Akinola and Abiola, 1999) Serum protein can be used diagnostically and prognostically in estimation of liver and kidney diseases. Total protein is an indication of the protein reserve in an animal (Akinmutimi, 2000). Apparent variations in the values obtained for total protein, creatinine, RBC and PCV for the RCBS were not significant. This could indicate the suitability of CBS as a substitute for maize in the diets of broiler chickens. That, differences in serum total protein were not significant suggest adequacy of dietary protein and its efficient utilization in the test diets.

The serum total protein values of 5.20-6.90g/dl (Mitruka and Rawnsley, 1977) , 3.40-4.10 g/dl (Akinmutimi, 2000) and 5.10-6.95g/dl compared favorably with the values of 5.59g/dl (control) 5.40-5.65g/dl for birds on RCBS-diets obtained in this study.

The red blood cell count, packed cell volume and hemoglobin did not follow same trend in this study. This white blood cell count (WBC) and globulin consistently increased with increase in the level of substitution of CBS for maize in

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the diets. The apparent increases, in the values of globulin and WBC with increase in dietary substitution of CBS for maize could be explained by an increased need to challenge a foreign body, or anti-nutritional factors would have elicited responses of globulin and white blood cell count (antibodies) for defence. Thus, the increase in these two parameters was a response to defend the body from the effect of increased test ingredient (CBS). The cholesterol level of control which was higher than those of all CBS based diets and the decreasing of cholesterol with increasing substitution of CBS for maize in the diets could be explained by the presence and increasing contents of anti-nutritional factors as the level of substitution increased. This agrees with the findings of Potter *et al.* (1979), Oakenful (1981) and Michael (2005) that anti-nutritional factor (Saponins) assert a physiological effect on lowering the level of plasma cholesterol concentration in experimental animals. The cholesterol contents (mg/dl) of serum from birds fed the control diet (165.37), RCBS (149.50-158.76) fell within the values of 135.33+ 11.22- 149.00+ 3.79 and 52 - 148mg/dl respectively reported for chickens by Akinola and Abiola (1999) and Mitruka and Rawnsley (1977).

However, a range of 84-94mg/dl recorded for broilers fed maggot meal by Akpodiete and Okagbare (2002) was lower than the values obtained in the present study. Although dietary fibers have been reported to lower blood cholesterol, total lipids and blood glucose (Hale *et al.*, 1986); Dietary fibre and Resistant Starch, 2001; Requirement of non-human primates, 2003). Moreover, Donnica (2000) and Dietary fibre and Resistant Starch (2001) specifically identified soluble dietary fibre (B-glucans) as capable of achieving this. These soluble fibers were found to be

capable of slowing digestion and absorption of carbohydrates thereby lowering blood glucose and insulin responses.

Variations observed in the values of serum glucose were apparent, as the level of substitution of CBS for maize increased the glucose level in the serum increased, this indicates available energy for the birds, the value obtained for the control were significantly different from those obtained from CBS based diet. The value obtained of the serum glucose for the birds on the control diet were 158.72 mg/dl, 155.30-158.08 for graded levels of cocoa bean shell. Creatinine points to extent of muscular activity and the levels of creatinine (mg/dl) of control 1.28, RCBS (1.25-1.35) falls within 0.90-1.85 report for chicken by Mitruka and Rawnsley (1977). The creatinine levels in this study increase with level of substitution of CBS for maize in response to increased anti-nutritional factors. This is in line with the findings of Eggum (1980) in which high creatinine indicated a high degradation of muscle phosphocreatine to form creatine.

### **Conclusion**

The non-significant variations observed in the RBC, PCV and hemoglobin values in the present study was an indication that the contents of anti-nutritional factors in CBS based diets did not precipitate inadequacy of nutrients which could create an anemic condition. It can therefore be concluded that broiler can effectively consume RCBS up to 10% inclusion in the diet without compromising the performance and the health status of the birds.

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